

# Breast Cancer Prediction by Machine Learning Algorithms - A Comparative Study of Naive Bayes, KNN and J48 in Weka Environment

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## Abstract

Breast cancer is considered one of the most common cancers occurring in women. Each year, it affects 2.1 million women, causing cancer-related deaths. As per the estimation, breast cancer took the lives of 627,000 women in 2018 alone. The disease is mostly observed in the developed areas of the world, with current rates expanding in almost every region across the world. The role of predicting cancer is crucial for the further progress of data mining tools currently available. K-nearest neighbor, J48 algorithm, and Naive Bayes are applied to predict cancer disease. For acquiring an extensive dataset, Naive Bayes is very helpful and easy to design. K-nearest neighbor produces a dataset, separating it into distinct categories. It predicts new points in the classification. Grounded on the Decision Tree, J48 Classifier uses such facts from the datasets of training, which can be utilized to decide the minor subsection. To measure the precision of the cancer dataset, the Weka tool can be applied. Its dataset encompasses nine kinds of cancer. A 70% train and 30% test data set split has been utilized to predict the cancer disease. The exactness of Naive Bayes is 91.81%, whereas the identity of J48 and K-nearest neighbor is respectively 92.98% and 97.07%.

## Keywords

Breast Cancer, K-nearest neighbor, j48 algorithm, Naive Bayes

## 1. Introduction

### 1.1. Background

Early diagnosis is essential to enhance the results and survival rates of breast cancer. There are two strategies for early detection of breast cancer, including screening and early diagnosis. The settings with limited resources and poor health organizations where most women are detected in advanced stages must focus on the early detection programs grounded on the consciousness of early symptoms and quick recommendations for analysis and treatment. Screening comprises assessing women for identifying the risks of cancer before the appearance of symptoms. These screening tools include breast self-exam, clinical breast exam, and mammography. Since it requires significant investment, the decision to continue with the screening procedure should be made following fundamental breast health amenities that include efficient detection and appropriate treatment. Early diagnosis involves delivering apt access to cancer treatment by decreasing the barriers that come before enhancing access to proper diagnosis services. The purpose is to study the comparison of Naive Bayes, KNN, and J48 classifier accuracy in predicting the proportion of breast cancer identification in the early phases [5, 12]. Cancer is a genetic disorder that happens due to the alterations to the genes and the sudden expansion of cells and division. Metastatic cancer is when the cancer cells spread to another place

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CVMLH-2022: Workshop on Computer Vision and Machine Learning for Healthcare, April 22 – 24, 2022, Chennai, India.

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CEUR Workshop Proceedings (CEUR-WS.org)

# **CVMLH-WTEK 2022**

## **Joint Proceedings of CVMLH 2022 and WTEK 2022**

**Joint Proceedings of the Workshop on Computer Vision and Machine Learning for Healthcare (CVMLH 2022) and the Workshop on Technological Innovations in Education and Knowledge Dissemination (WTEK 2022)**  
**Co-located with TOOTILL 100 - 6th International Conference on Computing Sciences (ICCS 2022)**

**Hybrid Event, Chennai, India, April 22 – 24, 2022.**

**Workshop on Computer Vision and Machine Learning for Healthcare (CVMLH 2022)**

**Edited by**

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**Workshop on Technological Innovations in Education and Knowledge Dissemination (WTEK 2022)**

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## Table of Contents

### Workshop on Computer Vision and Machine Learning for Healthcare

- [Preface](#)  
 Summary: There were 14 papers submitted for peer-review to this workshop. Out of these, 7 papers were accepted for this volume
- [Human Skin Disease Detection using MLXG Model](#) 01-14  
*Dhruv Dodia, Hemangi Jakharia, Ritik Soni, Shwetambari Borade, Nilakshi Jain*
- [Performance Measurement of Prostate Gland Segmentation Approaches in Transrectal Ultrasound and Magnetic Resonance Images](#) 15-25  
*Kiran Ingale, Pratibha P. Shingare, Mangal M. Mahajan, Pushkar S. Joglekar*
- [Chest X-Ray based Lung Disease Detection using Convolutional Neural Network](#) 26-32  
*Saravanan. M, Manoj Kumar, Dilsha Vijay, Gayathri. K, Jenifar. A*
- [A Classification Approach to Fetal Cardiotocography Dataset using R](#) 33-40  
*R. Hephzibah, A. Hephzibah Christinal, R. Jayanthi, S. Jebasingh, D. Abraham Chandy, Chandrajit Bajaj*
- [Brain Anomalies of MRI Segmentation](#) 41-46  
*R. Jayanthi, A. Hephzibah Christinal, R. Hephzibah, D. Abraham Chandy, T. Shekinah*
- [Breast Cancer Prediction by Machine Learning Algorithms - A Comparative Study of Naive Bayes, KNN and J48 in Weka Environment](#) 47-53  
*Trishit Banerjee, Geetha Ganesan*
- [Various intelligent approaches for classification using CT-scan images: A Systematic Literature Review](#) 54-61  
*Ritika Mahajan, Amritpal Singh, Aman Singh*

### Workshop on Technological Innovations in Education and Knowledge Dissemination

- [Preface](#)  
 Summary: There were 9 papers submitted for peer-review to this workshop. Out of these, 3 papers were accepted for this volume
- [Emotional Intelligence and its Relationship with Academic Stress, in High School Students, An Approach to the Computational Model](#) 62-69  
*Wilfredo Meza, Wilver Aucchuasi, Jhon Obispo, Sandra Meza, Monica Caipo, Karin Rojas, Oscar Linares, Tamara Pando-Ezcurra, Miryam Cosme*
- [Methodological Study on Civic Attitudes of Spanish-Speaking Students: Middle School Level](#) 70-76  
*Herrera Betty Pozo Sánchez, Wilver Aucchuasi, Francisco Hilario, Sandra Meza, Mercedes Evangelina López Almeida, Ana María Valencia Romero, Emigia Violeta Retamozo Cuellar, Karin Rojas, Oscar Linares, Tamara Pando-Ezcurra, Miryam Cosme*

- [The Application of Artificial Intelligence in Online Teaching Tools, appertained during the Pandemic period for effective and uninterrupted teaching](#)

77-82

*K. Deepa, K. Aruna, G. Gomathi Jawahar, Hepzibah Christinal, Sunanda Bhagavathi, K. Amudha*

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2023-02-05: submitted by Geetha Ganesan, metadata incl. bibliographic data published under [Creative Commons CC0](#)

2023-02-06: published on CEUR Workshop Proceedings (CEUR-WS.org, ISSN 1613-0073) [[valid HTML5](#)]

## CHAPTER 9

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# Social, Professional, Ethical, and Security Issues Associated with IoMT and Smart Healthcare: Post-COVID-19 Pandemic Scenario

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### ABSTRACT

The IoMT has gained high levels of notoriety in the modern world with advanced solutions being deployed in multiple treatment facilities along with care units. The methodology used in this research work is that existing scholarly articles with various case studies have been researched to bring out information about the topic. The secondary data researched will account for an inclination to the qualitative form of research, which will make the approach deal more in non-numerical data. This qualitative form of research will be backed by a further descriptive representation of the same in this research. The overall representation will thus blend the findings of various research works, bringing out a compilation of significant information about the topic. The information brought out in this research will be made subject to further critical analysis as a part of the preparation of this research work. The issues found in this research work is that the healthcare domain has been revamped to a great extent due to the introduction of such facilities

# **INTERNET OF MEDICAL THINGS IN SMART HEALTHCARE**

Post-COVID-19 Pandemic Scenario

*Edited by*

**Saravanan Krishnan, PhD  
Aboobucker Ilmudeen, PhD**

**AAP** | APPLE  
ACADEMIC  
PRESS

First edition published 2024

**Apple Academic Press Inc.**

1265 Goldenrod Circle, NE,  
Palm Bay, FL 32905 USA

760 Laurentian Drive, Unit 19,  
Burlington, ON L7N 0A4, CANADA

**CRC Press**

2385 NW Executive Center Drive,  
Suite 320, Boca Raton FL 33431

4 Park Square, Milton Park,  
Abingdon, Oxon, OX14 4RN UK

© 2024 by Apple Academic Press, Inc.

*Apple Academic Press exclusively co-publishes with CRC Press, an imprint of Taylor & Francis Group, LLC*

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Trademark notice: Product or corporate names may be trademarks or registered trademarks and are used only for identification and explanation without intent to infringe.

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**Library and Archives Canada Cataloguing in Publication**

Title: Internet of medical things in smart healthcare : post-COVID-19 pandemic scenario / edited by Saravanan Krishnan, PhD, Aboobucker Ilmudeen, PhD.

Names: Saravanan, Krishnan, 1982- editor. | Ilmudeen, Aboobucker, editor.

Description: First edition. | Includes bibliographical references and index.

Identifiers: Canadiana (print) 20230471951 | Canadiana (ebook) 20230471978 | ISBN 9781774913253 (hardcover)

| ISBN 9781774913260 (softcover) | ISBN 9781003369035 (ebook)

Subjects: LCSH: Internet in medicine.

Classification: LCC R859.7.I58 I58 2024 | DDC 610.285—dc23

**Library of Congress Cataloging-in-Publication Data**

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CIP data on file with US Library of Congress

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ISBN: 978-1-77491-325-3 (hbk)

ISBN: 978-1-77491-326-0 (pbk)

ISBN: 978-1-00336-903-5 (ebk)

# Contents

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<i>Contributors</i> .....	<i>ix</i>
<i>Abbreviations</i> .....	<i>xi</i>
<i>Preface</i> .....	<i>xv</i>
<b>1. IoMT-Based Telemedicine Monitoring Machine for COVID Patients .....</b>	<b>1</b>
T. Kesavan, E. Kaliappan, S. Sivaranjani, K. Rameshkumar, and P. Kathirvel	
<b>2. COVID-19 Detection Using Convolutional Neural Networks from Chest X-Ray Images .....</b>	<b>11</b>
Mandipalli Sai Preethi, Banala Rajitha, Kusa Sushmi Reddy, Bantu Kovala, and Santhosh Kumar Veeramalla	
<b>3. An AI-Powered IoMT Model for Continuous Remote Patient Monitoring using COVID Early Warning Score (CoEWS).....</b>	<b>39</b>
Sakthi Jaya Sundar Rajasekar, Swarnalingam Thangavelu, and Varalakshmi Perumal	
<b>4. Automatic Intravenous Fluid and Health Monitoring using an IoT System.....</b>	<b>57</b>
S. Sabena, K. Selvakumar, and L. Sai Ramesh	
<b>5. Hygieia: Multipurpose Healthcare Assistance Using the Internet of Things .....</b>	<b>77</b>
Jose Anand and R. Dhanalakshmi	
<b>6. Edge Computing and Artificial Intelligence Systems Adopted in Smart Healthcare: A Comprehensive Survey in Real-Time COVID-19 Pandemic .....</b>	<b>99</b>
K. Saravanan and G. Lakshmi Prabha	
<b>7. Decision Support and Knowledge Representation in Healthcare .....</b>	<b>119</b>
C. Muralidharan, Y. Mohamed Sirajudeen, and R. Somasundaram	
<b>8. Roadmap of AI and IoMT in Smart Healthcare: Current Applications and Future Perspectives .....</b>	<b>137</b>
Swamynathan Ramakrishnan, S. Jijitha, and T. Amudha	

<b>9. Social, Professional, Ethical, and Security Issues Associated with IoMT and Smart Healthcare: Post-COVID-19 Pandemic Scenario.....</b>	<b>163</b>
Trishit Banerjee	
<b>10. Smart Healthcare: Impacts, Implications, and Challenges for Future Healthcare Delivery.....</b>	<b>183</b>
Kunal Rawal, Anushree Acharya, and Shweta Soni	
<b>11. IoMT-Based Caring System for Aged People in a Post-COVID Scenario.....</b>	<b>207</b>
A. Ponmalar and Jose Anand	
<b><i>Index</i>.....</b>	<b>225</b>

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# Introduction to Operations Research Methodologies

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The domain of operational research involves various techniques applied for complex problem-solving and arriving at decisions. Operations research methodologies are applied by organizations to solve real-life problems, as they assist in managing all operations efficiently. Hence, operations research has emerged as a scientific method for problem-solving by engaging quantitative information for enhanced decision-making methodologies of operations research including probability, statistics, simulation and optimization. This study provides an introduction to the use of methods from operations research in scientific decision-making, design, analysis and management. It also includes a guide to using these approaches. The objective of this project was to produce a text that is both comprehensible and practical. An in-depth investigation into the mathematical models and the tried-and-true and cutting-edge approaches to problem-solving that lie at the foundation of today's software tools for quantitative research and deliberation has yielded insights that are both theoretically sound and practically applicable. While probability and statistics enable us to arrive at predictable solutions applicable in risk scenarios by applying mathematical algorithms, simulation allows the construction of models for solution testing before applying them. Optimization allows us to achieve optimum results within a given condition. Arriving at suitable solutions using operations research follows several steps by way of problem identification, construction of the mathematical model, deriving solutions from the model constructed, testing of the model, establishing control over solutions and finally arriving at the solution to implement them. The scope of this chapter will explore all such methodologies in detail and evaluate concepts that can be reliably applied in cases of smart edge computing.

## 1.1. Introduction

The use of quantitative techniques for the purpose of assisting analysts and decision-makers in the process of creating, assessing and improving the performance

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# Contents

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<b>Preface</b> . . . . .	xiii
Rajdeep CHAKRABORTY	
<b>Acknowledgments</b> . . . . .	xvii
<b>Chapter 1. Introduction to Operations Research Methodologies</b> . . . . .	1
Trishit BANERJEE and Arup DASGUPTA	
1.1. Introduction . . . . .	1
1.2. Decision-making framework/models for operations research . . . . .	3
1.3. Operations research in IoT, IIoT, edge and smart edge computing, sensor data. . . . .	8
1.4. Paradigms and procedures . . . . .	11
1.5. Conclusion . . . . .	18
1.6. References . . . . .	19
<b>Chapter 2. Edge Computing: The Foundation, Emergence and Growing Applications</b> . . . . .	25
P.K. PAUL	
2.1. Introduction . . . . .	25
2.2. Objective of the work . . . . .	27
2.3. Methods adopted. . . . .	27
2.4. Edge computing and edge cloud: basics . . . . .	27
2.5. Edge computing and edge devices . . . . .	29
2.6. Edge computing: working fashions, buying and deploying and 5G . . . . .	29
2.7. Functions and features of edge computing . . . . .	30
2.7.1. Privacy and security . . . . .	30
2.7.2. Scalability . . . . .	30
2.7.3. Reliability . . . . .	30

2.7.4. Speed . . . . .	31
2.7.5. Efficiency . . . . .	31
2.7.6. Latency and bandwidth . . . . .	31
2.7.7. Reduction in congestion . . . . .	32
2.8. Edge computing: applications and examples . . . . .	32
2.8.1. Self-managed and automated cars/vehicles . . . . .	33
2.8.2. Fleet management . . . . .	34
2.8.3. Predictive maintenance . . . . .	34
2.8.4. Voice assisting systems . . . . .	35
2.8.5. Smart cities and town planning . . . . .	35
2.8.6. Manufacturing and core sector . . . . .	35
2.8.7. Healthcare and medical segment . . . . .	36
2.8.8. Edge computing and augmented reality . . . . .	37
2.9. Drawbacks, obstacles and issues in edge computing . . . . .	38
2.10. Edge computing, cloud computing and Internet of Things: some concerns . . . . .	39
2.11. Future and emergence of edge computing . . . . .	41
2.12. Conclusion . . . . .	42
2.13. Acknowledgment . . . . .	43
2.14. References . . . . .	43

<b>Chapter 3. Utilization of Edge Computing in Digital Education: A Conceptual Overview . . . . .</b>	<b>47</b>
Ritam CHATTERJEE	

3.1. Introduction . . . . .	47
3.2. Objectives . . . . .	48
3.3. Methodology used . . . . .	49
3.4. Digital education . . . . .	49
3.4.1. Emerging technologies in digital education . . . . .	49
3.5. Education and information science . . . . .	49
3.6. Edge computing . . . . .	51
3.6.1. Edge computing promotes education and information science . . . . .	51
3.6.2. Conceptual overview of edge computing in education . . . . .	52
3.6.3. Conceptual diagram of edge computing in education . . . . .	53
3.6.4. Concept of communication between different layers of edge computing in education . . . . .	55
3.6.5. Diagram of communication between different layers of edge computing in education . . . . .	56
3.6.6. Stakeholder of edge computing in digital education . . . . .	56
3.6.7. Advantages of edge computing in digital education . . . . .	56
3.6.8. Challenges of edge computing in digital education . . . . .	60

3.7. Conclusion . . . . .	61
3.8. Acknowledgment . . . . .	61
3.9. References . . . . .	61

**Chapter 4. Edge Computing with Operations Research Using IoT Devices in Healthcare: Concepts, Tools, Techniques and Use Cases . . . . . 65**

Shalini RAMANATHAN, Mohan RAMASUNDARAM, Tauheed KHAN MOHD and Anabel PINEDA-BRISENO

4.1. Overview . . . . .	66
4.2. The smartness of edge across artificial intelligence with the IoT . . . . .	68
4.2.1. Operations research in edge computing . . . . .	69
4.2.2. Artificial intelligence and its innovative strategy . . . . .	70
4.2.3. Machine learning and its potential application . . . . .	70
4.2.4. Deep learning and its significance . . . . .	70
4.2.5. Generative adversarial network and healthcare records . . . . .	71
4.2.6. Natural language processing and its driving factors . . . . .	72
4.2.7. Cloud-based intelligent edge computing infrastructure . . . . .	73
4.2.8. Handling security and privacy issues . . . . .	74
4.3. Promising approaches in edge healthcare system . . . . .	74
4.3.1. Software adaptable network . . . . .	74
4.3.2. Self-learning healthcare IoT . . . . .	76
4.3.3. Towards Big Data in healthcare IoT . . . . .	76
4.4. Impact of smartphones on edge computing . . . . .	77
4.4.1. Use in clinical practice . . . . .	77
4.4.2. Application for healthcare professionals . . . . .	78
4.4.3. Edge computing in cutting edge devices . . . . .	78
4.4.4. Robust smartphone using deep learning . . . . .	80
4.4.5. Smartphone towards healthcare IoT . . . . .	81
4.5. Tools, techniques and use cases . . . . .	84
4.5.1. Smart self-monitoring healthcare system . . . . .	84
4.5.2. Healthcare development tools . . . . .	87
4.5.3. Simple use cases . . . . .	88
4.6. Significant forthcoming of edge healthcare IoT . . . . .	89
4.7. Software and hardware companies developing healthcare tools . . . . .	90
4.8. Summary . . . . .	90
4.9. References . . . . .	91

**Chapter 5. Performance Measures in Edge Computing Using the Queuing Model . . . . . 97**

Shillpi MISHRA

5.1. Introduction . . . . .	97
-----------------------------	----

5.2. Methodology . . . . .	100
5.2.1. Queuing theory on edge computing . . . . .	101
5.2.2. Result . . . . .	104
5.3. Conclusion . . . . .	109
5.4. Future scope . . . . .	109
5.5. References . . . . .	109

**Chapter 6. A Smart Payment Transaction Procedure by Smart Edge Computing . . . . . 113**

Animesh UPADHYAYA, Koushik MUKHOPADHYAY, Amejul ISLAM,  
Shaon Kalyan MODAK and Debdutta PAL

6.1. Introduction . . . . .	113
6.2. Related works . . . . .	115
6.3. Ethereum . . . . .	116
6.3.1. Ethereum's four stages of development. . . . .	117
6.4. Ethereum's components. . . . .	118
6.4.1. P2P network . . . . .	118
6.4.2. Consensus rules . . . . .	119
6.4.3. Transactions . . . . .	119
6.4.4. State machine . . . . .	119
6.4.5. Data structures . . . . .	119
6.4.6. Consensus algorithm . . . . .	120
6.4.7. Economic security . . . . .	120
6.4.8. Clients . . . . .	120
6.5. General-purpose blockchains to decentralized applications (DApps) . . . . .	120
6.6. Ether currency units . . . . .	121
6.7. Ethereum wallet . . . . .	121
6.7.1. MetaMask . . . . .	122
6.7.2. Jaxx . . . . .	122
6.7.3. MyEtherWallet (MEW) . . . . .	122
6.7.4. Emerald Wallet . . . . .	122
6.8. A simple contract: a test Ether faucet . . . . .	123
6.9. Ethereum clients . . . . .	125
6.9.1. Hardware requirements for a full node . . . . .	126
6.9.2. Advantages and disadvantages of full node. . . . .	127
6.9.3. The advantages and disadvantages of public testnet . . . . .	128
6.10. Conclusion . . . . .	129
6.11. References . . . . .	129

<b>Chapter 7. Statistical Learning Approach for the Detection of Abnormalities in Cancer Cells for Finding Indication of Metastasis. . . . .</b>	<b>133</b>
Soumen SANTRA, Dipankar MAJUMDAR and Surajit MANDAL	
7.1. Introduction . . . . .	133
7.2. Edge computation: a new era . . . . .	137
7.3. Impact of edge computation in cancer treatment . . . . .	138
7.4. Assessment parameters operational methodologies. . . . .	139
7.5. Shape descriptor analysis: statistical approach . . . . .	141
7.6. Results and discussion. . . . .	141
7.7. Conclusion . . . . .	145
7.8. References . . . . .	146
<b>Chapter 8. Overcoming the Stigma of Alzheimer’s Disease by Means of Natural Language Processing as well as Blockchain Technologies . . . . .</b>	<b>149</b>
Kaveri BANERJEE, Priyanka BHATTACHARYA, Sandip ROY and Rajesh BOSE	
8.1. Introduction . . . . .	150
8.2. Alzheimer’s disease . . . . .	152
8.3. Alzheimer’s disease types. . . . .	153
8.4. NLP in chat-bots/AI companions. . . . .	155
8.5. Proposed methodologies for reduction of stigma . . . . .	158
8.5.1. Proposed methodology using NLP . . . . .	158
8.5.2. Model objective function of Alzheimer’s disease . . . . .	159
8.6. Blockchain technology for securing all medical data. . . . .	160
8.6.1. Blockchain strategies for data privacy in healthcare. . . . .	163
8.6.2. Application of blockchain technologies. . . . .	164
8.6.3. Blockchain application intended for EHR data management . . . . .	165
8.6.4. Issues with blockchain security and privacy . . . . .	166
8.6.5. Challenges faced by blockchain applications. . . . .	167
8.7. Conclusion . . . . .	170
8.8. Future scope . . . . .	170
8.9. Acknowledgments . . . . .	171
8.10. References . . . . .	171
<b>Chapter 9. Computer Vision-based Edge Computing System to Detect Health Informatics for Oral Pre-Cancer . . . . .</b>	<b>175</b>
Animesh UPADHYAYA, Vertika RAI, Surajit BOSE, Dipankar BHATTACHARYA and Jayanta CHATTOPADHYAY	
9.1. Introduction . . . . .	175
9.2. Related works . . . . .	177
9.3. Materials and methods . . . . .	177
9.3.1. Microscopic imaging . . . . .	177
9.3.2. Proposed methodology . . . . .	178

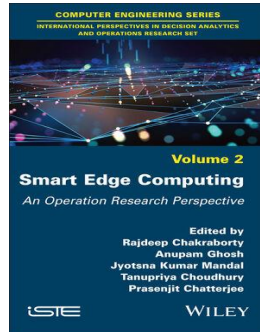
9.3.3. RGB color segmentation . . . . .	179
9.4. Results . . . . .	183
9.5. Conclusion . . . . .	185
9.6. References . . . . .	186
<b>Chapter 10. A Study of Ultra-lightweight Ciphers and Security Protocol for Edge Computing.</b> . . . . .	189
Debasmita PAUL, Aheli ACHARYA and Debajyoti GUHA	
10.1. Introduction . . . . .	189
10.1.1. Evolution of the IoT. . . . .	190
10.1.2. Content of the review work. . . . .	190
10.2. Ultra-lightweight ciphers . . . . .	192
10.2.1. SLIM . . . . .	193
10.2.2. Piccolo . . . . .	196
10.2.3. Hummingbird . . . . .	199
10.2.4. Comparison between SLIM, Piccolo and Hummingbird ciphers . . . . .	202
10.3. Ultra-lightweight security protocols . . . . .	203
10.3.1. Lightweight extensible authentication protocol (LEAP). . . . .	203
10.3.2. MIFARE . . . . .	207
10.3.3. Remote frame buffer (RFB) . . . . .	209
10.3.4. Comparison between LEAP, MIFARE and RFB protocols . . . . .	210
10.4. Conclusion . . . . .	211
10.5. References . . . . .	213
<b>Chapter 11. A Study on Security Protocols, Threats and Probable Solutions for Internet of Things Using Blockchain.</b> . . . . .	215
Debajyoti GUHA	
11.1. Introduction . . . . .	216
11.2. IoT architecture and security challenges . . . . .	217
11.3. Security threat classifications . . . . .	218
11.3.1. Low-level security threats . . . . .	218
11.3.2. Intermediate-level security threats . . . . .	219
11.3.3. High-level security threats . . . . .	221
11.4. Security solutions for IoT . . . . .	221
11.4.1. Low-level security solutions . . . . .	222
11.4.2. Intermediate-level security solutions. . . . .	222
11.4.3. High-level security solutions . . . . .	223
11.5. Blockchain-based IoT paradigm: security and privacy issues . . . . .	224
11.5.1. Lack of IoT-centric agreement mechanisms . . . . .	224
11.5.2. IoT device incorporation . . . . .	224
11.5.3. Software update . . . . .	224
11.5.4. Data scalability and organization. . . . .	224

11.5.5. Interoperability with the varied IoT devices organized lying on blockchain network . . . . .	225
11.5.6. Perception layer . . . . .	225
11.5.7. Network layer . . . . .	225
11.5.8. Processing layer . . . . .	225
11.5.9. Application layer . . . . .	226
11.6. IoT Messaging Protocols . . . . .	226
11.6.1. Hyper Text Transfer Protocol (HTTP). . . . .	226
11.6.2. Message Queue Telemetry Protocols (MQTT) . . . . .	226
11.6.3. Secure MQTT (SMQTT) . . . . .	227
11.6.4. Advanced Message Queuing Protocol (AMQP) . . . . .	227
11.6.5. Constrained Application Protocol (CoAP) . . . . .	228
11.6.6. Extensible Messaging and Presence Protocol (XMPP). . . . .	228
11.6.7. Relative study of different messaging protocols of IoT environments . . . . .	229
11.7. Advantages of edge computing . . . . .	230
11.8. Conclusion . . . . .	231
11.9. References . . . . .	231
<b>List of Authors . . . . .</b>	<b>237</b>
<b>Index . . . . .</b>	<b>241</b>



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## Smart Edge Computing: An Operation Research Perspective

Jyotsna Kumar Mandal, Prasenjit Chatterjee, Rajdeep Chakraborty, Tanupriya Choudhury, Anupam Ghosh

E-Book	978-1-394-27758-2	February 2024	<b>\$132.00</b>
Hardcover	978-1-786-30863-4	March 2024	<b>\$165.00</b>
O-Book	978-1-394-27759-9	February 2024	<b>Available on Wiley Online Library</b>

### Description

This book pioneers the synergy between state-of-the-art edge computing technologies and the power of operations research. It comprehensively explores real-world applications, demonstrating how various operations' research techniques enhance edge computing's efficiency, reliability and resource allocation. Innovative solutions for dynamic task scheduling, load balancing and data management, all tailored to the unique challenges of edge environments, are displayed.

Starting with operation research methodologies with foundations, applications and research challenges in edge computing and an overview of digital education, this book continues with an exploration of applications in the health sector using IoT, intelligent payment procedures and performance measurement of edge computing, using edge computing and operation research. Smart or AI-based applications are also explored further on and the book ends with insight into ultralightweight and security protocols with solutions for IoT using blockchain.

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## ANALYZING THE DIGITAL NOTE PROGRESSION OF RAGAS WITHIN A *THAAT* USING FRACTAL GEOMETRY

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[Received-15/01/2013, Accepted-12/03/2013]

### ABSTRACT:

Music is one of the oldest forms of art, something to experience and enjoy. In recent times we have seen a great interest of modern science interacting with this highly emotional and experiential phenomenon of music. Music is organized sound that is capable of conveying emotion; hence melody has to be ordered successions of musical notes and it is of interest to investigate if the successions depict a fractal nature. Successions are *fractal* if the incidence frequency  $F$  and the interval between successive notes  $i$  in a musical piece bear the relation:  $F = c/i^D$  where  $D$  is the fractional dimension and  $c$  is a constant of proportionality. The present work compares four ragas within a *thaat* (a raga-group based on scale) using fractals. Two of the ragas are of restful nature and the remaining two restless. Our findings are very interesting. Fractal nature is found to be far more prominent in both the restless ragas! We propose to extend the work to other *thaats* also as well as compare ragas between *thaats*.

**Key Words**— Fractals, melody, musical notes, *thaat*, raga

### 1. INTRODUCTION

Music is a way of expressing nature's harmony, and fractals are the tools that describe this harmony. Naturally it is of interest to explore the application of fractals in music. One direction of research could be to investigate whether a musical succession of digital notes depicts a fractal nature or not. Another interest can be if we can mathematically characterize the difference between the musical component of ragas (with different moods) within a *thaat* or those with similar moods between the *thaats* or finally can we make fractal music (music generated algorithmically using fractals) interesting? In this paper we are interested in comparing ragas within a *thaat* using

fractals while comparing ragas between *thaats* using fractals is reserved as a future work.

#### 1.1 Fractal and Music

Fractals are geometric shapes with interesting properties that set them apart from normal Euclidean shapes. The first interesting property is that of self similar nature. Another property of fractal is a non integer dimension which is related to the concept of self similarity. The term fractal was coined by Benoit Mandelbrot in 1975 to describe shapes that are "self-similar" – that is, shapes that look the same at different magnifications and we refer to his classic treatise [1] for an insight.

Mandelbrot’s fractal geometry has provided a new qualitative and quantitative approach for the understanding of the complex shapes of nature. The calculation of fractal dimension is an important way to classify objects that exhibit fractal characteristics.

The relative abundance or the incidence frequency  $F$ , of notes of different acoustic frequency  $f$  in a musical composition is not fractal [2]. Unplanned striking of the keys in a piano or a harmonium will not create music. Music is *organized sound that conveys emotion*; hence melody has to be ordered successions of musical notes. These successions are fractal if the incidence frequency  $F$  of the interval between successive notes  $i$  in a musical piece bear the relation  $F=c/i^D$  where  $D$  is the fractional dimension and  $C$  is a constant of proportionality [3]. or,  $\ln(F)=\ln(c)-D\ln(i)=C-D\ln(i)$  where  $C=\ln(c)$ , another constant. .... (1).

Voss and Clark [4] determined that music exhibits  $1/f$ -power spectra at low frequencies. This fact allows us to consider music as a time series and analyze the fractal dimension of a particular piece of music. Bigerelle and Lost [5] found the global  $D$  to be an invariant for different types of music. In another work [6],  $D$  in the music of Mozart and Bach was calculated. Hsu and Hsu [3] discussed the application of  $D$  to music in detail and for a work of Bach, found  $D$  to be 2.418.

**1.2 Ragas and Thaats**

A raga, in Indian classical music (both Hindustani and Cartatic), may be defined as a melodic structure with fixed notes and a set of rules that characterize a particular mood conveyed by performance. According to Vishnu Narayan Bhatkhande (1860-1930) one of the most influential musicologist in the field of Hindustani Classical Music in the twentieth century, each one of the traditional ragas is based on, or is a variation of ten basic *thaats*, or musical scales or frameworks. The ten *thaats* are Bilawal, Kalyan, Khamaj, Bhairav, Poorvi, Marwa, Kafi, Asavari, Bhairavi and Todi. If one were to pick a raga at random, it should be possible to find that it is based on one or the other of these *thaats* [7]. For instance, the four ragas Bhimpalashi (or Bhimpalashree), Pilu, Bageshree and Kafi studied here

all belong to the Kafi *thaat*. Table 1 gives the distinguishing musical features of these ragas.

**Table 1:** Musical Features of four ragas of the Kafi *thaat*

Musical feature:-	Raga 1: Bageshree	Raga 2: Pilu	Raga 3: Kafi	Raga 4: Bhimpalashi
<i>Thaat</i>	Kafi	Kafi	Kafi	Kafi
Arohan (ascent)	S g M D n S	N S g R g, M P, d P, n D P, S	S R g M P D n S	n S g M P n S
Awarohan (Descent)	S n D, M P D g, M g R S	S n D P M g, N S	S n D P M g R S	S n D P M g R S
Pakad (note assembly giving a catch of the raga)	S n D, S M D n D, M g R S	N S g N S, P d N S	S S R R g g M M P	n S M, M g, P M, g, M g R S
Vadi-Samvadi Swars (Most important and second most important notes)	M, S	g, N	P, S	M, S
Jati (raga group according to number of distinct notes allowed in ascent and descent)	Aurabh-Sampoorna (5 distinct notes allowed in ascent; 7 in descent)	Sampoorna-Sampoorna (7 distinct notes allowed in ascent; 7 in descent)	Sampoorna-Sampoorna (7 distinct notes allowed in ascent; 7 in descent)	Aurabh-Sampoorna (5 distinct notes allowed in ascent; 7 in descent)
Nyas Swars (stay notes in the raga)	g M D	G P N	R g M P	g M P n
Prakriti (nature)	Restful	Restless	Restless	Restful
Time of rendition	9PM-12PM	12.00-3PM	Midnight	1PM-3PM

Notes 1: The raga Pilu discussed here is actually *Mishra Pilu* and uses two notes N and d which are not used in the other three ragas of the Kafi *thaat*. In fact, these two notes are not among the parent notes of the Kafi *thaat*, namely, S R g M P D and n. However, these additional notes do make this raga more colourful and suitable for thumris, a lighter form of Hindustani classical music and it is the lighter form of Pilu that is more popular and hence being analyzed here.

2: Kafi is both a *thaat* and a raga within this *thaat*. Raga Kafi should not be confused with Kafi as a *thaat* which is a raga-group and not an individual raga.

**Abbreviations:** The letters S, R, G, M, P, D and N stand for Sa, *Sudh* Re, *Sudh* Ga, *Sudh* Ma, Pa, *Sudh* Dha and *Sudh* Ni respectively. The letters r, g, m, d, n represent *Komal* Re, *Komal* Ga, *Tibra* Ma, *Komal* Dha and *Komal* Ni respectively. Normal type indicates the

note belongs to middle octave; italics implies that the note belongs to the octave just lower than the middle octave while a bold type indicates it belongs to the octave just higher than the middle octave. Sa, the tonic in Indian music, is taken at C. Corresponding Western notation is also provided. (see table 2) The terms “*Sudh*”, “*Komal*” and “*Tibra*” imply, respectively, natural, flat and sharp.

**2. METHODOLOGY**

We take four different ragas from Kafi *thaat* and calculate intervals *i* as the absolute values of differences in pitch of two successive notes. For each sequence of notes, a frequency distribution is found of the intervals. Accordingly four tables of  $\ln F$  versus  $\ln i$  are formed, one for each raga. Calculations are made only for those values of *F* and *i* for which both  $\ln F$  and  $\ln i$  are defined. The note sequences are taken from a standard text [7] and not from any audio recording. There are some obvious advantages and disadvantages for doing so. If we go for audio recordings, it is not always necessary that the same raga performed by different artists (or even the same artist on different occasions) will exhibit the same fractal nature. Even if we analyze a single recording of an artist, it is not easy to say which part of the fractal nature is attributable to the raga itself and which part to the style. In a structure analysis, the style of the artist does not interfere with our analysis whereby the fractal nature can be studied for its presence (with dimension) in the raga structure itself in a general sense. The technique is to assign the number 0 to C (where the tonic Sa or S is taken), 1 to the next note Db (Komal Re or r) and so on (table 2). On the disadvantage side, we miss information on note duration and pitch movements between the notes which we could get in audio recordings.

**Table 2:** Numbers representing pitch of notes [8]

C	Db	D	Eb	E	F	F#	G	Ab	A	Bb	B
<i>S</i>	<i>r</i>	<b>R</b>	<i>g</i>	<b>G</b>	<i>M</i>	<i>m</i>	<b>P</b>	<i>d</i>	<b>D</b>	<i>n</i>	<b>N</b>
<b>(lower octave)</b>											
-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1

*S r R g G M m P d D n N*  
**(middle octave)**

0 1 2 3 4 5 6 7 8 9 10 11

**S r R g G M m P d D n N**  
**(higher octave)**

12 13 14 15 16 17 18 19 20 21 22 23

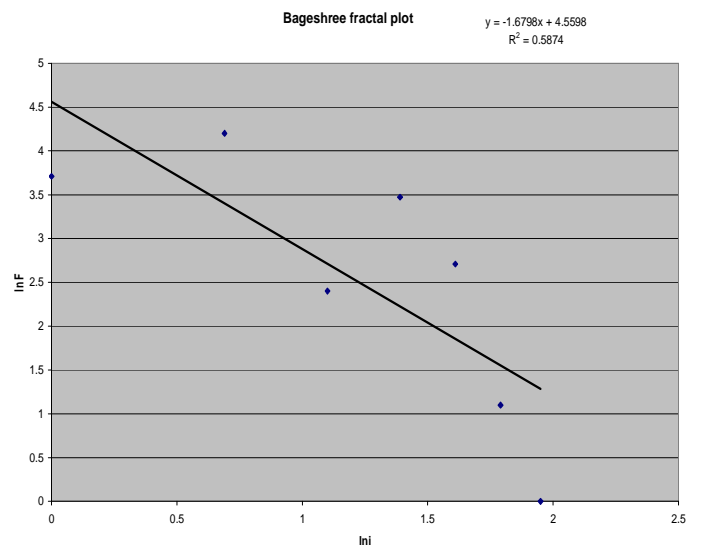
**3. EXPERIMENTAL RESULTS**

Our experimental results are summarized in tables 3-6 and corresponding fig. 1-4 for the ragas Bageshree, Pilu, Kafi and Bhimpalashi respectively.

**Thaat: Kafi** Raga: Bageshree

i	F	lni	lnF
0	10		2.30
1	41	0.00	3.71
2	67	0.69	4.20
3	11	1.10	2.40
4	32	1.39	3.47
5	15	1.61	2.71
6	3	1.79	1.10
7	1	1.95	0.00

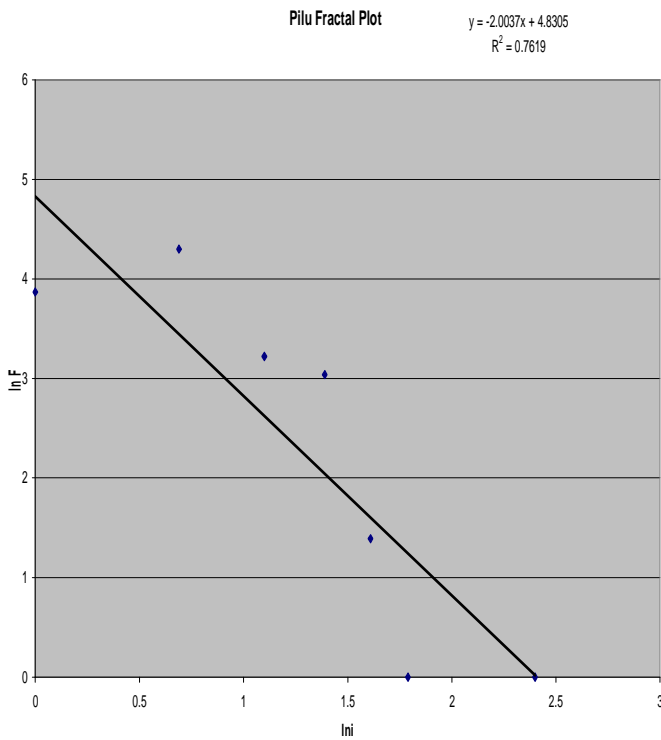
**Table 3:** Fractal Analysis for Bageshree



**Fig. 1** Fractal Plot of Bageshree

i	F	lni	lnF
0	6		1.79
1	48	0.00	3.87
2	74	0.69	4.30
3	25	1.10	3.22
4	21	1.39	3.04
5	4	1.61	1.39
6	1	1.79	0.00
11	1	2.40	0.00

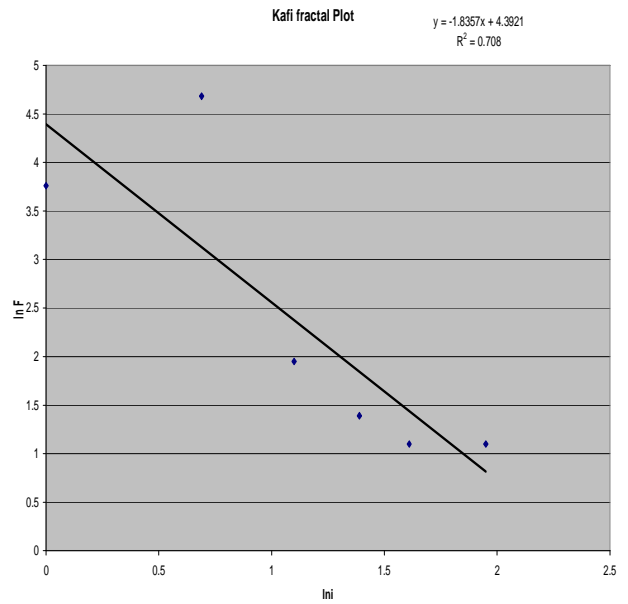
**Table 4:** Fractal Analysis for Pilu



**Fig. 2** Fractal Plot for Pilu

i	F	lni	lnF
0	12		2.48
1	43	0.00	3.76
2	108	0.69	4.68
3	7	1.10	1.95
4	4	1.39	1.39
5	3	1.61	1.10
6			
7	3	1.95	1.10

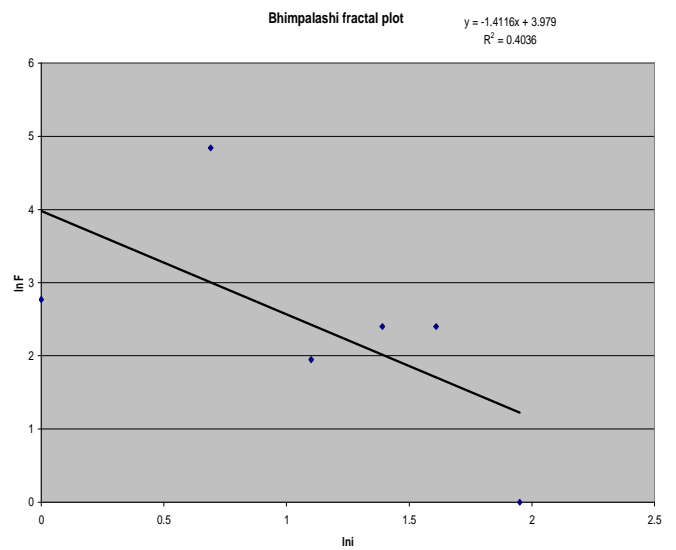
**Table 5:** Fractal Analysis for Kafi



**Fig. 3** Fractal Plot for Kafi.

i	F	lni	lnF
0	8		2.08
1	16	0.00	2.77
2	126	0.69	4.84
3	7	1.10	1.95
4	11	1.39	2.40
5	11	1.61	2.40
6	0	1.79	
7	1	1.95	0.00

**Table 6:** Fractal Analysis for Bhimpalashi



**Fig. 4** Fractal plot for Bhimpalashi

#### 4. DISCUSSION

The results on the four ragas are indeed very interesting. The ragas Kafi and Pilu are depicting fractal nature with comparatively higher dimension than the other two ragas (2.0037 for Pilu and 1.8357, i.e., nearly 2). The fractal nature in raga Bhimpalashree is not so prominent as  $R^2$  is not very high with fractal dimension 1.4116 and same is true about the other raga Bageshree which has fractal dimension 1.6798.  $100R^2$ , also called % coefficient of determination, gives the percentage of variation in the response (here  $\ln F$ ) explained by the predictor (here  $\ln i$ ) through the model (here a straight line). In a recent paper [9] it has been argued that fractal dimension is related with the *chalan* (melodic movement) of the raga. Thus our present finding suggests that Kafi and Pilu can be placed in one sub-group within the same *thaat* while Bageshree and Bhimpalashree can be placed in another sub-group within this *thaat*. Musically, we already know that Kafi and Pilu are both of restless nature and therefore can be placed in one group (*Chanchal prakriti* or restless nature). Bageshree and Bhimpalashree are both restful ragas and can be placed in another group (*shant prakriti* or restful nature). Hence the present study confirms once again that fractals do provide interesting mathematical properties that may be related to the melodic movement (in this case, whether restful or restless) of a raga. We caution the reader, however, that the nature (restful or restless) of the raga is not exactly the same thing as the mood or emotional content of the raga. For that matter, Pilu evokes sadness (*karuna rasa*) like Bageshree and Bhimpalashi while Kafi evokes joy in a romantic sense (*shringar rasa*). The paper [10] compares Kafi and Bageshree probabilistically using entropy.

Remarks 1: This is a paper on structure analysis of ragas. Readers interested in performance analysis of a raga are referred to [11]. This paper also gives a brief outline of what a raga is and how Indian classical music differs from Western classical music.

2. It is not correct to conclude in general that the restless ragas are more likely to exhibit a fractal nature. Our study is confined to only one *thaat* and

there too, we can study only a limited number of ragas even within a *thaat*. The present work is only illustrative and by no means exhaustive. We caution the reader that Malkauns, a restful raga of Bhairavi *thaat* (some experts say Asavari *thaat* is correct for this grouping this raga [7]), has been found to exhibit good fractal nature! [12]

3. The reader is also referred to the works of H. V. Sahasrabuddhe [13].

#### 5. CONCLUSION

The present work compares four ragas within a *thaat* using fractals. Fractal nature is found to be far more prominent in two of the ragas which happen to be of restless nature as compared to the other two which happen to be restful ones. Although the finding is interesting, yet in the light of the second remark made in the previous section, we have extended the work to other *thaats* as well as compare ragas between *thaats* and investigate a good number of ragas in each of the ten *thaats* in order to concretize things.

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Proceedings of the 11th International  
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ISSN 2194-5357

ISSN 2194-5365 (electronic)

Advances in Intelligent Systems and Computing

ISBN 978-3-030-73602-6

ISBN 978-3-030-73603-3 (eBook)

<https://doi.org/10.1007/978-3-030-73603-3>

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# Contents

<b>A Comparative Analysis of DNA Protein Synthesis for Solving Optimization Problems: A Novel Nature-Inspired Algorithm . . . . .</b>	<b>1</b>
Samaher Al-Janabi and Ayad F. Alkaim	
<b>An Evolutionary Approach for Solving the Minimum Volume Ellipsoid Estimator Problem . . . . .</b>	<b>23</b>
Rewayda Abo-Alsabeh, Hajem Ati Daham, and Abdellah Salhi	
<b>A Novel Clustering Based Undersampling Algorithm for Imbalanced Data Sets Using Artificial Bee Colony Algorithm . . . . .</b>	<b>32</b>
O. A. Ajilisa, V. P. Jagathyraraj, and M. K. Sabu	
<b>Flower Pollination Algorithm in Optimization of Interval Type-2 Fuzzy for Telemedical Problem . . . . .</b>	<b>43</b>
Uduak Umoh, Abdultaofeek Abayomi, Samuel Udoh, and Alimot Abdulazeez	
<b>A Hybrid Trust Probability Based C-ACO Model for Large Software Defined Networks . . . . .</b>	<b>55</b>
Divya Lanka and Selvaradjou Kandasamy	
<b>Novel Routing-Scheduling Problem for Home Health Care Network . . . . .</b>	<b>66</b>
Alireza Ferdowsi, Roghaye Bahrami Taghanaki, and Ajith Abraham	
<b>A Data-Driven Dynamic Discretization Framework to Solve Combinatorial Problems Using Continuous Metaheuristics . . . . .</b>	<b>76</b>
Felipe Cisternas-Caneo, Broderick Crawford, Ricardo Soto, Hanns de la Fuente-Mella, Diego Tapia, José Lemus-Romani, Mauricio Castillo, Marcelo Becerra-Rozas, Fernando Paredes, and Sanjay Misra	
<b>Minimizing Tardiness in Stochastic Flexible Job Shop Problem . . . . .</b>	<b>86</b>
Mahsa Nekouei-Shahraki, Ajith Abraham, and Mohammd Mehdi Lotfi	

<b>Classification of Metabolic Pathways Using Machine Learning Techniques</b> .....	97
Jyotshna Dongardive and Suruchi Jamkhedkar	
<b>Cooperative Slotted ALOHA with ZigZag Decoding and a Pricing Mechanism</b> .....	111
Ahmed Boujnoui, Abdellah Zaaloul, and Abdelkrim Haqiq	
<b>Grey Wolf Optimization Model for the Best Mean-Variance Based Stock Portfolio Selection</b> .....	120
Dalia Kriksciuniene, Virgilijus Sakalauskas, and Audrius Imbrasas	
<b>Modelling and Performance Evaluation of IoT Network During the COVID-19 Pandemic</b> .....	131
Abdessamad Bellouch, Ahmed Boujnoui, Abdellah Zaaloul, and Abdelkrim Haqiq	
<b>Meta-heuristic Based Multi Objective Supply Chain Model for the Oil Industry in Conditions of Uncertainty</b> .....	141
Omid Abdolazimi and Ajith Abraham	
<b>Effective Machine Learning Approaches for Credit Card Fraud Detection</b> .....	154
Md. Noor Alam, Prajoy Podder, Subrato Bharati, and M. Rubaiyat Hossain Mondal	
<b>Scheduling Activities of Smart Phone and Smart Watch Based on Optimal Pattern Model (SA-OPM)</b> .....	164
Ali Hamza Salman and Samaher Al-Janabi	
<b>Literature Survey: Application of Machine Learning Techniques on Static Sign Language Recognition</b> .....	179
Yael Robert, Yashshree Nigudkar, Anagha Kulkarni, Namita Mutha, and Pranjali Barve	
<b>EECT: Energy Efficient Clustering Technique Using Node Probability in Ad-Hoc Network</b> .....	187
Virendra Dani, Nisha Bhati, and Deepesh Bhati	
<b>A System to Detect the Faces in Unconstrained Environment</b> .....	196
D. N. Bhavya and H. K. Chethan	
<b>Machine Learning for Intrusion Detection: Design and Implementation of an IDS Based on Artificial Neural Network</b> .....	206
Younes Wadiai, Yousef El Mourabit, and Mohammed Baslam	
<b>Avoiding Wormhole Attack in MANET Using an Extending Network Knowledge</b> .....	217
Hicham Zougagh, Noureddine Idboufker, Yousef El Mourabit, Yousef Saadi, and Samir Elouaham	

**Analysis of Socio-cognitive Skills Among 90’s and 2k’s Generations Using Machine Learning Techniques** . . . . . 231  
 Natarajan Anitha, Rangasamy Devi Priya, Chelladurai Baskar, and V. Devi Surya

**Particulate Matter Forecasting Using Neural Networks: A Case Study of Delhi** . . . . . 241  
 Shambhavi Trivedi, Maninder Kaur, and Tarushi Singh

**Security Challenges of Blockchain** . . . . . 248  
 Yousuf Khan, S. B. Goyal, and Pradeep Bedi

**Blockchain Transforming Cyber-Attacks: Healthcare Industry** . . . . . 258  
 Anthony Ugochukwu Nwosu, S. B. Goyal, and Pradeep Bedi

**Effectiveness of Ensemble Machine Learning Algorithms in Weather Forecasting of Bangladesh** . . . . . 267  
 Atik Mahabub, Al-Zadid Sultan Bin Habib, M. Rubaiyat Hossain Mondal, Subrato Bharati, and Prajoy Podder

**Significance of the Internet of Things to the Covid-19 Pandemic in the Philippines** . . . . . 278  
 Maria Rosario T. Garcia and Alvin B. Culaba

**Relationship Between the Monopoly of Tobacco Law and Lung Cancer Using the Theory of Dynamic Systems** . . . . . 289  
 Nazanin Fozooni, Hamed Daneshvari, Sohaib Dastgoshade, and Ajith Abraham

**Comparative Analysis of Cellular Automata Based Multilingual Encryption Using Syndicate Rules for Data Security** . . . . . 301  
 Ayan Banerjee and Anirban Kundu

**A Comprehensive Review on Cyber Physical System and Its Applications in Robotic Process Automation** . . . . . 311  
 Durgesh M. Sharma, Shishir Kumar Shandilya, and Ashish K. Sharma

**Analysis of Papers Based on Sentiment Analysis Applications on E-Commerce Data** . . . . . 323  
 Beena Kapadia and Amita Jain

**IoT Based Time Triggered SPE Smart Switch for AC Appliances Control** . . . . . 341  
 Omar Bin Samin, Maryam Omar, Musadaq Mansoor, Noman Naseeb, Samad Ali Shah, and Aqil Amjad Khan

**An Approach to Store Data in Cloud Based Storage Using Mapping Technique** . . . . . 352  
 Saswati Sarkar and Anirban Kundu

<b>Context-Based Cultural Visits</b> .....	362
Mariana Assis, Maria Teresa Andrade, and Paula Viana	
<b>Optimization of Road Traffic Congestion in Urban Traffic Network Using Dinic’s Algorithm</b> .....	372
Somasee Bhadra, Anirban Kundu, and Sunirmal Khatua	
<b>Optimising Criteria for Manual Smear Review Following Automated Blood Count Analysis: A Machine Learning Approach</b> . . . .	380
Marta Avalos, H�el�ene Touchais, and Marcela Henr�iquez-Henr�iquez	
<b>Online Courses Performance Prediction Using Machine Learning Techniques</b> .....	392
Jyotshna Dongardive, Mousmi Pawar, and Pooja Manghirmalani Mishra	
<b>The Ground Based Scatterometer for Agriculture Applications</b> .....	402
Geeta Desai and Abhay Gaikwad	
<b>Automatic Terminology Extraction Using a Dependency-Graph in NLP</b> .....	411
Yusuke Kimura, Kazuma Kusu, Kenji Hatano, and Tokiya Baba	
<b>Assessment of Plant Health in the Green Belt Around Coal Handling Area for Sustained and Effective Control of Fugitive Emissions</b> .....	422
Prashant Kokil, Niketa Gandhi, and Sanjay Deshmukh	
<b>ICT in Indian Agriculture: An Overview of the Major Services, Their Penetration and Infrastructural Development</b> .....	429
Nikhil Kumar Rajput, Niketa Gandhi, and Bhavya Ahuja Grover	
<b>Insurance Policy Claim Verification Model of Unnatural Death Cases – An Artificial Intelligence Based Approach</b> .....	441
Tanaya Das, Subhasish Mohapatra, and Abhishek Roy	
<b>A Study on Argument-Based Analysis of Legal Model</b> .....	449
Riya Sil, Dipanjan Saha, and Abhishek Roy	
<b>A Hybrid Machine Learning Model for Predicting Customer Churn in the Telecommunication Industry</b> .....	458
Modupe Odusami, Olusola Abayomi-Alli, Sanjay Misra, Adebayo Abayomi-Alli, and Mayank Mohan Sharma	
<b>Metrics for Measuring Progress and Productivity in Agile Software Development</b> .....	469
Sanjay Misra, F. Martha Omorodion, and Robertas Damasevicius	
<b>Renewable Energy in Rural Economy: Nigeria</b> .....	479
Abubakar John and Sanjay Misra	

**End-To-End Security in Communication Networks: A Review** . . . . . 492  
Okpe Jonah Bameyi, Sanjay Misra, Francis Idachaba,  
and Jonathan Oluranti

**Data Extraction Based on Web Scrapy** . . . . . 506  
Reem Alshammari, Rwan Alrashed, Atheer Almutiri, Mathail Alwalah,  
Wadha Al-marrai, Dana Alqahtani, and Amani Alzahrani

**Multicriteria Model for Sorting the Quality of Services Provided  
by Airports** . . . . . 515  
Phelipe Medeiros da Rocha and Helder Gomes Costa

**Cyber Security Management Model for Critical Infrastructure  
and Improving the Security Level on Transferring Digital Data** . . . . . 525  
Pradeep Bedi, S. B. Goyal, Jugnesh Kumar, and Ritika

**Smart Appointments Booking Systems for Social Distancing:  
Technologies and Solutions** . . . . . 535  
Fatimah H. Almuhsin, Naba Almadan, Atheer Almarhoon,  
Hawra A. Al Mohssin, Thowiba Hagali Ahmed, Dabiah Alboaneen,  
and Enas E. El-sharawy

**Security Challenges of Digital Currency System** . . . . . 546  
Shaun De Silva, S. B. Goyal, and Pradeep Bedi

**Author Index** . . . . . 557



# An Approach to Store Data in Cloud Based Storage Using Mapping Technique

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**Abstract.** Cloud based data storage technique is going to be proposed in this paper. The paper introduces mapping technique to write data in a disk and to read data from the disk. Proposed cloud based technique is designed to calculate the efficiency and IOPS (Input/output operations per second) of storage. Proposed algorithm is more effective to find out a particular memory location to store data. Comparison graphs have been demonstrated for IOPS, storage space utilization and storage efficiency in cloud. Proposed cloud based data storage technique represents better read and write performance than existing approaches. The paper is going to propose more reliable storage framework than existing techniques. The paper exhibits cloud based framework which shows the utility of data storage in cloud. Proposed framework is better than existing approaches with respect to cost and protection of storage. Performance parameter chart represents the comparison of performances between existing techniques and proposed framework. Comparisons have been shown that performances of proposed approach are better than existing approaches.

**Keywords:** Cloud storage · Redundant Array of Independent Drives (RAID) · Empty location map · Address location map · Storage efficiency · Storage performance · Data redundancy

## 1 Introduction

Over the period, hardware architecture and capacity of storage have been improved a lot. Redundant Array of Independent Disk (RAID) [1, 2] is data storage technology that combines multiple physical disk components into one logical unit for the purpose of performance improvement. Different types of RAID architectures [3, 4] are RAID 0, RAID 1, RAID 10, RAID 5 etc.. RAID 0 architecture uses stripping technique to store data across multiple disks for parallel storage and retrieval. The architecture utilizes the full storage capacity. If data is lost, it cannot be recovered in RAID 0 [5]. RAID 1 architecture uses mirroring technique. Each disk has a mirror. Data is stored in two disks. If one disk has failed then the data would be retrieved from another disk. RAID 10 architecture [6, 7] is combination of RAID 0 and RAID 1. RAID 0 + 1 has been designed by mirroring first followed by stripping, whereas RAID 1 + 0 have performed stripping first followed by mirroring [8].

Ajith Abraham · Hideyasu Sasaki ·  
Ricardo Rios · Niketa Gandhi ·  
Umang Singh · Kun Ma  
Editors

# Innovations in Bio-Inspired Computing and Applications

Proceedings of the 11th International  
Conference on Innovations in Bio-Inspired  
Computing and Applications (IBICA 2020)  
held during December 16–18, 2020

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ISSN 2194-5357

ISSN 2194-5365 (electronic)

Advances in Intelligent Systems and Computing

ISBN 978-3-030-73602-6

ISBN 978-3-030-73603-3 (eBook)

<https://doi.org/10.1007/978-3-030-73603-3>

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The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

# Contents

<b>A Comparative Analysis of DNA Protein Synthesis for Solving Optimization Problems: A Novel Nature-Inspired Algorithm . . . . .</b>	<b>1</b>
Samaher Al-Janabi and Ayad F. Alkaim	
<b>An Evolutionary Approach for Solving the Minimum Volume Ellipsoid Estimator Problem . . . . .</b>	<b>23</b>
Rewayda Abo-Alsabeh, Hajem Ati Daham, and Abdellah Salhi	
<b>A Novel Clustering Based Undersampling Algorithm for Imbalanced Data Sets Using Artificial Bee Colony Algorithm . . . . .</b>	<b>32</b>
O. A. Ajilisa, V. P. Jagathyraraj, and M. K. Sabu	
<b>Flower Pollination Algorithm in Optimization of Interval Type-2 Fuzzy for Telemedical Problem . . . . .</b>	<b>43</b>
Uduak Umoh, Abdultaofeek Abayomi, Samuel Udoh, and Alimot Abdulazeez	
<b>A Hybrid Trust Probability Based C-ACO Model for Large Software Defined Networks . . . . .</b>	<b>55</b>
Divya Lanka and Selvaradjou Kandasamy	
<b>Novel Routing-Scheduling Problem for Home Health Care Network . . . . .</b>	<b>66</b>
Alireza Ferdowsi, Roghaye Bahrami Taghanaki, and Ajith Abraham	
<b>A Data-Driven Dynamic Discretization Framework to Solve Combinatorial Problems Using Continuous Metaheuristics . . . . .</b>	<b>76</b>
Felipe Cisternas-Caneo, Broderick Crawford, Ricardo Soto, Hanns de la Fuente-Mella, Diego Tapia, José Lemus-Romani, Mauricio Castillo, Marcelo Becerra-Rozas, Fernando Paredes, and Sanjay Misra	
<b>Minimizing Tardiness in Stochastic Flexible Job Shop Problem . . . . .</b>	<b>86</b>
Mahsa Nekouei-Shahraki, Ajith Abraham, and Mohammd Mehdi Lotfi	

<b>Classification of Metabolic Pathways Using Machine Learning Techniques</b> .....	97
Jyotshna Dongardive and Suruchi Jamkhedkar	
<b>Cooperative Slotted ALOHA with ZigZag Decoding and a Pricing Mechanism</b> .....	111
Ahmed Boujnoui, Abdellah Zaaloul, and Abdelkrim Haqiq	
<b>Grey Wolf Optimization Model for the Best Mean-Variance Based Stock Portfolio Selection</b> .....	120
Dalia Kriksciuniene, Virgilijus Sakalauskas, and Audrius Imbrasas	
<b>Modelling and Performance Evaluation of IoT Network During the COVID-19 Pandemic</b> .....	131
Abdessamad Bellouch, Ahmed Boujnoui, Abdellah Zaaloul, and Abdelkrim Haqiq	
<b>Meta-heuristic Based Multi Objective Supply Chain Model for the Oil Industry in Conditions of Uncertainty</b> .....	141
Omid Abdolazimi and Ajith Abraham	
<b>Effective Machine Learning Approaches for Credit Card Fraud Detection</b> .....	154
Md. Noor Alam, Prajoy Podder, Subrato Bharati, and M. Rubaiyat Hossain Mondal	
<b>Scheduling Activities of Smart Phone and Smart Watch Based on Optimal Pattern Model (SA-OPM)</b> .....	164
Ali Hamza Salman and Samaher Al-Janabi	
<b>Literature Survey: Application of Machine Learning Techniques on Static Sign Language Recognition</b> .....	179
Yael Robert, Yashshree Nigudkar, Anagha Kulkarni, Namita Mutha, and Pranjali Barve	
<b>EECT: Energy Efficient Clustering Technique Using Node Probability in Ad-Hoc Network</b> .....	187
Virendra Dani, Nisha Bhati, and Deepesh Bhati	
<b>A System to Detect the Faces in Unconstrained Environment</b> .....	196
D. N. Bhavya and H. K. Chethan	
<b>Machine Learning for Intrusion Detection: Design and Implementation of an IDS Based on Artificial Neural Network</b> .....	206
Younes Wadiai, Yousef El Mourabit, and Mohammed Baslam	
<b>Avoiding Wormhole Attack in MANET Using an Extending Network Knowledge</b> .....	217
Hicham Zougagh, Noureddine Idboufker, Yousef El Mourabit, Yousef Saadi, and Samir Elouaham	

**Analysis of Socio-cognitive Skills Among 90’s and 2k’s Generations Using Machine Learning Techniques** . . . . . 231  
 Natarajan Anitha, Rangasamy Devi Priya, Chelladurai Baskar, and V. Devi Surya

**Particulate Matter Forecasting Using Neural Networks: A Case Study of Delhi** . . . . . 241  
 Shambhavi Trivedi, Maninder Kaur, and Tarushi Singh

**Security Challenges of Blockchain** . . . . . 248  
 Yousuf Khan, S. B. Goyal, and Pradeep Bedi

**Blockchain Transforming Cyber-Attacks: Healthcare Industry** . . . . . 258  
 Anthony Ugochukwu Nwosu, S. B. Goyal, and Pradeep Bedi

**Effectiveness of Ensemble Machine Learning Algorithms in Weather Forecasting of Bangladesh** . . . . . 267  
 Atik Mahabub, Al-Zadid Sultan Bin Habib, M. Rubaiyat Hossain Mondal, Subrato Bharati, and Prajoy Podder

**Significance of the Internet of Things to the Covid-19 Pandemic in the Philippines** . . . . . 278  
 Maria Rosario T. Garcia and Alvin B. Culaba

**Relationship Between the Monopoly of Tobacco Law and Lung Cancer Using the Theory of Dynamic Systems** . . . . . 289  
 Nazanin Fozooni, Hamed Daneshvari, Sohaib Dastgoshade, and Ajith Abraham

**Comparative Analysis of Cellular Automata Based Multilingual Encryption Using Syndicate Rules for Data Security** . . . . . 301  
 Ayan Banerjee and Anirban Kundu

**A Comprehensive Review on Cyber Physical System and Its Applications in Robotic Process Automation** . . . . . 311  
 Durgesh M. Sharma, Shishir Kumar Shandilya, and Ashish K. Sharma

**Analysis of Papers Based on Sentiment Analysis Applications on E-Commerce Data** . . . . . 323  
 Beena Kapadia and Amita Jain

**IoT Based Time Triggered SPE Smart Switch for AC Appliances Control** . . . . . 341  
 Omar Bin Samin, Maryam Omar, Musadaq Mansoor, Noman Naseeb, Samad Ali Shah, and Aqil Amjad Khan

**An Approach to Store Data in Cloud Based Storage Using Mapping Technique** . . . . . 352  
 Saswati Sarkar and Anirban Kundu

<b>Context-Based Cultural Visits</b> . . . . .	362
Mariana Assis, Maria Teresa Andrade, and Paula Viana	
<b>Optimization of Road Traffic Congestion in Urban Traffic Network Using Dinic’s Algorithm</b> . . . . .	372
Somasee Bhadra, Anirban Kundu, and Sunirmal Khatua	
<b>Optimising Criteria for Manual Smear Review Following Automated Blood Count Analysis: A Machine Learning Approach</b> . . . . .	380
Marta Avalos, H�el�ene Touchais, and Marcela Henr�iquez-Henr�iquez	
<b>Online Courses Performance Prediction Using Machine Learning Techniques</b> . . . . .	392
Jyotshna Dongardive, Mousmi Pawar, and Pooja Manghirmalani Mishra	
<b>The Ground Based Scatterometer for Agriculture Applications</b> . . . . .	402
Geeta Desai and Abhay Gaikwad	
<b>Automatic Terminology Extraction Using a Dependency-Graph in NLP</b> . . . . .	411
Yusuke Kimura, Kazuma Kusu, Kenji Hatano, and Tokiya Baba	
<b>Assessment of Plant Health in the Green Belt Around Coal Handling Area for Sustained and Effective Control of Fugitive Emissions</b> . . . . .	422
Prashant Kokil, Niketa Gandhi, and Sanjay Deshmukh	
<b>ICT in Indian Agriculture: An Overview of the Major Services, Their Penetration and Infrastructural Development</b> . . . . .	429
Nikhil Kumar Rajput, Niketa Gandhi, and Bhavya Ahuja Grover	
<b>Insurance Policy Claim Verification Model of Unnatural Death Cases – An Artificial Intelligence Based Approach</b> . . . . .	441
Tanaya Das, Subhasish Mohapatra, and Abhishek Roy	
<b>A Study on Argument-Based Analysis of Legal Model</b> . . . . .	449
Riya Sil, Dipanjan Saha, and Abhishek Roy	
<b>A Hybrid Machine Learning Model for Predicting Customer Churn in the Telecommunication Industry</b> . . . . .	458
Modupe Odusami, Olusola Abayomi-Alli, Sanjay Misra, Adebayo Abayomi-Alli, and Mayank Mohan Sharma	
<b>Metrics for Measuring Progress and Productivity in Agile Software Development</b> . . . . .	469
Sanjay Misra, F. Martha Omorodion, and Robertas Damasevicius	
<b>Renewable Energy in Rural Economy: Nigeria</b> . . . . .	479
Abubakar John and Sanjay Misra	

**End-To-End Security in Communication Networks: A Review** . . . . . 492  
Okpe Jonah Bameyi, Sanjay Misra, Francis Idachaba,  
and Jonathan Oluranti

**Data Extraction Based on Web Scrapy** . . . . . 506  
Reem Alshammari, Rwan Alrashed, Atheer Almutiri, Mathail Alwalah,  
Wadha Al-marrai, Dana Alqahtani, and Amani Alzahrani

**Multicriteria Model for Sorting the Quality of Services Provided  
by Airports** . . . . . 515  
Phelipe Medeiros da Rocha and Helder Gomes Costa

**Cyber Security Management Model for Critical Infrastructure  
and Improving the Security Level on Transferring Digital Data** . . . . . 525  
Pradeep Bedi, S. B. Goyal, Jugnesh Kumar, and Ritika

**Smart Appointments Booking Systems for Social Distancing:  
Technologies and Solutions** . . . . . 535  
Fatimah H. Almuhsin, Naba Almadan, Atheer Almarhoon,  
Hawra A. Al Mohssin, Thowiba Hagali Ahmed, Dabiah Alboaneen,  
and Enas E. El-sharawy

**Security Challenges of Digital Currency System** . . . . . 546  
Shaun De Silva, S. B. Goyal, and Pradeep Bedi

**Author Index** . . . . . 557



# Comparative Analysis of Cellular Automata Based Multilingual Encryption Using Syndicate Rules for Data Security

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**Abstract.** Authors propose cellular automata (CA) based multilingual encryption algorithm to provide data security. Different components (keyset and encryption key) are required in proposed single attractor cellular automata (SACA) based algorithm to prepare multilingual encrypted dataset. A particular set of keyset and encryption key should be applied on a particular set of multilingual raw dataset to prepare multilingual key mapped dataset. Different syndicate rules should be applied in proposed algorithm using CA based state transition mapping. Data security should be increased due to usage of different syndicate rules. Efficiency of proposed algorithm should be measured using experimental results. Superiority of CA based proposed multilingual encryption algorithm should be measured using comparative analysis with existing algorithms (Blowfish, Twofish, RSA, Triple Data Encryption Standard, Advanced Encryption Standard).

**Keywords:** SACA · CA based multilingual encryption · State transition mapping · Encryption efficiency analysis

## 1 Introduction

A secure communication system called cryptosystem has been developed for encrypting and decrypting multilingual plaintext based on several rules and regulations. Information secrecy and computation complexity have been increased using cryptosystem. Researchers have introduced different multilingual data encryption technique for providing more security and confidentiality. MTDAS has been developed using character repetition EETUM has been developed using involvement of more characters and Quotient value numerals has been developed using substitution technique [1]. Researchers have introduced MULET based on modulus mapping. Information has been secured from brute force attack and 80% data recovery is possible due to usage of MULET [2].

In proposed approach, authors have applied different syndicate rules to encrypt multilingual data using multilingual keyset.

Authors' aim is to propose a SACA based multilingual encryption algorithm maintaining data security. Objectives of proposed multilingual approach are such as, to establish comparison between proposed multilingual encryption algorithm with existing


Abdelkader Hameurlain ·  
A Min Tjoa · Richard Chbeir (Eds.)

Transactions on  
Large-Scale  
Data- and Knowledge-  
Centered Systems XLVII

Special Issue on Digital Ecosystems  
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ISSN 0302-9743                      ISSN 1611-3349 (electronic)  
Lecture Notes in Computer Science  
ISSN 1869-1994                      ISSN 2510-4942 (electronic)  
Transactions on Large-Scale Data- and Knowledge-Centered Systems  
ISBN 978-3-662-62918-5            ISBN 978-3-662-62919-2 (eBook)  
<https://doi.org/10.1007/978-3-662-62919-2>

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# Contents

Mapping Experience Ecosystems as Emergent Actor-Created Spaces . . . . .	1
<i>Andrea Resmini and Bertil Lindenfalk</i>	
A Semantic-Based Strategy to Model Multimedia Social Networks . . . . .	29
<i>Kurosh Madani, Antonio M. Rinaldi, and Cristiano Russo</i>	
Social Big Data: Concepts and Theory. . . . .	51
<i>Hiroshi Ishikawa and Yukio Yamamoto</i>	
Social Big Data: Case Studies. . . . .	80
<i>Hiroshi Ishikawa and Yasushi Miyata</i>	
Data Analysis in Social Network: A Case Study . . . . .	112
<i>Mou De, Anirban Kundu, and Nivedita Ray De Sarkar</i>	
Smart Services Using Voice and Images . . . . .	137
<i>Alexander I. Iliev and Peter L. Stanchev</i>	
Big Spatial and Spatio-Temporal Data Analytics Systems. . . . .	155
<i>Polychronis Velentzas, Antonio Corral, and Michael Vassilakopoulos</i>	
Cloud Based e-Feedback Services Using Performance Analysis: A Linear Approach . . . . .	181
<i>Ayan Banerjee and Anirban Kundu</i>	
Semantic-Based Automatic Generation of Reconfigurable Distributed Mobile Applications in Pervasive Environments . . . . .	213
<i>Abderrahim Lakehal, Adel Alti, and Philippe Roose</i>	
<b>Author Index</b> . . . . .	235



# Cloud Based e-Feedback Services Using Performance Analysis: A Linear Approach

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**Abstract.** Authors propose an online feedback system having distinct layers to access frameworks through multiple entry points such as, student module, administration module, and teacher module which have been operated from any geographically distributed locations. There is no need to install software based application and no need of extra hardware expenses to access proposed cloud based system due to usage of software-as-a-service, and platform-as-a-service. Students provide specific information to server-side for authenticity regarding entry to feedback questionnaires. Administrative authorities analyze teacher performance based on students' feedback. Teacher observes individual performance from server. Human effort and human activities have been reduced due to usage of paperless feedback. Teacher performance is measured using preparedness, class-performance, responsiveness, effectiveness, and overall grade. Different nodes have been required in proposed system for distributing and replicating data storage in server-side. Time consumption and load distribution of servers are analyzed based on number of users and servers. Different nodes have been accessed by multiple users working with different or same modules of the system. Energy efficient framework has incorporated into proposed system to enhance system performance. Authors have incorporated different weightage factors in energy efficient framework using distinct layers of proposed system. Time complexity and space complexity are measured using proposed algorithms. Web based approach is required in proposed system to reduce manpower consumption and workload. Comparative study between existing feedback systems and proposed feedback system is established based on different characteristics.

**Keywords:** Cloud based feedback · Multi-user system · Online feedback · Distributed system · Energetic system · Paperless feedback

## 1 Introduction

Cloud consists of various web services and refers to distinct environment for remote accessing possibilities to the scalable heterogeneous network resources. Cloud Computing provides services to users at minimum cost and interference of service providers. Users access the services of distributed network on demand basis for utilizing a shared



# Data Analysis in Social Network: A Case Study

Mou De<sup>1,2</sup>(✉), Anirban Kundu<sup>1,2</sup>, and Nivedita Ray De Sarkar<sup>1,2</sup>

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**Abstract.** Authors propose a structural design of social networks to study architecture of social networking site and its working principles. Typical social networking sites have three-tier architecture which induces higher searching time for user queries. Our proposal presents a load balancing module for protecting user enquiries before spreading them to data server. In this chapter, query optimization of user queries for faster results has been discussed. Experimentation results exhibit possibilities of data (user queries) failure reduction due to external disturbances. Authors have analyzed large scale data of social network through graph for reducing data loss and minimal network failure to maintain scale free growth in Social network. Properties of interface module and growth coefficient are to be analyzed to exhibit benefits of proposed system architecture for balancing load from web server to data server through Hash table cache, Log table and index control module with scale-free query optimization.

**Keywords:** Social network (SN) · Query optimization · Social architecture · Distributed network · Data analysis

## 1 Introduction

SNs provide virtual connections among users by the use of specific domains according to users' choice like sports, cinema, music, and so on. A user is interconnected with SN using share, like, post and joins on particular domains to build their social relationships. User is able to like/follow other profiles unless it is blocked. Users also send friend requests to other persons for connecting to outer world based on particular choices [1–4]. Each social networking site [5–8] needs authenticated/valid users (registered users on particular site and their profiles are visible to public users) who are treated as existing users. Interaction between users through the friendship request using SN makes the relationship/ networking [9–12]. User exchanges their views with other users on SN platform to create a virtual network connectivity using web server and data server working on behalf of users.

User data analysis [13] has a major impact for maintaining data security and network connections among users of SN [14, 15]. In SN [16, 17], user networks are not always structured [18], and do not maintain specific patterns for communication purpose. It is necessary for flawless platform to understand and analyze [19–21] SN data according


Abdelkader Hameurlain ·  
A Min Tjoa · Richard Chbeir (Eds.)

Transactions on  
Large-Scale  
Data- and Knowledge-  
Centered Systems XLVII

Special Issue on Digital Ecosystems  
and Social Networks

*Editors-in-Chief*  
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*Guest Editor*  
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University of Pau and the Adour Region  
Anglet, France

ISSN 0302-9743                      ISSN 1611-3349 (electronic)  
Lecture Notes in Computer Science  
ISSN 1869-1994                      ISSN 2510-4942 (electronic)  
Transactions on Large-Scale Data- and Knowledge-Centered Systems  
ISBN 978-3-662-62918-5            ISBN 978-3-662-62919-2 (eBook)  
<https://doi.org/10.1007/978-3-662-62919-2>

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# Contents

Mapping Experience Ecosystems as Emergent Actor-Created Spaces . . . . .	1
<i>Andrea Resmini and Bertil Lindenfalk</i>	
A Semantic-Based Strategy to Model Multimedia Social Networks . . . . .	29
<i>Kurosh Madani, Antonio M. Rinaldi, and Cristiano Russo</i>	
Social Big Data: Concepts and Theory. . . . .	51
<i>Hiroshi Ishikawa and Yukio Yamamoto</i>	
Social Big Data: Case Studies. . . . .	80
<i>Hiroshi Ishikawa and Yasushi Miyata</i>	
Data Analysis in Social Network: A Case Study . . . . .	112
<i>Mou De, Anirban Kundu, and Nivedita Ray De Sarkar</i>	
Smart Services Using Voice and Images . . . . .	137
<i>Alexander I. Iliev and Peter L. Stanchev</i>	
Big Spatial and Spatio-Temporal Data Analytics Systems. . . . .	155
<i>Polychronis Velentzas, Antonio Corral, and Michael Vassilakopoulos</i>	
Cloud Based e-Feedback Services Using Performance Analysis: A Linear Approach . . . . .	181
<i>Ayan Banerjee and Anirban Kundu</i>	
Semantic-Based Automatic Generation of Reconfigurable Distributed Mobile Applications in Pervasive Environments . . . . .	213
<i>Abderrahim Lakehal, Adel Alti, and Philippe Roose</i>	
<b>Author Index</b> . . . . .	235

Debotosh Bhattacharjee · Dipak Kumar Kole ·  
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# Proceedings of International Conference on Frontiers in Computing and Systems

COMSYS 2020

 Springer

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ISSN 2194-5357

ISSN 2194-5365 (electronic)

Advances in Intelligent Systems and Computing

ISBN 978-981-15-7833-5

ISBN 978-981-15-7834-2 (eBook)

<https://doi.org/10.1007/978-981-15-7834-2>

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# Contents

## Computational Intelligence Track

<b>HOG and LBP Based Writer Verification</b> . . . . .	3
Jaya Paul, Anasua Sarkar, Nibaran Das, and Kaushik Roy	
<b>Implementation of Real-Time Virtual Dressing Room Using Microsoft Kinect SDK and Supervised Learning</b> . . . . .	13
Soma Bandyopadhyay, S. S. Thakur, and J. K. Mandal	
<b>Multiple Radar Data Fusion to Improve the Accuracy in Position Measurement Based on K-Means Algorithm</b> . . . . .	25
Sourav Kaity, Biswapati Jana, P K Das Gupta, and Saikat Das	
<b>A Brief Survey of Steganographic Methods for ECG Signal</b> . . . . .	35
Pushan Bhattacharjee, Debayan Ganguly, and Kingshuk Chatterjee	
<b>Spectral–Spatial Active Learning in Hyperspectral Image Classification Using Threshold-Free Attribute Profile</b> . . . . .	45
Kaushal Bhardwaj, Arundhati Das, and Swarnajyoti Patra	
<b>A Fuzzy Logic-Based Crop Recommendation System</b> . . . . .	57
Gouravmoy Banerjee, Uditendu Sarkar, and Indrajit Ghosh	
<b>Community Detection and Design of Recommendation System Based on Criminal Incidents</b> . . . . .	71
Sohom Roy, Sayan Kundu, Dhruvasish Sarkar, Chandan Giri, and Premananda Jana	
<b>Personalized Word Recommendation System Using Sentiment Analysis</b> . . . . .	81
Subhra Samir Kundu, Krutika Desai, Soumyajit Ghosh, and Dhruvasish Sarkar	

<b>Simulative Performance Analysis of All Optical Universal Logic TAND Gate Using Reflective Semiconductor Optical Amplifier (RSOA)</b> .....	95
Kajal Maji, Kousik Mukherjee, and Mrinal Kanti Mandal	
<b>Development of a Publicly Available Terahertz Video Dataset and a Software Platform for Experimenting with the Intelligent Terahertz Visual Surveillance</b> .....	105
Alexei A. Morozov and Olga S. Sushkova	
<b>Identification of Plant Species Using Deep Learning</b> .....	115
S. K. Mahmudul Hassan and Arnab Kumar Maji	
<b>A Hybrid Approach for Segmenting Grey and White Matter from Brain Magnetic Resonance Imaging (MRI)</b> .....	127
Ruhul Amin Hazarika, Khrawnam Kharkongor, Arnab Kumar Maji, Debdatta Kandar, and Sugata Sanyal	
<b>Retinal Vessel Segmentation Using Unsharp Masking and Otsu Thresholding</b> .....	139
Sk Latib, Diksha Saha, and Chandan Giri	
<b>Region Growing-Based Scheme for Extraction of Text from Scene Images</b> .....	149
Ranjit Ghoshal and Ayan Banerjee	
<b>An Automated Reflector Based Traffic Signal System</b> .....	157
Somasree Bhadra, Sunirmal Khatua, and Anirban Kundu	
<b>A Novel Sentence Scoring Method for Extractive Text Summarization</b> .....	169
Kamal Sarkar and Sohini Roy Chowdhury	
<b>A Novel Approach for Face Recognition Using Modular PCA and MAP-MRF Classifier</b> .....	181
Sumit Majumdar, Avijit Bose, and Prasenjit Das	
<b>A “Bright-on-Dark, Dark-on-Bright” Approach to Multi-lingual Scene Text Detection</b> .....	191
Neelotpai Chakraborty, Ayatullah Faruk Mollah, Subhadip Basu, and Ram Sarkar	
<b>Pig Breed Detection Using Faster R-CNN</b> .....	201
Pritam Ghosh, Subhranil Mustafi, Kaushik Mukherjee, Sanket Dan, Kunal Roy, and Satyendra Nath Mandal	
<b>Black Bengal Goat Identification Using Iris Images</b> .....	213
Subhojit Roy, Sanket Dan, Kaushik Mukherjee, Satyendra Nath Mandal, Dilip Kumar Hajra, Santanu Banik, and Syamal Naskar	

**Component-level Script Classification Benchmark with CNN on AUTNT Dataset** . . . . . 225  
 Tauseef Khan and Ayatullah Faruk Mollah

**Analysis of Diabetic Retinopathy Abnormalities Detection Techniques** . . . . . 235  
 Sudipta Dandapat, Soumil Ghosh, Shukrity Si, and Anisha Datta

**Supervised Change Detection Technique on Remote Sensing Images Using F-Distribution and MRF Model** . . . . . 249  
 Srija Raha, Kasturi Saha, Shreya Sil, and Amiya Halder

**A New Technique for Estimating Fractal Dimension of Color Images** . . . . . 257  
 Chinmaya Panigrahy, Ayan Seal, and Nihar Kumar Mahato

**Deep Neural Network for Multivariate Time-Series Forecasting** . . . . . 267  
 Samit Bhanja and Abhishek Das

**Study on Information Diffusion in Online Social Network** . . . . . 279  
 Sutapa Bhattacharya and Dhruvasish Sarkar

**A Multi-layer Content Filtration of Textual Data for Periodic Report Generation in Post-disaster Scenario** . . . . . 289  
 Sudakshina Dasgupta, Indrajit Bhattacharya, and Tamal Mondal

**Categorization of Videos Based on Text Using Multinomial Naïve Bayes Classifier** . . . . . 299  
 Arghyadip Sinha and Jayjeet Ganguly

**Improved Multi-scale Opening Algorithm Using Fuzzy Distance Transform Based Geodesic Path Propagation** . . . . . 309  
 Nirmal Das, Indranil Guha, Punam K. Saha, and Subhadip Basu

**Voice-Based Railway Station Identification Using LSTM Approach** . . . . . 319  
 Bachchu Paul, Somnath Bera, Tanushree Dey, and Santanu Phadikar

**Voting in Watts-Strogatz Small-World Network** . . . . . 329  
 Soujanya Ray, Kingshuk Chatterjee, Ritaji Majumdar, and Debayan Ganguly

**Transfer Learning in Skin Lesion Classification** . . . . . 343  
 Samrat Mukherjee and Debayan Ganguly

**Knowledge-Based Expert System for Diagnosis of Agricultural Crops** . . . . . 351  
 Subhankar Halder and Sourav Kumar Singh

**An Effective Hybrid Statistical and Learning Based Approach to Confined Domain of a Web Document from Corpus** . . . . . 361  
 Amit Dutta

<b>Face Recognition Using Siamese Network</b> .....	369
Srinibas Rana and Dakshina Ranjan Kisku	
<b>Contrast Enhancement Algorithm Using Definite Integration Mathematical Method Trapezoidal Rule</b> .....	377
Amiya Halder and Nikita Shah	
<b>Self Organizing Map-Based Strategic Placement and Task Assignment for a Multi-agent System</b> .....	387
Mukund Subhash Ghole, Arabinda Ghosh, Arindam Singha, Chinmay Das, and Anjan Kumar Ray	
<b>Classification of Indian Languages Through Audio</b> .....	401
Samim Raja, Suchibrota Dutta, Debanjan Banerjee, and Arijit Ghosal	
<b>Neural Dynamics-based Complete Coverage of Grid Environment by Mobile Robots</b> .....	411
Arindam Singha, Anjan Kumar Ray, and Arun Baran Samaddar	
<b>Solving Student Project Allocation with Preference Through Weights</b> .....	423
Juwesh Binong	
<b>Computational Biology Track</b>	
<b>Deep Learning-Based Automated Detection of Age-Related Macular Degeneration from Retinal Fundus Images</b> .....	433
Rivu Chakraborty and Ankita Pramanik	
<b>An Artificial Bee Colony Inspired Density-Based Approach for Clustering with New Index Measure</b> .....	443
Ankita Bose and Kalyani Mali	
<b>An Investigation of Accelerometer Signals in the 0.5–4 Hz Range in Parkinson’s Disease and Essential Tremor Patients</b> .....	455
Olga S. Sushkova, Alexei A. Morozov, Alexandra V. Gabova, Alexei V. Karabanov, and Larisa A. Chigaleychik	
<b>Simulation of Action Potential Duration and Its Dependence on <math>[K]_O</math> and <math>[Na]_i</math> in the Luo-Rudy Phase I Model</b> .....	463
Ursa Maity, Anindita Ganguly, and Aparajita Sengupta	
<b>Automated Classification and Detection of Malaria Cell Using Computer Vision</b> .....	473
Subhrasankar Chatterjee and Pritha Majumder	
<b>A Novel Approach to 3D Face Registration for Biometric Analysis Using RCompute_ICP</b> .....	483
Parama Bagchi, Debotosh Bhattacharjee, and Mita Nasipuri	

**Sequence Characterization of Glutamate Receptor Genes of Rat (Vertebrate) and Arabidopsis Thaliana (Plant)** . . . . . 495  
 Antara Sengupta, Pabitra Pal Choudhury, and Subhadip Chakraborty

**The Estimation of Inter-Channel Phase Synchronization of EEG Signals in Patients with Traumatic Brain Injury Before and Post the Rehabilitation** . . . . . 511  
 Renata A. Tolmacheva, Yury V. Obukhov, and Ludmila A. Zhavoronkova

**Identification of Differentially Expressed Genes Using Deep Learning in Bioinformatics** . . . . . 521  
 Srirupa Dasgupta, Supriti Mondal, Abhinandan Khan, Rajat Kumar Pal, and Goutam Saha

**An Efficient Region of Interest Detection and Segmentation in MRI Images Using Optimal ANFIS Network** . . . . . 533  
 K. Amal Thomas, S.P. Kaarmukilan, Sucheta Biswas, and Soumyajit Poddar

**Follicle Segmentation Using K-Means Clustering from Ultrasound Image of Ovary** . . . . . 545  
 Ardhendu Mandal, Debasmita Saha, and Manas Sarkar

**Follicle Segmentation from Ovarian USG Image Using Horizontal Window Filtering and Filled Convex Hull Technique** . . . . . 555  
 Ardhendu Mandal, Manas Sarkar, and Debasmita Saha

**Evolution of E-Sensing Technology** . . . . . 565  
 Aramita De Das and Ankita Pramanik

**Extraction of Leaf-Vein Parameters and Classification of Plants Using Machine Learning** . . . . . 579  
 Guruprasad Samanta, Amlan Chakrabarti, and Bhargab B. Bhattacharya

**Individual Pig Recognition Based on Ear Images** . . . . . 587  
 Sanket Dan, Kaushik Mukherjee, Subhojit Roy, Satyendra Nath Mandal, Dilip Kumar Hajra, and Santanu Banik

**Analysis of Large-Scale Human Protein Sequences Using an Efficient Spark-Based DBSCAN Algorithm** . . . . . 601  
 Soumyendu Sekhar Bandyopadhyay, Anup Kumar Halder, Piyali Chatterjee, Jacek Sroka, Mita Nasipuri, and Subhadip Basu

**Biomolecular Clusters Identification in Linear Time Complexity for Biological Networks** . . . . . 611  
 Soumyadeep Debnath, Somnath Rakshit, Kaustav Sengupta, and Dariusz Plewczynski

## Security Track

<b>Prevention of the Man-in-the-Middle Attack on Diffie–Hellman Key Exchange Algorithm: A Review</b> . . . . .	625
Samrat Mitra, Samanwita Das, and Malay Kule	
<b>Blind Source Camera Identification of Online Social Network Images Using Adaptive Thresholding Technique</b> . . . . .	637
Bhola Nath Sarkar, Sayantani Barman, and Ruchira Naskar	
<b>Event-B Based Formal Modeling of a Controller: A Case Study</b> . . . . .	649
Rahul Karmakar, Bidyut Biman Sarkar, and Nabendu Chaki	
<b>High Payload RDH Through Directional PVO Exploiting Center-Folding Strategy</b> . . . . .	659
Meikap Sudipta, Jana Biswapati, Bera Prasenjit, and Singh Prabhash Kumar	
<b>A Robust Audio Authentication Scheme Using (11,7) Hamming Error Correcting Code</b> . . . . .	671
Datta Kankana and Jana Biswapati	
<b>Authentication on Interpolated Subsampled Based Image Steganography Exploiting Secret Sharing</b> . . . . .	681
Jana Manasi and Jana Biswapati	
<b>Evolving Secret Sharing with Essential Participants</b> . . . . .	691
Jyotirmoy Pramanik and Avishek Adhikari	
<b>A New Lossless Secret Image Sharing Scheme for Grayscale Images with Small Shadow Size</b> . . . . .	701
Md. K. Sardar and Avishek Adhikari	
<b>Multi-factor Authentication-Based E-Exam Management System (EEMS)</b> . . . . .	711
Sharthak Mallik, Shovan Halder, Pranay Saha, and Saswati Mukherjee	
<b>A Novel High-Density Multilayered Audio Steganography Technique in Hybrid Domain</b> . . . . .	721
Dipankar Pal, Anirban Goswami, Soumit Chowdhury, and Nabin Ghoshal	
<b>Multi Data Driven Validation of E-Document Using Concern Authentic Multi-signature Combinations</b> . . . . .	731
Soumit Chowdhury, Sontu Mistry, Anirban Goswami, Dipankar Pal, and Nabin Ghoshal	
<b>A Survey Report on Underwater Acoustic Channel Estimation of MIMO-OFDM System</b> . . . . .	745
Avik Kumar Das and Ankita Pramanik	

**Vulnerability of Cloud: Analysis of XML Signature Wrapping Attack and Countermeasures** . . . . . 755  
 Subrata Modak, Koushik Majumder, and Debashis De

**VLSI Track**

**Verification of Truth Table Minimization Using Min Term Generation Algorithm Weighted Sum Method** . . . . . 769  
 Rohit Kumar Baranwal, Debapriyo Saurav Mazumdar, Niladri Pramanik, and Jishan Mehedi

**A Supervised Trajectory Anomaly Detection Using Velocity and Path Deviation** . . . . . 777  
 Suman Mondal, Arindam Roy, and Sukumar Mandal

**Modular Secured IoT Using SHAKTI** . . . . . 785  
 Soutrick Roy Chowdhury, Aishwarjyamoy Mukherjee, S. Madan Kumar, Kotteeswaran, Anand, N. Sathya Narayanan, and Shankar Raman

**Test-Bench Setup for Testing and Calibration of a Newly Developed STS/MUCH-XYTER ASIC for CBM-MUCH Detectors** . . . . . 795  
 Jogender Saini, Gitesh Sikder, Amlan Chakrabarti, and Subhasis Chattopadhyay

**A New Function Mapping Approach in Defective Nanocrossbar Array Using Unique Number Sequence** . . . . . 805  
 Tanmoy Chaku, Mahaswata Kundu, Debanjan Dhara, and Malay Kule

**Tunneling Barrier Modulation in Negative Capacitance-TFET** . . . . . 815  
 Anup Dey and Ruben Ray

**Page Replacement Technique on the Basis of Frequency of Occurrence of Pages** . . . . . 823  
 Sayak Das, Nirvik Ranjan Das, Soumik Kr. Basu, Hridhhi Mondal, and Avijit Bose

**Fault-Tolerant Implementation of Quantum Arithmetic and Logical Unit (QALU) Using Clifford+T-Group** . . . . . 833  
 Laxmidhar Biswal, Chandan Bandyopadhyay, Sudip Ghosh, and Hafizur Rahaman

**Approximation of Fractional-Order Integrator in Delta Domain** . . . . . 845  
 Jaydeep Swarnakar

**Design of Ternary Content-Addressable Memory Using CNTFET** . . . . . 853  
 Vikash Prasad and Debaprasad Das

**3-D IC: An Overview of Technologies, Design Methodology, and Test Strategies** . . . . . 859  
 Pranab Roy, Arko Dutt, and Hafizur Rahaman

**Oh Dear! It’s Just a Tool to Plan the Deployment of a Post-Disaster Network!** ..... 873  
Partha Sarathi Paul, Krishnandu Hazra, Sujoy Saha, and Subrata Nandi

**A Reconfigurable Architecture to Implement Linear Transforms of Image Processing Applications** ..... 881  
Atri Sanyal and Amitabha Sinha

**Introduction of Fuzzy Logic Controller in a Modified Phase-Locked Frequency Divider Leading to an Exceptional Noise Rejection** ..... 893  
B. Chatterjee and S. Sarkar

**IoT in Agriculture: Smart Farming Using MQTT Protocol Through Cost-Effective Heterogeneous Sensors**..... 903  
Santanu Mandal, Imran Ali, and Sujoy Saha

**High-Speed Low-Power CML Technique-Based Frequency Divider in 180 nm Technology** ..... 915  
Swarup Dandapat, Shrabanti Das, Moumita Das, and Sayan Chatterjee

**Correction to: Extraction of Leaf-Vein Parameters and Classification of Plants Using Machine Learning** ..... C1  
Guruprasad Samanta, Amlan Chakrabarti, and Bhargab B. Bhattacharya

# An Automated Reflector Based Traffic Signal System



Somasree Bhadra, Sunirmal Khatua, and Anirban Kundu

**Abstract** Smart traffic automation is an integral part of smart cities in recent days. Huge amount of energy and power is consumed by the usage of high end computers and electronic devices. An energy optimization technique is proposed in this paper to minimize energy dissipation and power consumption by the existing traffic systems. Green computing concept is implemented in automated traffic system. It is observed that a remarkable amount of energy is dissipated and eventually wasted due to the use of regular electric lights at traffic points. ‘Traffic Reflector’ concept is introduced in place of regular traffic lights. LED lights or incandescent bulbs in the traffic signal posts would be replaced by the reflectors. Sunlight would be focused on these reflectors by properly placed mirrors. Mirrors would be adjusted automatically to change their angles according to sun’s position. Light source would be replaced by solar panel driven light in the absence of sunlight at night or other weather conditions. Energy consumption by traffic signal lights at traffic signal points is minimized by our proposed approach.

**Keywords** Smart traffic · Green computing · Energy · Reflector · Traffic signal lights

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# Computational Intelligence in Pattern Recognition

Proceedings of CIPR 2022

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ISSN 2367-3370

ISSN 2367-3389 (electronic)

Lecture Notes in Networks and Systems

ISBN 978-981-19-3088-1

ISBN 978-981-19-3089-8 (eBook)

<https://doi.org/10.1007/978-981-19-3089-8>

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# Contents

<b>COVID-19 Detection Using Deep Learning: A Comparative Study of Segmentation Algorithms</b> . . . . .	1
Pranchal Sihare, Azeem Ullah Khan, Poritosh Bardhan, and B. K. Tripathy	
<b>Time Series Analysis on Covid 19 Summarized Twitter Data Using Modified TextRank</b> . . . . .	11
Ajit Kumar Das, Kushagra Chitkara, and Apurba Sarkar	
<b>Low-Computation IoT System Framework for Face Recognition Using Deep Learning Algorithm</b> . . . . .	24
Jayanta Paul, Rajat Subhra Bhowmick, and Jaya Sil	
<b>Vehicle Number Plate Recognition System</b> . . . . .	36
Ibidun Christiana Obagbuwa, Vincent Mohale Zibi, and Mishi Makade	
<b>An Approach to Medical Diagnosis Using Smart Chatbot</b> . . . . .	43
Shreya Verma, Mansi Singh, Ishita Tiwari, and B. K. Tripathy	
<b>Performance Analysis of Hybrid Filter Using PI and PI-Fuzzy Based UVTG Technique</b> . . . . .	57
B. Pavankumar and Saroj Pradhan	
<b>Transmission of Aggregated Data in LOADng-Based IoT Networks</b> . . . . .	67
Sayeda Suaiba Anwar and Asaduzzaman	
<b>Deep Learning Based Facial Mask Detection Using Mobilenetv2</b> . . . . .	77
Arijit Goswami, Biswarup Bhattacharjee, Rahul Debnath, Ankita Sikder, and Sudipta Basu Pal	
<b>A Novel Approach to Detect Power Theft in a Distribution System Using Machine Learning and Artificial Intelligence</b> . . . . .	90
Abhinandan De, Somesh Lahiri Chakravarty, Sayan Kar, Abhijnan Maiti, and Sanchari Chatterjee	

**Adversarial Surround Localization and Robust Obstacle Detection with Point Cloud Mapping** . . . . . 100  
Rapti Chaudhuri and Suman Deb

**Perceptive Analysis of Chronic Kidney Disease Data Through Conceptual Visualization** . . . . . 110  
P. Antony Seba and J. V. Bibal Benifa

**Islanding Detection in Microgrid Using Decision Tree Pattern Classifier** . . . . . 123  
Shyamal Das and Abhinandan De

**Identification of Lung Cancer Nodules from CT Images Using 2D Convolutional Neural Networks** . . . . . 133  
Sutrisna Anjoy, Paramita De, and Sekhar Mandal

**A Pixel Dependent Adaptive Gamma Correction Based Image Enhancement Technique** . . . . . 141  
Satyajit Panigrahi, Abhinandan Roul, and Rajashree Dash

**Summarization of Comic Videos** . . . . . 151  
Tanushree Das, Arpita Dutta, and Samit Biswas

**TextUnet: Text Segmentation Using U-net** . . . . . 163  
Awritrojit Banerjee, Ranjit Ghoshal, and Arijit Ghosal

**A Survey on Prediction of Heart Disease Using Machine Intelligence Techniques** . . . . . 173  
Farzana Begum and J. Arul Valan

**Predictive Analysis of Child’s Mental Health/Psychology During the COVID-19 Pandemic** . . . . . 183  
Sandipan Saha, Sandip Murmu, Surajit Manna, Bappaditya Chowdhury, and Nibaran Das

**Impact of Security in Blockchain Based Real Time Applications** . . . . . 193  
Ankush Kumar Gaur and J. Arul Valan

**An Evaluative Review on Various Tele-Health Systems Proposed in COVID Phase** . . . . . 201  
Tanima Bhowmik, Rohan Mojumder, Dibyendu Ghosh, and Indrajit Banerjee

**Efficient Scheduling Algorithm Based on Duty-Cycle for e-Health Monitoring System** . . . . . 211  
Tanima Bhowmik, Rohan Mojumder, Dibyendu Ghosh, and Indrajit Banerjee

**Image Splicing Detection Using Feature Based Machine Learning Methods and Deep Learning Mechanisms** . . . . . 221  
Debjit Das and Ruchira Naskar

**Audio Driven Artificial Video Face Synthesis Using GAN and Machine Learning Approaches . . . . .** 233  
 Arnab Kumar Das and Ruchira Naskar

**Design of an Elevator Traffic System Using MATLAB Simulation . . . . .** 245  
 Ibidun Christiana Obagbuwa and Morapedi Tshepang Duncan

**A Simple Strategy for Handling ‘NOT’ Can Improve the Performance of Sentiment Analysis . . . . .** 255  
 Ranit Kumar Dey and Asit Kumar Das

**Rule Based Classification Using Particle Swarm Optimization for Heart Disease Prediction . . . . .** 268  
 Udita Basu, Shraya Majumdar, Shreyasee Dutta, Soumyajit Mullick, Sagnik Ganguly, and Priyanka Das

**A Deep Learning Based Approach to Measure Confidence for Virtual Interviews . . . . .** 278  
 Ravi Kumar Rungta, Parth Jaiswal, and B. K. Tripathy

**A Commercial Banking Industry Resilience in the Case of Pandemic: An Impact Analysis Through ANOVA . . . . .** 292  
 Sweta Mishra, Shikta Singh, and Debabrata Singh

**Fractal Analysis of RGB Color Images . . . . .** 304  
 Sukanta Kumar Das, Jibitesh Mishra, and Soumya Ranjan Nayak

**Deep Features for COVID-19 Detection: Performance Evaluation on Multiple Classifiers . . . . .** 313  
 Asifuzzaman Lasker, Mridul Ghosh, Sk Md Obaidullah, Chandan Chakraborty, and Kaushik Roy

**Issues, Challenges, and Possibilities in IoT and Cloud Computing . . . . .** 326  
 Vinay Kumar Mishra, Rajeev Tripathi, Raj Gaurang Tiwari, Alok Misra, and Sandeep Kumar Yadav

**Agricultural Image Augmentation with Generative Adversarial Networks GANs . . . . .** 335  
 Sayan De, Ishita Bhakta, Santanu Phadikar, and Koushik Majumder

**Thermal Image Augmentation with Generative Adversarial Network for Agricultural Disease Prediction . . . . .** 345  
 Ishita Bhakta, Santanu Phadikar, and Koushik Majumder

**Learning Temporal Mobility Patterns to Improve QoS in Mobile Wireless Communications . . . . .** 355  
 Satyaki Roy, Bilas Chandra, Anubhav Anand, Preetam Ghosh, and Nirnay Ghosh

<b>Automatic Question Generation from Video</b> .....	366
T. Janani Priya, K. P. Sabari Priya, L. Raxxelyn Jenneyl, and K. V. Uma	
<b>Features Selection for Vessel Extraction Inspired by Survival of the Fittest Method</b> .....	373
Sumit Mukherjee, Ranjit Ghoshal, and Bibhas Chandra Dhara	
<b>A Proposed Federated Learning Model for Vaccination Tweets</b> .....	383
Medha Singh, Madhulika, and Shefali Bansal	
<b>A New Reversible Data Hiding Scheme by Altering Interpolated Pixels Exploiting Neighbor Mean Interpolation (NMI)</b> .....	393
Manasi Jana, Shubhankar Joardar, and Biswapati Jana	
<b>A Proposed Fuzzy Logic Model for Waste Water Treatment Analysis</b> .....	403
Kanishk Srivastava, Chirag Handa, and Madhulika	
<b>Deep Learning Based Identification of Three Exotic Carps</b> .....	416
Arnab Banerjee, Roopsia Chakraborty, Samarendra Behra, Nagesh Talagunda Srinivasan, Debotosh Bhattacharjee, and Nibarun Das	
<b>Single Image Fog Removal Using WLS Smoothing Filter Combining CLAHE with DWT</b> .....	427
Soumya Chakraborty, Biswapati Jana, and Sharmistha Jana	
<b>Smart Surveillance Video Monitoring for Home Intruder Detection Using Deep Neural Network</b> .....	437
Rishav Chakraborty, Shubham Kumar, Subhadip De, and Oishila Bandyopadhyay	
<b><i>is</i>-Entropy: A Novel Uncertainty Measure for Image Segmentation</b> . . . .	448
Bhaveshkumar Choithram Dharmani	
<b>AGC Based Market Modeling of Deregulated Power System Employing Electric Vehicles and Battery Energy Storage System</b> .....	458
Debdeep Saha, Rajesh Panda, and Bipul Kumar Talukdar	
<b>Acute Lymphocytic Leukemia Classification Using Color and Geometry Based Features</b> .....	469
Sourav Chandra Mandal, Oishila Bandyopadhyay, and Sanjoy Pratihar	
<b>Thermal Strain Resolution Improvement in Brillouin OTDR Based DTS System Using LWT-MPSO Technique</b> .....	479
Ramji Tangudu and P. Sirish Kumar	
<b>Wrapper Based Feature Selection Approach Using Black Widow Optimization Algorithm for Data Classification</b> .....	487
Himanshu Dutta, Mahendra Kumar Gourisaria, and Himansu Das	

**Multi-objective Optimization for Complex Trajectory Tracking of 6-DOF Robotic Arm Manipulators** . . . . . 497  
 Bivash Chakraborty, Rajarshi Mukhopadhyay, and Paramita Chattopadhyay

**MANDS: Malicious Node Detection System for Sinkhole Attack in WSN Using DRI and Cross Check Method** . . . . . 511  
 Minakshi Sahu, Nilambar Sethi, Susant Kumar Das, and Umashankar Ghugar

**An Intelligent Framework Towards Managing Big Data in Internet of Healthcare Things** . . . . . 520  
 Sujit Bebortta and Sumanta Kumar Singh

**Deep Learning Approach for Anomaly Detection in CAN Bus Network: An Intelligent LSTM-Based Intrusion Detection System** . . . . . 531  
 Ch. Ravi Kishore, D. Chandrasekhar Rao, and H. S. Behera

**Predictive Geospatial Crime Data Analysis and Their Association with Demographic Features Through Machine Learning Approaches** . . . . . 545  
 Anupam Mukherjee and Anupam Ghosh

**Design of an Image Transmission System Employing a Hybridization of Bit-Plane Slicing, Run-Length Encoding and Vector Quantization Based Visual Cryptography Scheme** . . . . . 558  
 Surya Sarathi Das and Kaushik Das Sharma

**Gravitational Search Optimized Light Gradient Boosting Machine for Identification of Malicious Access in IoT Network** . . . . . 570  
 Geetanjali Bhoi, Bighnaraj Naik, Etuari Oram, and S. Vimal

**A Hybrid Semi-supervised Learning with Nature-Inspired Optimization for Intrusion Detection System in IoT Environment** . . . . . 580  
 Dukka Karun Kumar Reddy, Janmenjoy Nayak, and H. S. Behera

**Secure Sharing of Medical Images Using Watermarking Technique** . . . . . 592  
 Priyanka Priyadarshini, Alina Dash, and Kshiramani Naik

**An Impact Study on Covid-19 with Sustainable Sports Tourism: Intelligent Solutions, Issues and Future Challenges** . . . . . 605  
 Saumendra Das, Janmenjoy Nayak, and Sharmila Subudhi

**Deep Learning Based Framework for Breast Cancer Mammography Classification Using Resnet50** . . . . . 625  
 Pandit Byomakesha Dash, H. S. Behera, and Manas Ranjan Senapati

**A Game Theoretic Group Coordination Strategy for Multi Robot Navigation** ..... 634  
Buddhadeb Pradhan, Jnyana Ranjan Mohanty, Rabindra Kumar Barik, and Diptendu Sinha Roy

**Moth Flame Optimization Algorithm Optimized Modified TID Controller for Automatic Generation Control of Multi Area Power System** ..... 644  
K. Alfoni Jose, G. Raam Dheep, and Tulasichandra Sekhar Gorripotu

**Identification of Malicious Access in IoT Network by Using Artificial Physics Optimized Light Gradient Boosting Machine** ..... 653  
Etuari Oram, Bighnaraj Naik, Manas Ranjan Senapati, and Geetanjali Bhoi

**Author Index** ..... 663



# Predictive Geospatial Crime Data Analysis and Their Association with Demographic Features Through Machine Learning Approaches

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**Abstract.** Crime is a socioeconomic issue that has a negative impact on life quality and economic progress. By identifying crime trends, we will be able to handle difficulties with unique strategies in different criminal categories and improve societal security. This research focuses on the Vancouver crime dataset, with the goal of analyzing and predicting crimes in states using machine learning algorithms. In this work, we develop a model that can be used to estimate the number of crimes committed by category in a given state. Machine learning algorithms have exploded in popularity, making crime prediction possible based on historical data. This work mainly creates ensembled models that perform significantly better results with respect to stability, accuracy and provide more accurate forecasting results compare to the existing algorithms. If we follow data decomposition techniques based on district-wise accuracy rate then the result will outperform the existing methodologies. Geo-spatial crime data analysis is another significant aspect of this work.

**Keywords:** Geo spatial heat map · Regression · Random forest · Gradient boost · Naïve Bayes · Generalized linear model · Decision tree

## 1 Introduction

Criminal investigation is a law enforcement activity that includes systematic investigation of trends and patterns in crime and violence. Crime analysis also helps in identifying remedies to crime problems and developing crime prevention methods. Crime investigation is the methodical study of antisocial behavior complications, in addition to other law enforcement issues, such as socio-demographic, geographic, and sequential aspects. Crime analysis, in particular, makes use of both qualitative and quantitative data and procedures [1]. When examining non-numerical data for the purpose of identifying fundamental reasons of corruption, crime predictors employ qualitative data and methodologies. Field research is one of the qualitative tools used in crime analysis (analyzing

# A Novel Noise Removal Technique Influenced by Deep Convolutional Autoencoders on Mammograms



Swarup Kr Ghosh, Biswajit Biswas, and Anupam Ghosh

**Abstract** Nowadays a lot of deep learning algorithm has been developing for data analytics on both structured and unstructured data. There is a big challenge for biomedical image such as CT image, MRI, X-ray for automatic detection of some deadly diseases. A field of advance deep learning that made available a plethora of architecture as increase the dimension and complexity of the mammogram images has been focused, in this study. Removal of noise is a crucial part for better visibility of noisy mammograms and hence a deep learning method for degrading mammogram restoration scheme has been suggested in this chapter. A deep convolutional denoising autoencoder method based on total variational multi-norm loss function minimization approach has been introduced for the restoration of mammograms. The proposed scheme is utilized to restore the perceptible structural details of mammograms as well as decrease the noise level. Moreover, processing speed for target noisy images is faster than other methods after fine tuning the network. The proposed method has been validated by several state-of-the-art methods.

## 1 Introduction

Recently, deep learning is becoming very popular tool for feature extraction and classification on large datasets since deep learning in contrast advocates solving the problem end-to-end and creation of abstract feature is a nice property of it. The concept of deep learning is originated from an artificial neural network (ANN). Deep learning takes place a crucial role on medical imaging such that image

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# Deep Learning in Data Analytics

Recent Techniques, Practices  
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ISSN 2197-6503

Studies in Big Data

ISBN 978-3-030-75854-7

<https://doi.org/10.1007/978-3-030-75855-4>

ISSN 2197-6511 (electronic)

ISBN 978-3-030-75855-4 (eBook)

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The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

# Contents

<b>Theoretical Foundation of Deep Learning Theory and Analysis</b>	
<b>A Study on Discrete Action Sequences Using Deep Emotional Intelligence</b> .....	3
R. Santhoshkumar and M. Kalaiselvi Geetha	
<b>A Novel Noise Removal Technique Influenced by Deep Convolutional Autoencoders on Mammograms</b> .....	25
Swarup Kr Ghosh, Biswajit Biswas, and Anupam Ghosh	
<b>A High Security Framework Through Human Brain Using Algo Mixture Model Deep Learning Algorithm</b> .....	45
S. Balakrishnan, J. P. Ananth, L. Ramanathan, R. Sachinkanithkar, and S. Rajkumar	
<b>Knowledge Framework for Deep Learning: Congenital Heart Disease</b> .....	61
Ritu Chauhan and Harleen Kaur	
<b>Computing System and Machine Learning</b>	
<b>Automatic Image Segmentation by Ranking Based SVM in Convolutional Neural Network on Diabetic Fundus Image</b> .....	77
Biswajit Biswas, Swarup Kr Ghosh, and Anupam Ghosh	
<b>Deep Learning in Healthcare</b> .....	97
Deeksha Kaul, Harika Raju, and B. K. Tripathy	
<b>On the Study of Machine Learning Algorithms Towards Healthcare Applications</b> .....	117
Shanmuganathan Harinee and Anand Mahendran	
<b>A Predictive Data Analytic Approach to Get Insight of Healthcare Databases</b> .....	131
Ritu Chauhan and Harleen Kaur	

**Deep Learning Algorithms**

**A Survey on Deep Learning Methodologies of Recent Applications . . . . . 145**

Amit Adate and B. K. Tripathy

**An Extensive Study of Privacy Preserving Recommendation System Using Collaborative Filtering . . . . . 171**

Abhaya Kumar Sahoo, Chittaranjan Pradhan, Brojo Kishore Mishra, and Bhabani Shankar Prasad Mishra

**A Comparative Study of Nature-Inspired Algorithm Based Hybrid Neural Network Training Algorithms in Data Classification . . . . . 191**

Sudarshan Nandy and Anirban Mitra

**Anomaly Credit Card Fraud Detection Using Deep Learning . . . . . 207**

Ezz El-Din Hemdan and D. H. Manjaiah

**Applications of Deep Learning Techniques**

**Application of Deep Learning for Energy Management in Smart Grid . . . . . 221**

Sourasekhar Banerjee, Soumitra Ghosh, and Brojo Kishore Mishra

**Cost Optimization of Software Quality Assurance . . . . . 241**

Soobia Saeed, N. Z. Jhanjhi, Syed Mehmood Raza Naqvi, and Azeem Khan

**Analytical Approach for Security of Sensitive Business Cloud . . . . . 257**

Soobia Saeed, N. Z. Jhanjhi, Syed Mehmood Raza Naqvi, and Azeem Khan

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# Understanding COVID-19: The Role of Computational Intelligence

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ISSN 1860-949X

ISSN 1860-9503 (electronic)

Studies in Computational Intelligence

ISBN 978-3-030-74760-2

ISBN 978-3-030-74761-9 (eBook)

<https://doi.org/10.1007/978-3-030-74761-9>

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The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

# Contents

<b>Learning from Various Modalities of COVID-19 Data</b>	
<b>COVID-19 Pandemic: Theory, Concepts and Challenges</b> . . . . .	3
Anindya Banerjee, Raj krishan Ghosh, Surajit Basak, and Arijit Dey	
<b>Evolutionary Algorithm Based Summarization for Analyzing COVID-19 Medical Reports</b> . . . . .	31
Chirantana Mallick, Sunanda Das, and Asit Kumar Das	
<b>Chest CT in COVID-19 Pneumonia: Potentials and Limitations of Radiomics and Artificial Intelligence</b> . . . . .	59
Federica Vernuccio, Giuseppe Cutaia, Roberto Cannella, Laura Vernuccio, Roberto Lagalla, and Massimo Midiri	
<b>Use of Deep Learning Based Frameworks on Pixel Scaled Images of Chest CT Scans for Detection of COVID-19</b> . . . . .	77
Sushant Shetty, Amit Gawade, and Subodh Deolekar	
<b>SARS-CoV-2 Infection and Antibody-Dependent Enhancement</b> . . . . .	101
Aliye Bastug and Hurrem Bodur	
<b>Graph-Based Clustering Algorithm for Social Community Transmission Control of COVID-19 During Lockdown</b> . . . . .	115
Varun Nagesh Jolly Behera, Ashish Ranjan, and Motahar Reza	
<b>COVID-19 Recommendation System of Chest X-Ray Images Using CNN Deep Learning Technique with Optimizers and Activation Functions</b> . . . . .	141
Niyati Sinha, Puhup Karjee, Riddhi Agrawal, Ankita Banerjee, and Chittaranjan Pradhan	
<b>Application of Deep Learning Techniques for COVID-19 Management</b> . . . . .	165
Rajan Gupta, Anshuman Gupta, Manan Bedi, and Saibal K. Pal	

<b>Prediction and Risk Analysis of COVID-19 Susceptibility</b>	
<b>An Exploratory Study of Disaster Risk Management Mobile Applications in Pandemic Periods . . . . .</b>	<b>201</b>
K Saravanan, K. Ramesh, V. Sri Vigna Hema, and S. Viganesh	
<b>Potential of Deep Learning Algorithms in Mitigating the Spread of COVID-19 . . . . .</b>	<b>225</b>
Oluwafemi A. Sarumi, Ons Auouedi, and Lawan J. Muhammad	
<b>Predicting Antiviral Drugs for COVID-19 Treatment Using Artificial Intelligence Based Approach . . . . .</b>	<b>245</b>
Ayan Banerjee and Soumen Kumar Pati	
<b>Geographic Spread and Control of 2019-nCoV in the Absence of Vaccine . . . . .</b>	<b>271</b>
Himadri Shekhar Mondal, Motahar Reza, and Prasanta Sahoo	
<b>Machine Learning Based Anxiety Prediction of General Public from Tweets During COVID-19 . . . . .</b>	<b>291</b>
Shubham Tribedi, Anuraag Biswas, Swarup Kr Ghosh, and Anupam Ghosh	
<b>A Role of Emerging Technologies in the Design of Novel Framework for COVID-19 Data Analysis and Decision Support System. . . . .</b>	<b>313</b>
S. Rama Krishna and Mohammad Sirajuddin	
<b>Gaussian Regression Models for Day-Level Forecasting of COVID-19 in European Countries . . . . .</b>	<b>339</b>
Umut Özkaya and Şaban Öztürk	
<b>Computational Intelligence Based Hybrid Hyperparameter Tuned Prediction Techniques for COVID-19 Epidemiological Data . . . . .</b>	<b>357</b>
S. Dhamodharavadhani and R. Rathipriya	
<b>Combating COVID-19 with Advanced Computational Intelligence Techniques</b>	
<b>Computational Intelligence, Machine Learning and Deep Learning Techniques for Effective Future Predictions of COVID-19: A Review . . . . .</b>	<b>379</b>
K. Aditya Shastry and H. A. Sanjay	
<b>Early Prediction of COVID-19 Outcome: Contrasting Clinical Scores and Computational Intelligence Methods . . . . .</b>	<b>403</b>
Salvatore Greco, Alessandro Salatiello, Nicolò Fabbri, and Angelina Passaro	

**Enhanced Classification Using Restricted Boltzmann Machine Method in Deep Learning for COVID-19** ..... 425  
R. Jayashree

**An Integrated GIS/GPS Based e-Governance Approach for Different Agencies to Fight Against COVID-19** ..... 447  
Meghna Patel and Mitesh Patel

**Deep Learning for COVID-19: COVID-19 Detection Based on Chest X-Ray Images by the Fusion of Deep Learning and Machine Learning Techniques** ..... 471  
Swati V. Shinde and Deepak T. Mane

**Convolutional Neural Networks for COVID-19 Diagnosis** ..... 501  
Vidyadevi G. Biradar, H. A. Sanjay, and H. C. Nagaraj

**Deep Learning for COVID-19** ..... 531  
B. S. Prashanth, M. V. Manoj Kumar, Likewin Thomas,  
M. A. Ajay Kumar, Dinghao Wu, B. Annappa, Anirudh Hebbar,  
and Y. V. Srinivasa Murthy

# Machine Learning Based Anxiety Prediction of General Public from Tweets During COVID-19



Shubham Tribedi, Anuraag Biswas, Swarup Kr Ghosh, and Anupam Ghosh

**Abstract** In this crisis of COVID19, everyone is staying in touch with the world through social media. This has led to social media becoming a significant source of new information for many people and unfortunately this phenomenon has given birth to a lot of misinformation, chaos and fear in people's minds. This fear is often due to the inadequate and wrong information. Therefore, there is a important need to understand this crisis. Patterns need to be established between popular tweets and its effect on the public's sentiments, especially their fear. So, tweets of three different countries namely United States of America, Federative Republic of Brazil and Republic of India. Sentiment analysis reveals that fear of this unknown and mysterious nature of the coronavirus is dominant among the public. Predominant analysis of tweets within past two months will be done and then a model will be built to predict future reaction of the general public based on the crisis level in the country. Machine Learning algorithms such as 'Logistic Regression (LR)', 'Multinomial Naïve Bayes' and 'Support Vector Machine (SVM)' are used for classification purpose preceded by the pre-processing steps of raw data from each country. 90% of accuracy has been achieved from sentiment classification result. Insights to the fear, sentiments have also been provided. Tweets with negative sentiment and emotion indicates the cases for the pandemic outbreak.

**Keywords** Fear · Sentiments · Negative emotion · Twitter · Machine learning · Public awareness

## 1 Introduction

Sentiment Analysis is the classification, understanding, interpretation, definition of all sorts of emotions which one uses in his or her text. In one way it can be said that this is an analysis of text technique which allows one to understand the sentiment

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# Multi-level Feature-Based Subcellular Location Prediction of Apoptosis Proteins



**Soumyendu Sekhar Bandyopadhyay, Anup Kumar Halder, Kaustav Sengupta, Piyali Chatterjee, Mita Nasipuri, Dariusz Plewczynski, and Subhadip Basu**

**Abstract** Apoptosis is considered a vital component of various processes including normal cell turnover, proper development and functioning of the immune system, hormone-dependent atrophy, embryonic development, and chemical-induced cell death (Elmore in *Toxicol Pathol* 35:495–516, 20). Apoptosis proteins are strongly related to many diseases like neurodegenerative diseases, ischemic damage, autoimmune disorders, and many types of cancer and play an indispensable role in maintaining the dynamic balance between cell death and division. Many apoptosis proteins are identified but their activity at cellular or molecular level needs to be investigated. The prediction of subcellular localization of an apoptosis protein is still a challenging task. The subcellular localization prediction of apoptosis proteins can help to understand their function and the role of metabolic processes. In this paper, we have

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Proceedings of International  
Conference on Data,  
Electronics and Computing  
ICDEC 2022

 Springer

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ISSN 2524-7565

ISSN 2524-7573 (electronic)

Algorithms for Intelligent Systems

ISBN 978-981-99-1508-8

ISBN 978-981-99-1509-5 (eBook)

<https://doi.org/10.1007/978-981-99-1509-5>

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The registered company address is: 152 Beach Road, #21-01/04 Gateway East, Singapore 189721, Singapore

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# Contents

## Artificial Intelligence

<b>Correlation Analysis of Stock Index Data Features Using Sequential Rule Mining Algorithms</b> .....	3
Nayanjyoti Mazumdar and Pankaj Kumar Deva Sarma	
<b>A CRF-Based POS Tagging Approach for Bishnupriya Manipuri Language</b> .....	19
Bhubneswar Das and Smriti Kumar Sinha	
<b>IFS: An Incremental Feature Selection Method to Classify High-Dimensional Data</b> .....	29
Nazrul Hoque, Hasin A. Ahmed, and Dhruba K. Bhattacharyya	
<b>Computer-Aided Identification of Loom Type of Ethnic Textile, the Gamusa, Using Texture Features and Random Forest Classifier</b> ....	37
Kangkana Bora, Lipi B. Mahanta, C. Chakraborty, Prahlad Borah, Kungnor Rangpi, Barun Barua, Bishnu Sharma, and R. Mala	
<b>Spanning Cactus Existence, Optimization and Extension in Windmill Graphs</b> .....	51
Chinmay Debnath, Krishna Daripa, Ritu Mondal, and Alak Kumar Datta	
<b>Effect of Noise in Khasi Speech Recognition System</b> .....	59
Fairriky Rynjah, Khiakupar Jyndiang, Bronson Syiem, and L. Joyprakash Singh	
<b>Text and Language Independent Classification of Voice Calling Platforms Using Deep Learning</b> .....	67
Tapas Chakraborty, Rudrajit Bhattacharyya, Priti Shaw, Sourav Kumar, Md Mobbasher Ansari, Nibaran Das, Subhadip Basu, and Mita Nasipuri	

<b>An Application of Anomaly Detection to Financial Fraud Using Machine Learning</b> .....	77
Udochukwu Okoro, Usman Ahmad Baba, and Sandip Rakshit	
<b>A Pre-processing-Aided Deep Transfer Learning Model for Human Object Detection in Crowd Scenarios</b> .....	85
Soma Hazra, Sunirmal Khatua, and Banani Saha	
<b>Signal Processing</b>	
<b>Component Adaptive Superpixel-Based Joint Sparse Representation for Hyperspectral Image Classification</b> .....	97
Amos Bortiew and Swarnajyoti Patra	
<b>Convolutional Autoencoder-Based Models for Image Denoising: A Comparative Study</b> .....	107
Rowsonara Begum and Ayatullah Faruk Mollah	
<b>Simultaneous Prediction of Hand Gestures, Handedness, and Hand Keypoints Using Thermal Images</b> .....	117
Sichao Li, Sean Banerjee, Natasha Kholgade Banerjee, and Soumyabrata Dey	
<b>3D Point Cloud-Based Hand Gesture Recognition</b> .....	129
Soumi Paul, Ayatullah Faruk Mollah, Mita Nasipuri, and Subhadip Basu	
<b>Motion-Based Representations for Trajectory-Based Hand Gestures: A Brief Overview</b> .....	139
Debajit Sarma, Trishna Barman, M. K. Bhuyan, and Yuji Iwahori	
<b>An Approach Toward Detection of Doubling Print Defect Using SSIM Algorithm</b> .....	153
Jayeeta Saha and Shilpi Naskar	
<b>Multi-variant Statistical Tools and Soft Computing Methodology-Based Hybrid Model for Classification and Characterization of Yeast Data</b> .....	165
Shrayasi Datta and J. Pal Choudhury	
<b>Recent Challenges and Opportunities of Multilingual Natural Scene Text Recognition and Its Real World Deployment</b> .....	173
Kalpita Dutta, Soumik Chowdhury, Mahantapas Kundu, Mita Nasipuri, and Nibaran Das	
<b>Healthcare</b>	
<b>Automated Cervical Dysplasia Detection: A Multi-resolution Transform-Based Approach</b> .....	185
Kangkana Bora, Kasmika Borah, Lipi B. Mahanta, M. K. Bhuyan, and Barun Barua	

**An IoT-Enabled Vital Cardiac Parameter Monitoring System on Real-Time Basis** ..... 201  
 Nayana Dey and Prami Ghosh

**Elucidating the Inhibition Mechanism of FDA-Approved Drugs on P-glycoprotein (P-gp) Transporter by Molecular Docking Simulation** ..... 221  
 Abira Dey, Ruoya Li, Nathalie Larzat, Jean Bernard Idoipe, Ahmet Kati, and Ashwani Sharma

**A Fast Restoration of Weather Degraded Images** ..... 231  
 Avra Ghosh, Ajoy Dey, and Sheli Sinha Chaudhuri

**Multi-level Feature-Based Subcellular Location Prediction of Apoptosis Proteins** ..... 241  
 Soumyendu Sekhar Bandyopadhyay, Anup Kumar Halder, Kaustav Sengupta, Piyali Chatterjee, Mita Nasipuri, Dariusz Plewczynski, and Subhadip Basu

**The Identification of Chromatin Contact Domains (CCD) in Human Genomes from ChIA-PET Data Using Graph Methods** ..... 251  
 Rafał Chabasiński, Kaustav Sengupta, and Dariusz Plewczynski

**Prediction of COVID-19 Drug Targets Based on Protein Sequence and Network Properties Using Machine Learning Algorithm** ..... 259  
 Barnali Chakraborty, Atri Adhikari, Akash Kumar Bhagat, AbhinavRaj Gautam, Piyali Chatterjee, and Sovan Saha

**A Meta-consensus Strategy for Binarization of Dendritic Spines Images** ..... 269  
 Shauvik Paul, Nirmal Das, Subhrabesh Dutta, Dipannita Banerjee, Soumee Mukherjee, and Subhadip Basu

**Malignancy Identification from Cytology Images Using Deep Optimal Features** ..... 279  
 Soumyajyoti Dey, Soumya Nasipuri, Oindrila Ghosh, Sukanta Chakraborty, Debashri Mondal, and Nibaran Das

**Source Camera Identification Using GGD and Normalized DCT Model-Based Feature Extraction** ..... 289  
 Pabitra Roy, Shyamali Mitra, and Nibaran Das

**Lesion Image Segmentation for Skin Cancer Detection Using Pix2Pix: A Deep Learning Approach** ..... 303  
 Nema Roy, Achisman Kundu, Pritiman Sikder, and Showmik Bhowmik

**Pap-Net: A Patch-Based Multi-Scale Deep Learning Framework for Nucleus Segmentation from Pap Smear Images** ..... 313  
 Bijoyini Bagchi, Kaushiki Roy, Debotosh Bhattacharjee, and Christian Kollmann

<b>Performance Evaluation of Different Deep Learning Models for Breast Cancer Detection in Mammograms</b> .....	321
Jayanta Das, Sourav Pramanik, and Debotosh Bhattacharjee	
<b>Electronics and Communications</b>	
<b>Compact Multi-Band Bandpass Filters Using Substrate Integrated Waveguide and Fractal Resonators</b> .....	333
Amartya Paul and Pankaj Sarkar	
<b>Testing a 6 Axis Force-Torque Tactile Sensor for Robotic Arm</b> .....	341
Marut Deo Sharma and Juwesh Binong	
<b>ASER of Dual-Hop DF Relaying Systems with Coherent Modulation Scheme and MRC at Destination over Fisher-Snedecor <math>F</math> Fading Channels</b> .....	361
Darilangi S. Lyngdoh and Rajkishur Mudoj	
<b>Modeling and Characterization of Propagation Delay of Negative Capacitance Field-Effect Transistors</b> .....	371
Raunak Roy, Rahul Dhabbal, Gargi Bandhyopadhyay, Tuhin Karmakar, Rajdeep Sarkar, Anirban Samanta, and Alokesh Mondal	
<b>Outage Probability of a DF Relay-Assisted Communication System over Mixed Nakagami-<math>m</math> and Weibull Fading Channels</b> .....	381
Deep Baishya and Rajkishur Mudoj	
<b>A Triple Band Reconfigurable Filtering Antenna with High Frequency Selectivity</b> .....	387
Sangeeta Das and Pankaj Sarkar	
<b>3D Thermal Modelling of SiC-Avalanche Transit Time Oscillator Under Large-Signal Pulsed Operating Conditions</b> .....	399
Niratay Biswas, Debraj Chakraborty, Madhurima Chattopadhyay, and Moumita Mukherjee	
<b>A Compact Miniaturized Implantable Antenna for 2.45 GHz ISM Band Application</b> .....	415
Santoshkumar Singh Moirangthem, Sourav Roy, Soumendu Ghosh, and Abhishek Sarkhel	
<b>Miniaturized Dielectric Disc Loaded Monopole Antenna</b> .....	423
Khan Masood Parvez, SK. Moinul Haque, and Laxmikant Minz	
<b>Design of Optimum <math>n</math>-bit ALU Using Crossbar Gate</b> .....	435
Rakesh Das, Alongbar Wary, Arindam Dey, Raju Hazari, Chandan Bandyopadhyay, and Hafizur Rahaman	

**ML-Based PCB Classification with Gabor and Statistical Features** . . . . . 445  
Kangkana Bora, M. K. Bhuyan, Yuji Iwahori, Genevieve Chyrmang,  
and Debajit Sarma

**Capacity Analysis Over Shadowed BX Fading Channels  
for Various Adaptive Transmission Schemes** . . . . . 457  
Sisira Hawaibam and Aheibam Dinamani Singh

**Performance Comparison of L-SC and L-MRC over Various  
Fading Channels** . . . . . 467  
Sisira Hawaibam and Aheibam Dinamani Singh

**A Learning Model for Channel Selection and Allocation  
in Cognitive Radio Networks** . . . . . 479  
Subhabrata Dhar, Sabyasachi Chatterjee, and Prabir Banerjee

**An Ultrathin Multifunctional Polarization Converting Metasurface  
with Wide Angular Stability** . . . . . 491  
Soumendu Ghosh, Sourav Roy, Moirangthem Santoshkumar Singh,  
and Abhishek Sarkhel

**Author Index** . . . . . 499

# Prediction of COVID-19 Drug Targets Based on Protein Sequence and Network Properties Using Machine Learning Algorithm



Barnali Chakraborty, Atri Adhikari, Akash Kumar Bhagat, AbhinavRaj Gautam, Piyali Chatterjee, and Sovan Saha

**Abstract** Recently, human health has been critically exposed to a pandemic caused by coronavirus (COVID-19), which has threatened public health for the last 2 years. Some medications that treat other diseases seem effective in treating COVID-19 without explicit support. A search for new drug/drug targets is underway. This research will focus on the main virus-based and host-based targets that may provide valuable insights into discovering drugs in medicinal chemistry. The task of identification and selection of drug targets is becoming very promising research in drug discovery. Computational approach-based analyzes are beneficial in providing information about the principles of proteins and drugs by analyzing drug target features. At the same time, in-silico target identification becomes attractive in terms of time and cost for large-scale human genomic and proteomic data. This work mainly deals with predicting COVID-19 drug targets and non-targets in humans through several machine learning approaches like decision tree, random forest classifier, support vector machine, K-means, and logistic regression based on protein sequence features and network properties. However, the random forest classifier seems to obtain an overall accuracy of 0.83, significantly higher than the other existing *state-of-the-arts*.

**Keywords** COVID-19; Drug targets · Machine learning · Random forest classifier · Protein sequence features · Network features · Protein–protein interaction network · COVID-19 drug targets · COVID-19 drug non-targets

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ISSN: (Online) Journal homepage: <https://www.ijmit.org>

# M-Bagging: A New Modified Bagging Classification Model to Improve Prediction accuracy

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Published online: 22 January 2024



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# M-Bagging: A New Modified Bagging Classification Model to Improve Prediction accuracy

Chandra Das<sup>1</sup>, Abhishek Paul<sup>1</sup>, Camellia Mukherjee<sup>1</sup>, Debatosh Paul Majumdar<sup>1</sup>, Shilpi Bose<sup>1\*</sup>

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## ABSTRACT

Ensemble learning is a one kind of machine learning technique that improves the performance and robustness of the classification models and how the outputs of base classifiers are combined is one of the fundamental challenges in ensemble learning systems. Among different types of ensemble learning models, Bagging is most popular due to its simplicity but Bagging has several drawbacks. As for example in bootstrapped creation out of bag samples are not used properly or it does not take care for misclassified samples and it uses homogeneous classifiers. So, in this work, we have developed a modified bagging ensemble classification model by embedding modified bootstrapping techniques so that misclassified samples are specially taken care, out of bag samples are also taken care. Apart from these several heterogeneous classifiers are also used here in novel manner. From experimental results it has been found that the proposed model is superior compared to other existing basic ensemble models as well as other state of the art models.

## KEYWORDS

Ensemble learning; Bagging; Bootstrapping; Classification; Class imbalance.

## 1. INTRODUCTION

In machine learning, ensemble learning [1] is one of the most important algorithms and is based on the supervised learning technique. Ensembles learning systems are inspired from the nature of decision making process of human beings. This is because humans tend to take decisions based on different factors. They also take opinions of other people to make decisions. Let us take an example to describe the process. Suppose when we buy a particular product from an e-commerce portal, we try to check for price of the same product from different sellers. We check the quality and specifications of the product. We also check the ratings of the product and also read the reviews of various customers who bought the product. In this way we decide whether to buy that product or not instead of buying it blindly. In Machine learning, the same thing is done using ensemble learning systems [1].

The word Ensemble means “union of parts” which is derived from Latin [2]. In ensemble learning, results of different classifiers are combined together using different approaches to give a new result which is better than the individual results of those classifiers. This concept of integrating classifiers provided new direction in improving the performance of regular classifiers. The regular classifiers when run independently often give poor performance when applied on large and high dimensional datasets. These classifiers also cannot handle class imbalance problem in an efficient way. To reduce these errors and improve their performance, ensemble learners are needed to construct by combining their predictions [1, 2]. Today ensemble learning systems are used in wide range of real world applications such as in biomedical, finance, politics, medicine etc.

There are four different category based ensemble classifiers- Bagging, Boosting, Stacking and Blending [1]. Among these four categories, bagging model, introduced by Breiman, is one of the most popular and successful ensemble classifier to improve accuracy of classification [2]. Bagging [2,3] is also known as Bootstrap Aggregation as it aggregates various versions of prediction accuracy of a weak learner when it is applied independently on various bootstrapped versions of the original training dataset. Every bootstrapped version of the training dataset is created by random sampling with replacement procedure. In this model first different bootstrapped versions are created and then a machine learning model is trained on these bootstrapped datasets independently and run in parallel. After training, the predictions of these models are combined using majority voting or weighted average method or using other approach to get the final prediction. However Bagging work with homogeneous classifier where only a single base classifier or weak learner is used.

Although Bagging is a popular classifier, it has several drawbacks. The first drawback is that as it generates different bootstrapped datasets by selecting samples randomly from the training dataset so some samples are not selected at all (out of bag samples) and so some samples are not used in the training phase. Secondly drawback is that it does not take any special care for the samples which are not properly classified in the training phase. The third drawback is that for every bootstrapped version it uses homogeneous classifiers such as either decision tree or SVM or KNN and so on. It results small variance but stable classifiers like KNN or SVMs generally does not generate in smaller classification error rates. So, there is no significance improvement in result via running computationally extensive classification methods on different bootstrapped versions. Apart from this, it is very difficult to judge that which classification algorithm does have the best

Jyotsna Kumar Mandal · Debashis De  
Editors

# Frontiers of ICT in Healthcare

Proceedings of EAIT 2022

 Springer

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ISSN 2367-3370

ISSN 2367-3389 (electronic)

Lecture Notes in Networks and Systems

ISBN 978-981-19-5190-9

ISBN 978-981-19-5191-6 (eBook)

<https://doi.org/10.1007/978-981-19-5191-6>

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# Contents

## Healthcare Informatics

<b>Continuous Speech Recognition in Hindi for Health Care Using Deep Learning</b> .....	3
Shubhojeet Paul, Sujan Kumar Saha, and Vandana Bhattacharjee	
<b>Improving Mental Health Through Multimodal Emotion Detection from Speech and Text Data Using Long-Short Term Memory</b> .....	13
Dhritesh Bhagat, Aritra Ray, Adarsh Sarada, Nilanjana Dutta Roy, Mufti Mahmud, and Debashis De	
<b>Hybridized Support Vector Machine and Adaboost Technique for Malaria Diagnosis</b> .....	25
Joseph Bamidele Awotunde, Sanjay Misra, Femi Emmanuel Ayo, Akshat Agrawal, and Ravin Ahuja	
<b>FNH—A Data Repository for Studying Fake News in Healthcare Domain</b> .....	39
Isha Agarwal, Dipti Rana, Ch Surya Teja, and Nunna Naga Surya Sai Daivik	
<b>Modeling and Simulation of Total Harmonic Distortion (THD) in Multilevel H Bridge Inverters for Healthcare</b> .....	53
Akash Mourya and Mithlesh Gautam	
<b>Classification of Melanoma Skin Cancer Using Inception-ResNet</b> .....	65
Sumit Kumar Singh, Shubhendu Banerjee, Avishek Chakraborty, and Aritra Bandyopadhyay	
<b>Melanoma (Skin Cancer) Classifier Using RESNet</b> .....	75
Naveen Kanuri, Bhaskar K. Uday, and Teegala Tejaswi	

<b>Complementarity of Logistic Regression over the Nonparametric Classifications for Improved Decision-Making—A Case of Maternal Health Risk Data</b> .....	87
Abhijit Roy	
<b>Towards Machine Learning-Based Emotion Recognition from Multimodal Data</b> .....	99
Md. Faiyaz Shahriar, Md. Safkat Azad Arnab, Munia Sarwat Khan, Safwon Sadif Rahman, Mufti Mahmud, and M. Shamim Kaiser	
<b>A Hybrid Approach for Stress Prediction from Heart Rate Variability</b> .....	111
Md. Rahat Shahriar Zawad, Chowdhury Saleh Ahmed Rony, Md. Yeaminul Haque, Md. Hasan Al Banna, Mufti Mahmud, and M. Shamim Kaiser	
<b>Machine Learning in Healthcare</b>	
<b>A Method of Genome Sequence Comparison Based on a New Form of Fuzzy Polynucleotide Space</b> .....	125
Soumen Ghosh, Jayanta Pal, Bansibadan Maji, and Dilip Kumar Bhattacharya	
<b>Identification of Humans by Using Machine Learning Models on Gait Features</b> .....	137
Jayati Ghosh Dastidar, Souvik Samanta, Arghya Basu, and Santanu Purkait	
<b>Efficient Heart Disease Prediction Using Modified Hybrid Classifier</b> ....	151
Rishabh Pipalwa, Abhijit Paul, Tamoghna Mukherjee, and Ashika Jain	
<b>An Unstructured Mammogram Analysis for Feasible Classification and Detection of Breast Cancer Using a Convolutional Approach</b> .....	165
Debkumar Chowdhury, Tirtharaj Sinha, Arnobrata Ghosh, Anurag Unnikannan, Susmit De, Kartik Sau, and Sanjukta Mishra	
<b>Emotion Recognition from EEG Data Using Hybrid Deep Learning Approach</b> .....	179
Trishita Dhara and Pawan Kumar Singh	
<b>Colon Cancer Prediction with Transfer Learning and K-Means Clustering</b> .....	191
Tina Babu and Rekha R. Nair	
<b>Lightweight Authentication Protocol for E-Healthcare Systems Using Fuzzy Commitment Scheme</b> .....	201
Jhuma Dutta, Subhas Barman, Rathit Bandyopadhyay, and Moumita Ghosh	

**Performance Analysis of Machine Learning Algorithms for Prediction of Cerebral Attack (Stroke)** ..... 215  
 Diganta Sengupta, Subhash Mondal, Yash Raj Singh, and Amartya Pandey

**Breast Cancer Detection Using Transfer Learning Techniques in Convolutional Neural Networks** ..... 229  
 Soma Mitra, Mauparna Nandan, and Randrita Sarkar

**A Machine Learning-Based Prediction Model for Fetal Health Assessment** ..... 239  
 Hirdesh Varshney and Avtar Singh

**A Smart System for Assessment of Mental Health Using Explainable AI Approach** ..... 251  
 Sirshendu Hore, Sinjini Banerjee, and Tanmay Bhattacharya

**Binary Classification of Thyroid Using Comprehensive Set of Machine Learning Algorithms** ..... 265  
 Diganta Sengupta, Subhash Mondal, Aman Raj, and Ankit Anand

**Interpretability Approaches of Explainable AI in Analyzing Features for Lung Cancer Detection** ..... 277  
 Mahua Pal, Sujoy Mistry, and Debashis De

**Healthcare Security and Blockchain**

**Impregnable Healthcare Ecosystem Using Blockchain and Artificial Intelligence Approaches** ..... 291  
 Anto Rahul Mahiban, Pritish Gupta, Aditya Raj, and Sumaiya Thaseen Ikram

**RIWT Generative Feedback Residual Network for Secure Clinical Data Communication in Healthcare Unit** ..... 303  
 Prabhash Kumar Singh, Biswapati Jana, Kakali Datta, Partha Chowdhuri, and Pabitra Pal

**Blockchain-Based Smart Integrated Healthcare System** ..... 315  
 Deepa Parasar, Preet Viradiya, Aryaa Singh, Sumit Chahar, Vivek Prasad, and Varun Iyengar

**Designing a Secure Robust Medical Image Authentication Based on Watermarking Using the ED-DWT and Encryption** ..... 325  
 Chandan Kumar and Sadaf Hussaini

**IoT-Based Secure Blockchain Framework for Patient Record Management Using MPRESENT Lightweight Block Cipher** ..... 339  
 Rajdeep Chakraborty and Runa Chatterjee

**A Secure Electronic Health Record Storage System Based on Hyperledger Fabric, IPFS, and Secret Sharing Scheme** ..... 355  
Puja Sarkar, Lopamudra Pathak, Rohan Molia, Sima Boro, and Amitava Nag

**Attribute-Based Personal Health Record Protection Algorithm for Cloud-Based Healthcare Services** ..... 367  
F. Sammy and Gadisa Kana

**Pixel Interpolation Followed by Prediction Error Expansion-Based Reversible Information Hiding Algorithm for Securing Healthcare Data** ..... 375  
Sakhi Bandyopadhyay, Sunita Sarkar, Subhadip Mukherjee, and Somnath Mukhopadhyay

**Healthcare in COVID-19 Scenario**

**Similarity Study of Spike Protein of Coronavirus by PCA Using Physical Properties of Amino Acids** ..... 389  
Jayanta Pal, Soumen Ghosh, Bansibadan Maji, and Dilip Kumar Bhattacharya

**Analysis of Spread of COVID-19 Based on Socio-economic Factors: A Comparison of Prediction Models** ..... 397  
Seema Patil, Isha Patil, Ravneesh Singh, Aayushi Verma, and Raghav Gaur

**India’s COVID-2019 Epidemic Data Analysis Using Machine Learning Techniques: A Case Study of SIR Model** ..... 417  
Ramjeet Singh Yadav

**Fine-Tuned Predictive Models for Forecasting Severity Level of COVID-19 Patient Using Epidemiological Data** ..... 431  
Shweta A. Tikhe and Dipti P. Rana

**An Ensemble Machine Learning Model to Detect COVID-19 Using Chest X-Ray** ..... 443  
Somenath Chakraborty and Beddhu Murali

**Prediction of COVID-19 Cases Using the ARIMA Model and Machine Learning** ..... 453  
Akash Pal, Garima Jain, Ishita Roy, and Sumit Sharma

**Travelling Guidance Using ACO and HBMO Techniques in COVID-19 Pandemics: A Novel Approach** ..... 467  
Shashwat Saket, Shivam P. Mishra, Vandana Bhattacharjee, and Kamta Nath Mishra

**Restoration and Enhancement of COVID-19 Variants Using CT Images** ..... 485  
 R. Ranjani and R. Priya

**IoT in Healthcare**

**MediFi: An IoT-Based Health Monitoring Device** ..... 501  
 Saradwata Bandyopadhyay, Akash Kumar Singh, Sunil Kumar Sharma, Rajrupa Das, Arju Kumari, Angira Halder, and Sandip Mandal

**Fog-Based Smart Road Safety Application Using IoT** ..... 513  
 Dougani Bentabet

**Efficient Computing Resource Sharing for Mobile Edge-Cloud Computing Networks** ..... 523  
 Shashank Mishra, Aman Gupta, and K. Jairam Naik

**Intuitionistic Fuzzy Stream Cipher for Privacy Preservation of Biometric Data in IoMT** ..... 539  
 Arun Sarkar, Rajdeep Chakraborty, and Malabika Das

**Sleep Monitoring with Wearable Sensor Data in an eCoach Recommendation System: A Conceptual Study with Machine Learning Approach** ..... 551  
 Ayan Chatterjee, Andreas Prinz, Nibedita Pahari, Jishnu Das, and Michael Alexander Riegler

**LSEA-IOMT: On the Implementation of Lightweight Symmetric Encryption Algorithm for Internet of Medical Things (IoMT)** ..... 565  
 Sohail Saif, Priya Das, and Suparna Biswas

**Image Processing in Healthcare**

**Cardiovascular Disease Prediction in Retinal Fundus Images Using ERNN Technique** ..... 579  
 M. Shahina Parveen and Savitha Hiremath

**Medical Image Security Using RIW for Grayscale and Color Images** ... 589  
 Aishi Pramanik, Aniket Banerjee, Dhrupadi Das, Debashis De, and Sudip Ghosh

**Feather-Light Vessel Segregation Model** ..... 601  
 Shirsendu Dhar, Sumit Mukherjee, Ranjit Ghoshal, and Bibhas Chandra Dhara

**Hyperspectral Image Segmentation Using Balanced Entropic Thresholding** ..... 613  
 Radha Krishna Bar, Somnath Mukhopadhyay, and Debasish Chakraborty

<b>Deep SqueezeNet-Based Diagnosis of the Breast Cancer Using Ultrasound (US) Images</b> .....	625
Mithun Karmakar and Amitava Nag	
<b>Automated Brain Tumor Segmentation Using GAN Augmentation and Optimized U-Net</b> .....	635
Swathi Jamjala Narayanan, Adithya Sreemandiram Anil, Chinmay Ashtikar, Sasank Chunduri, and Sangeetha Saman	
<b>Estimation of Different Transformation Parameters Based on Optimised Scale Invariant Feature Transform for Image Registration</b> .....	647
Joydev Hazra, Aditi Roy Chowdhury, Kousik Dasgupta, and Paramartha Dutta	
<b>Designing an Iterative Adaptive Arithmetic Coding-Based Lossless Bio-signal Compression for Online Patient Monitoring System (IAALBC)</b> .....	655
Uttam Kr. Mondal, Asish Debnath, N. Tabassum, and J. K. Mandal	
<b>Healthcare Security of Patient’s Medical Images by PEE-Based RIW Without Location Mapping</b> .....	665
Soumen Bhowmick, Debashis De, and Sudip Ghosh	
<b>Deep Cervix Model Development from Heterogeneous and Partially Labeled Image Datasets</b> .....	679
Anabik Pal, Zhiyun Xue, and Sameer Antani	
<b>Region Separated Vessel Segmentation in Fundus Image Using Multi-scale Layer-Based Convolutional Neural Network</b> .....	689
Supratim Ghosh, Mahantapas Kundu, and Mita Nasipuri	
<b>MsMED-Net: An Optimized Multi-scale Mirror Connected Encoder-Decoder Network for Multilingual Natural Scene Text Recognition</b> .....	699
Kalpita Dutta, Shuvayan Ghosh Dastidar, Mahantapas Kundu, Mita Nasipuri, and Nibaran Das	
<b>Author Index</b> .....	711

# IoT-Based Secure Blockchain Framework for Patient Record Management Using MPRESENT Lightweight Block Cipher



Rajdeep Chakraborty  and Runa Chatterjee 

**Abstract** This paper deals with the patient record management framework and its security by our novel lightweight block cipher MPRESENT. Blockchain is a distributed data repository and used nowadays in various use cases, and one of them is Patient Record Management. Blockchain also provides a trusted distributed network. Internet of things (IoT) is the one mostly used network to record patient data in various units of a hospital. A Blockchain framework for storing patient records and its management from IoT devices installed at various units in a hospital and the security established by lightweight block cipher is proposed in this paper. Further, we also provided a second layer of security in the IoT sensor layer through MPRESENT.

**Keywords** IoT · Lightweight cryptography · Blockchain · Patient Record Management

## 1 Introduction

This section gives a brief introduction of Internet of things (IoT) and lightweight cryptography (LWC). Section 1.1 discusses the basics of Internet of things (IoT), and Sect. 1.2 and Sect. 1.3 discuss lightweight cryptography and the Blockchain, respectively.

### 1.1 Internet of Things (IoT)

Many advanced devices are currently being used in the progressive world which are highly constrained. To accomplish some tasks, these devices are interconnected and communicated by transferring information to one another. The Internet of things (IoT) is one of the important areas where we use these advanced devices. The IoT

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# Environmental Informatics

Challenges and Solutions

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ISBN 978-981-19-2082-0

ISBN 978-981-19-2083-7 (eBook)

<https://doi.org/10.1007/978-981-19-2083-7>

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# Contents

<b>1</b>	<b>Environmental Informatics: Basics, Nature, and Applications Using Emerging Technologies with Reference to Issues and Potentialities</b> .....	<b>1</b>
	P. K. Paul	
<b>2</b>	<b>Exploring the Role of ICCT Underlying Technologies in Environmental and Ecological Management</b> .....	<b>15</b>
	P. S. Aithal and Shubhrajyotsna Aithal	
<b>3</b>	<b>The Practice of Green Computing for Businesses</b> .....	<b>31</b>
	Abdool Qaiyum Mohabuth	
<b>4</b>	<b>Green Information Centres and Allied Foundations: <i>The Concern of Environmental Information and Documentation Practice</i></b> .....	<b>53</b>
	Sarmistha Chowdhury, K. S. Tiwary, and Jayati Lahiri Dey	
<b>5</b>	<b>A Study on the Social and Economic Impact of Artificial Intelligence-Based Environmental Forecasts</b> .....	<b>67</b>
	Paramita Bhattacharjee, Ajitesh Moy Ghosh, and Pabak Indu	
<b>6</b>	<b>AI in Waste Management: The Savage of Environment</b> .....	<b>97</b>
	Sharda Bharti, Shourat Fatma, and Vinay Kumar	
<b>7</b>	<b>Smart Energy Conservation in Irrigation Management for Greenhouse Agriculture</b> .....	<b>125</b>
	T. George Princess, E. Poovammal, and G. Kothai	
<b>8</b>	<b>Role of Artificial Intelligence and IoT in Environmental Monitoring—A Survey</b> .....	<b>141</b>
	S. Karkuzhali and S. Senthilkumar	
<b>9</b>	<b>E-Waste Management in Digital Healthcare System and Sustainability Paradigm</b> .....	<b>157</b>
	Abhijit Bandyopadhyay, Ritam Chatterjee, and Nilanjan Das	

- 10 Advances and Applications of Bioremediation: Network of Omics, System Biology, Gene Editing and Nanotechnology . . . . . 167**  
Rohit Chakraborty, Sahita Karmakar, and Waliza Ansar
- 11 Internet of Things (IoT): Emphasizing Its Applications and Emergence in Environmental Management—The Profound Cases . . . . . 201**  
Mustafa Kayyali
- 12 LiFi-Based Energy-Efficient Traffic Sensing and Controlling System Management for Smart City Application . . . . . 213**  
Abhinandan Sarkar, Rajdeep Chakraborty, and Hoimanti Dutta
- 13 Technology-Based Management and Monitoring System to Combat COVID-19: An Environmental Disaster of the Century . . . . . 227**  
Sandeep Poddar
- 14 Drone Applications in Wildlife Research—A Synoptic Review . . . . . 237**  
Subhendu Mazumdar
- 15 An Integrated Application of AHP and GIS-Based Model to Identify the Waterlogged Zones Susceptible for Water-Borne Diseases . . . . . 259**  
Pranay Paul and Rumki Sarkar
- 16 An Automated Geoprocessing Model for Accuracy Assessment in Various Interpolation Methods for Groundwater Quality . . . . . 285**  
Baskaran Venkatesh and M. A. M. Mannar Thippu Sulthan

# Chapter 12

## LiFi-Based Energy-Efficient Traffic Sensing and Controlling System Management for Smart City Application



Abhinandan Sarkar, Rajdeep Chakraborty, and Hoimanti Dutta

**Abstract** Alternative research efforts have been conducted for the last few years to overcome the deficit spectrum of electromagnetic waves which can release the network traffic from the saturated radio frequency domain. With some of the culture and development, it can be stated that optical wireless communication can lead to a new spectrum of data sharing. Consumption of data and its usage has increased more than 100 times in the last 10 years. Development of around 80 billion IOT systems has also contributed to the crisis of radio spectrum availability and increased traffic. It is forecasted that by 2022 there will be use of around 50 zettabytes of data, that can be imagined as many bits of stars and planets in the universe. With the recent contribution from researches, a new domain has been termed as visible light communication (VLC) and will reinforce the communication protocol. In this domain, the architectural transformation resulted in light fidelity (Li-Fi), replacing the wireless fidelity (WiFi) with added security and unrestricted bandwidth allocation.

There are 300 Tetra Hz unused bandwidth (1000 times 300 Giga Hz of radio frequency spectrum) available at higher frequencies in the visible light spectrum. LiFi uses the visible light spectrum for communication, which is much faster than radio frequency, and can be easily used in near field communication. Many researches have served with multiple conceptions and misconceptions in this experimental area. The technology is advancing with the speed of its own concept, visible light. Establishing the liable system and computing the data, parametrical diversity is in progress. Professor Harald Haas of Edinburgh University has provided many clear out reach for the proposed system. Many tech-giants have configured their own. But in our daily life, bringing ease to our society has been a concept and dream till now. Converging all the thought at a point with the recent development and implementation, in this chapter we claim to successfully design a light fidelity-based system, which can be used for traffic signal sensing and managing, and it will be energy efficient. As it is studied that LiFi system transmits data through LED and receives through photocell,

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# PSO Optimized Decentralized Secondary Control for Frequency and Voltage Restoration in Islanded AC Microgrid

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**Abstract**—This paper proposes a decentralized secondary control scheme suitable for islanded microgrid consist of multiple VF controlled inverters connected in parallel. The controller is based on proportional-integral control to maintain frequency and voltage under different load switching conditions. Moreover improved system performance and reliability are accomplished by managing proper power sharing among the participating inverters. Particle swarm optimization is adopted to find best suitable gain parameters of the proportional-integral controller. Multiple simulation results of the islanded microgrid using MATLAB are discussed in detail to establish the above mentioned two main objectives of the paper i.e. maintaining frequency, voltage and balance load sharing among inverters.

**Keywords**— *Adaptive droop curve positioning, decentralized secondary droop control, islanded microgrid, particle swarm optimization.*

## I. INTRODUCTION

The present day microgrid (MG) can be considered as a flexible electrical network consisting of different components like distributed energy resources (DERs), energy storage systems (ESSs), different power electronics converters and different types of loads operating in unison with protection, energy management and different controllers [1]. It can operate efficiently both in islanding mode and in grid connected mode. For grid connected mode MG frequency and voltage is directly controlled by the grid, whereas in islanded mode voltage and frequency control is solely handled by MG by introducing different controllers [2].

The control of parallel operation, having multiple inverters connected DERs is difficult under islanding operation due to absence of utility grid. Thus for islanding operation voltage and frequency (VF) control (grid-forming) is essential for the inverters for proper regulation and

control of frequency and voltage under load variation conditions within an acceptable limit [3][4].

In islanding operation various disturbances often take place to create challenges for the participating controllers to sustain system nominal voltage and frequency. Hierarchical control schemes were proposed earlier to handle such difficulties where three layer control approach i.e. primary, secondary and tertiary control are recently used [5].

The responsibility of primary control is to manage active and reactive power sharing and regulate the MG operating voltage and frequency [6]. To accomplish these duties both centralized and decentralized architectures are used [7]. This paper adopts the decentralized droop control approach to ensure communication free ‘plug-and-play’ function. Since droop control often suffers from poor voltage and frequency regulation secondary controllers are required to accompany primary controller to restore voltage and frequency [8]. Generally due to frequent switching of different types of load, frequent frequency and voltage fluctuations are experienced by MG during islanding operation. The centralized secondary control scheme addresses such disturbances by involving a centralized controller and strong communication network among all the sections of MG [9]. MG with increased size and capacity may suffer from serious reliability; stability issues due to failure or delay in communications [10][11]. Thus decentralized secondary controllers are preferable over centralized one as distributed independent controllers are available for individual DER units to regulate voltage and frequency. Moreover communication free control approach overcomes the unnecessary complexities, reliability and stability issues with increased capacity of MG [12]. The main function of tertiary controller is to accomplish economic dispatch and optimal power flow between utility grid and MG [13].

This paper attempts to put forward a distributed secondary control scheme to restore frequency and voltage fluctuations under frequent load switching conditions in islanded MG. For the above mentioned advantages

978-1-6654-4175-9/21/\$31.00 ©2021 IEEE



PROCEEDINGS OF THE  
**IEEE INDICON 2021**  
THE FLAGSHIP CONFERENCE OF IEEE INDIA COUNCIL

DECEMBER 19-21, 2021

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## Table of Contents

### Track: Artificial intelligence and Data Science

A Neural Network Approach with Iterative Strategy for Long-term PM2.5 Forecasting	K. Krishna Rani Samal; Korra Babu; Santos Ku Das
Time Series Forecasting of Air Pollution using Deep Neural Network with Multi-output Learning	K. Krishna Rani Samal; Korra Babu; Santos Ku Das
A CNN-BiLSTM-SVR based Deep Hybrid Model for Water Quality Forecasting of the River Ganga	Aishwarya Premlal Kogekar; Rashmikiranjan Nayak; Umesh Chandra Pati
Level Sensitive Context Aware Translation Suggestions	Supriya Mandal; Pavithra C P; Purvi Shah
Modelling of Churn in Indian Politics: A Case Study of Andhra Pradesh	Narayana Darapaneni; Easwar Krishna Iyer
Comparative Performance Investigation of MIMO-OTFS and MIMO-OFDM using Deep Neural Network Modeling	Manoj Joshi; Gaurav Punjabi; B. Sainath; Ananthakrishna Chintanpalli
Privacy preserving and secure machine learning	Akshay Prabhu; Niranjana Balasubramanian; Chinmay Tiwari; Rugved Deolekar
Improved Prediction of Agronomic Models with Outlier Detection and Region-based Clustering	Sahitya Mondal; Chayan Biswas; Chitrita Chaudhuri
GL-DDEA: Global and Local Surrogate Based Framework for Solving Offline Data-Driven Evolutionary Optimization	Subhadip Pramanik; Adrijit Goswami
Automatic Modulation Classification: A Novel Convolutional Neural Network Based Approach	Deep Jariwala; Kamal Manharlal Captain
Machine Comprehension Comparison using Latest Advancements in Deep Learning	Aryan Kumar Singh; Kapil Gyanchandani; Pramod Kumar Singh; Jay Prakash
A Script Independent Hybrid Feature Extraction Technique for Offline Handwritten Devanagari and Bangla Character Recognition	Raghunath Dey; Rakesh Chandra Balabantaray; Jayashree Piri
VarDenGrid: A New Variable Density Clustering Algorithm with Grid-Based Initialization	Rohit Paul; Somnath Pal
A weighted critic update approach to Multi Agent Twin Delayed Deep Deterministic Algorithm	Tamal Sarkar; Shobhanjana Kalita
Predictive Modeling of Healthcare Professional's Stress Based on XGBoost Model	Pooja Gupta; Srabanti Maji; Ritika Mehra
SInGER: A Recommendation System based on Social-Influence-aware Graph Embedding Approach	Sucheta Dawn; Monidipa Das; Sanghamitra Bandyopadhyay

Sweep Nearest Algorithm for Capacitated Vehicle Routing Problem	Neha Sehta; Urjita Thakar
AI Driven Edge Device for Screening Skin Lesion and Its Severity in Peripheral Communities	Chathura N JaiKishore; Venkanna U.; Debanjan Das
RNN Encoder and Decoder with Teacher Forcing Attention Mechanism for Abstractive Summarization	Shaik Rafi; Ranjita Das
Infant Mood Prediction and Emotion Classification with Different Intelligent Models	Reuben Johann Rosen; Debadeepta Tagore; Tharun Iyer; Ruban Nersisson; Alex Noel Joseph Raj
Benchmarking Shallow and Deep Neural Networks for Contextual Representation of Social Data	Reshma Unnikrishnan; Sowmya S Kamath; Ananthanarayana Vs
Quality Assessment of Deep Learning Based Super Resolution Techniques on Thermal Images	Shashwat Pandey; Darshika Sharma; Basant Kumar; Himanshu Singh
Iterative Dense Network using Laplacian Pyramid Model for Blind Super Resolution	Shashikant Deepak; Chanda Singh; Dipti Patra
A pinball loss support vector machine based regression model	Pritam Anand
Consistency Analysis of NLP Approaches for a Conference Reviewer-Manuscript Match-Making System	Nishith Kotak; Anil Roy; Sourish Dasgupta; Tirthankar Ghosal
Deep Learning Oriented Satellite Remote Sensing for Drought and Prediction in Agriculture	Yogesh Dhyani; Rahul Jashvantbhai Pandya
Robust Portfolio Design and Stock Price Prediction Using an Optimized LSTM Model	Jaydip Sen; Saikat Mondal; Gourab Nath
A Deep Learning Model for Redundancy Analysis Algorithm Recommendation	Atishay Kumar; Helik Kanti Thacker; Ankit Gupta; Keerthi Kiran Jagannathachar; Deokgu Yoon
An Autoencoder Based Approach to Enable High Fidelity Video Conferencing over Low Bandwidth Networks	Ashish Kumar Sahani; Shourya Kulshrestha; Akshay Jain
Machine Learning Method to Discover the Novel Association of Vaccine and Vitamin A Supplement on Covid 19 Infection: A Biclustering Approach	Namita Jain; Susmita Ghosh
Exploiting Web Snippets for Multi-label Anime Genre Prediction	Joyeta Sharma; Abu Nowshed Chy
Exploiting Ensemble of Transformer Models for Detecting Informative Tweets	Abu Nowhash Chowdhury; Shawon Guha; Nurul Amin; Shahidul Islam Khan
Cube Sampled K-Prototype Clustering for Featured Data	Seemandhar Jain; Aditya A. Shastri; Kapil Ahuja; Yann Busnel; Navneet Pratap Singh

**Track: Antenna and Microwave Techniques**

Lotus Shaped Printed Antenna For UWB Applications	Anett Antony; Bidisha DasGupta
A Highly Efficient High Power Doherty Power Amplifier with Large Output Back-Off Range for Base Station Application	Dushyant Kumar Sharma; Parag Aggarwal; Kalyan Giri; Anirban Sengupta; Mrinal Kanti Mandal; Subhas Chandra Mondal; Ravi Bura
Liquid Crystal Polymer based Tunable Microstrip Filter at Q-Band	Nishant Shukla
A Novel Wideband 3-dB Branch Line Coupler Using Capacitively-Couple Coupled Line	Dushyant Kumar Sharma
High Gain Compact Antipodal Vivaldi Antenna for UWB Applications	Diddi Pavitra Varsha; Pallepogu Prasanna Kumar; Purna Saxena
Jaya's Algorithm Derived Cavitation Inspired Lightweight and Broadband Microwave Absorbing Structure	Ravi Yadav; Ravi Panwar
Ka Band approach for mitigating communication blackout	Danthi Susheel kumar; Sachin Jain
A Wideband Circularly Polarized Endfire Microstrip Antenna	Anantha Bharathi; Lakshminarayana Merugu
Ultra-Wideband Microstrip Filter Using Interdigital Coupled Line Ring Resonator	Deepraj Chowdhury; Vasu Nand; Maifuz Ali; Lakhindar Murmu; Kalyan Mondal; T. Mandal
Circularly Polarized Graphene Antenna for THz Applications	Amit Sharma; Dinesh Vishwakarma
Multi-Folded Bandpass Filter with Harmonic Suppression by Meander Spurline	Tarun Kumar Das; Pritam Paul; Suprava Das; Sayan Chatterjee
Half Substrate Integrated Waveguide Based Wideband Slot Antenna	Meha Agrawal; Trivesh Kumar
Design and Analysis of Dual Band Tapered-Fed Monopole Antenna for 5G and Satellite Applications	Jayshri S Kulkarni; Chow-Yen-Desmond Sim; Rajendra Talware; Vivek Deshpande; Abhijit Chitre; Jaume Anguera

### **Track: Communications, Networks and Internet of Things**

Performance Analysis of 5G NR PUCCH Format 0 Receiver	Sriram Tadavarty; Nanda Kishore Chavali
Full Duplex Relay Assisted Coded Cooperation for Next Generation Wireless Networks	Sagnik Bhattacharyya; Pankaj Kumar; Sam Darshi; Omraj Burnwal; Kushal Singhal
Experimental Analysis of Deep Learning-based Modulation Classification in Indoor Environments	Tamizhelakkiya K; Prabhu Chandhar

Secrecy Capacity of Hybrid, Outage-based Power Adaptive, Cooperative Relaying Networks with Imperfect CSI	Anuj Deshmukh; Devashree Paithankar; B. Sainath
Pricing Scheme for UAV-Enabled Charging of Sensor Network	Ajay Kumar Gupta; Saptarshi Ghosh; Manav Bhatnagar
Outage Analysis for Drone Assisted Multi-user Coded Cooperation	Pankaj Kumar; Sagnik Bhattacharyya; Sam Darshi
Outage Performance Analysis of a Multihop Relaying Network With Two-Stage Relay Selection under Rayleigh Fading Channel	Oleti Nagi Reddy; Keerthana Kandasamy; Mandha Damodaran Selvaraj
Energy Profiling based Load-Balancing Approach in IoT-Edge for Split Computing	Jyotirmoy Karjee; Praveen Naik S; Srinidhi N
Deployment of Computer Vision Application on Edge Platform	Geetha Vasantha; Kiran C; Manash Sharma; Rakshith Kumar J
A T-BS and a UAV Based IoT enabled D2D Network for Disaster Management	Sayanti Ghosh; Sanjay Dhar Roy; Sumit Kundu
Impact of Spatial Correlation on Sum-Rate Capacity in MU-MIMO Broadcast Channels	Swadhin Mishra; Ashok Panda; Arunanshu Mahapatro; Radhashyam Patra
NOMA Based Generalized Precoding Aided Spatial Modulation with Multiuser MIMO in Downlink	Shekhar Pratap Singh; Pyari Mohan Pradhan
Machine Learning based Vehicle-to-Infrastructure Communication in VANETs	Mamata Sataraddi; Mahabaleshwar S. Kakkasageri
Solving Multi-Objective Hierarchical Hub Facility Location Problem Using GA-Based Approaches	Arup Kumar Bhattacharjee; Anirban Mukhopadhyay
Impact of HARQ Retransmission on VoLTE Call Blocking in Cellular LTE	Mohan Kumar Dehury; Hemanta Kumar Pati
sCalib: A Warehouse Sensor Fault Detection and Self-Calibration Technique for Sustainable IoT	Aparna Sinha; Debanjan Das
Localization for Flow assisted Molecular Communication Networks in the Presence of Inter-Symbol Interference	Ajit Kumar; Sudhir Kumar
A Novel Interference-aided RF Energy Harvesting scheme for Cooperative NOMA Network	Chandrima Thakur; Sudipta Chattopadhyay
Particle Swarm Optimization based Task Offloading in Vehicular Edge Computing	Niharika Keshari; Tejas Gupta; Dinesh Singh
A Combined Spectrum Prediction and Sensing Approach for Cognitive Radios	Abdul Rahim, V C; Chris Prema
Sum Rate Analysis of Cooperative NOMA Over Dual-Hop Wireless-Power Line Communication	Roopesh Ramesh; Sanjeev Gurugopinath
KNN based Novel Recommendation System for Mobile Edge Caching	Sourab Mishra; Sparsh Bansal; Krishnendu S; Vimal Bhatia

An improved multi-IRS aided MISO system using multivariate analysis	Gyana Ranjan Mati; Susmita Das; Tapesh Swami
Enhancement of Precision on Cloud Data using Multi-Layered Bloom Filter	D V N. Siva Kumar; Saptarsi Saha
Spectrum Auction Mechanism Based on Concurrent Bidding for Channel Allocation in Ad Hoc CRNs	Monisha Devi; Nityananda Sarma; Sanjib K. Deka
Distributed DBA Scheme for Fog Node Equipped LR-EPON Based FiWi Network	Ateet Gupta; Vinod Chandra; Subhajit Mukherjee; Aneek Adhya
Bilateral Access Control with Traceability and Revocability in Secure Cloud-Fog Computing Framework	Vishnu Kalgi; Priyanka Parimi; Rashmi Ranjan Rout
Fuzzy Logic based Task Scheduling Algorithm in Vehicular Fog Computing Framework	Krishnanand Rai; Satish Vemireddy; Rashmi Ranjan Rout
Adaptive Replacement Cache with Quality of Service for Delay Sensitive Applications in Named Data Networking	Prajwal Singh; Nityananda Sarma
Level Crossing Rate and Average Fade Duration of RIS-Assisted RF Communication System	Amina Girdher; Ankur Bansal; Ankit Dubey

### **Track: Computational biology and biomedical informatics**

Multi-Class Classification on Chest X-Ray Images Using Convolution Neural Network	Bipal Khanal; Astha Singh; Sourav Paul; Ranjita Das
Improvement in ECG R-peak detection compared to conventional methods using LSTM	Soubarna Chowdhury; Chaity Sarkar; Aparajita Sengupta
Classification of Seizure Types Based on Statistical Variants and Machine Learning	Anand Shankar; Samarendra Dandapat; Shovan Barma
Emergent Regulatory Response and Shift of Half induction point under Resource Competition in Genetic circuits	Priya Chakraborty; Sayantari Ghosh
Effects of Vaccination Decisions and Peer influence on Epidemic Dynamics: A Network Perspective	Ganapati Dash; Kumar Gaurav; Sayantari Ghosh
Automatic Kernel Selection of Support Vector Machine for Drug/Non-Drug Compounds Classification	Lakshmi Mandal; Nanda Jana
Deep Learning-based Mixed Data Approach for COVID-19 Detection	Santosh Sanjeev; Balne Charithchandrasai; Tudi Jayadeep Reddy; Gogulamudi Pradeep Reddy
Osteosarcoma Classification using Multilevel Feature Fusion and Ensembles	Bhuma Chandra Mohan
RecU-Net++: Improved Utilization of Receptive Fields in U-Net++ for Skin Lesion Segmentation	Rukhshanda Hussain; Hritam Basak

Breast Cancer Prediction using Supervised Machine Learning Techniques	Sonal Singh; Jatin Prasad; Shivangini Prasad; Srinivas Naik
Binary classification of meditative state from the resting state using EEG	Jerrin Thomas Panachakel; Pradeep Kumar Govindaiah; Kanishka Sharma; Ramakrishnan Angarai Ganesan
Retinal Blood Vessel Segmentation using a Multi-Scale Layer in Deep Learning	Supratim Ghosh; Mahantapas Kundu; Mita Nasipuri
A Non-Fiducial Noise Robust VMD-based Framework for ECG-based Biometric Recognition	Tilendra Choudhary; Mousumi Das; L N Sharma; Manas Kamal Bhuyan
Speed Invariant Gait Event Identification using Dynamic Time Warping	Jayeeta Chakraborty; Harin Santosh Dabbiru; Anup Nandy
Follicle Segmentation from Ultrasound images of Ovary by using sub-band entropy-based wavelet thresholding and object contours	Manas Sarkar; Ardhendu Mandal
An Audio Signal-based COVID-19 Detection Methodology using Modified DenseNet121	Shrabana Saha; Rajarshi Bhadra; Subhajit Kar
A Decision Support System for Prediction of Paroxysmal Atrial Fibrillation based on Heart Rate Variability Metrics	Dipen Deka; Bhabesh Deka
Huffman Coding based ECG Processing For Compression-Distortion Tradeoff	Debarpan Bhattacharya
A Study of Kidney Exchange Problem and its Recent Challenges	Sanjeev Kumar; Bhabendu kumar Mohanta
Parkinson's Disease Classification from Magnetic Resonance Images (MRI) using Deep Transfer Learned Convolutional Neural Networks	Iswarya Kannothe Veetil; Gopalakrishnan E A; V Sowmya; Soman K P
Causal Connectivity based Classification of Functional MRI data	J Siva Ramakrishna; Hariharan Ramasangu
Segmentation and Classification of Brain Tumors using Deep Learning Techniques	Gaurav Chandra; Ms. Shambhavi; Pushp Paritosh; Sriparna Saha
Cognitive State Classification using Optimized Feature Selection Approach	J Siva Ramakrishna
Coronavirus Infection Segmentation & Detection Using UNET Deep Learning Architecture	Naman Saxena; Ekam Singh Chahal; Adwitiya Sinha; Satish Chand
Selecting an Optimizer to Detect the Field of View for CT and MRI Brain Images	Leena Chandrashekar; Dinesh M n
Application of Computer Science in Pineapple Cultivation and Diagnosis of its Diseases- A Systematic Study	Pritimoy Sanyal; Achyuth Sarkar
Cellular Automata based Coupled Nephron Model for Pressure-Driven Oscillations	Siva Manohar Reddy Kesu; Hariharan Ramasangu

Multibranch 1D CNN for Detection and Localization of Myocardial Infarction from 12 Lead Electrocardiogram Signal  
Pharvesh Salman Choudhary;  
Samarendra Dandapat

**Track: Computer Architecture and Embedded Systems**

PRFL: Predicate Rank based Fault Localization  
Sangharatna Godbole; Arpita Dutta

Implementation and Performance Analysis of Indian Sign Language Recognition on various Computing Devices  
Eshaan Rathi; Jatin Luthra; Abhishek Sharma

Energy Efficient Approximate MACs  
Thejaswini P; John Jose; Sukumar Nandi

Low Power, Light Weight and Transparent Multi-Chip Communication Link for IoT Segment  
Ankit Gupta; Saksham Soni; Sriram Muthukumar; Dileep John Kurian; Venkataramana Parvatha

Precise Shared Instruction Cache Analysis to Estimate WCET of Multi-threaded Programs  
Paraman Padma Priya Dharishini; Prakriya Murthy

Extended Base-Delta Compression Technique for On-chip Data Transfer  
Vivekananda G; Thejaswini P

Hardware Accelerator for Object Detection using Tiny YOLO-v3  
Manan Sharma; Rahul R; Madhusudan S; Deepu Sp; Sumam David S.

Long-Distance Communication via Pseudo-3D Networks-on-Chip  
Gagan N; Biswajit R. Bhowmik

Novel Approach for Detection, Localization, and Mitigation of Malicious Node in NoC based SoC  
Sachin Bagga; Ruchika Gupta

**Track: Control and Instrumentation**

Development of Event triggered Feed forward Control Scheme for Fed-Batch E.coli Fermentation Process  
Lufunyo Betania Lupenza; Sutha Subbian; Chitra Murugan

Self-Powered Intelligent Street Light Management System for Smart City  
Prajnyajit Mohanty; Umesh Chandra Pati; Kamala Kanta Mahapatra

Design and experimental validation of non-singular terminal sliding mode control for level control system  
Mukesh Ghogare; Sanjay Patil; Chetankumar Patil; Ajit Laware; Lalit Chaudhari

Stealthy GPS Spoofer Design by Incorporating Processing Time and Clock Offsets  
Pardhasaradhi Bethi; Pathipati Srihari, Dr

UDE based RISE controller for Active Flutter Suppression of 2D Aerofoil  
Balraj Sharma; Abhishek Dixit; Pooja Agrawal; Ajay Misra

Achieving Synchrony in Physical Systems with Mutual Adaptation  
Swethaashri Ramesh; Gayatri Sreenivasan; Vittal Srinivasan; Rajini Makam; Koshy George

Design and Validation of a Fail-safe Digital Igniter tester for Pyro initiator health measurement	Noel Philip; Saroop A; Latha T.; Saleem Haneefa
Pulse Train Modulation And ANN Based Temperature Sensor With Semi-automatic Calibration	Pranabendra Prasad Chandra; Debarpan Bhattacharya; Biswajit Bhattacharyya; Sugata Munshi
Pitch Channel Tracking Control of an Autonomous Underwater Vehicle with Delayed Output	Ravishankar Prakash Desai; Narayan S Manjarekar
Modelling and Control of a nonlinear distillation column: A, using fractional-order controllers	Omar Hanif; Shipra Tiwari; Vivek Kumar
Robust Observer-based Sliding Mode Control of a Pressurized Water Reactor	Soubhagia Suheesan; Ravindra Munje
Application of PID and Sliding Mode Control on Quadcopter for Autonomous Optimized Flight	Mohammad Saad; Chinmay Rajhans; Surender Kannaiyan
Comparative Analysis of Modern Control Schemes in Improved Dynamics of Inverted Pendulum	Faizan Jan; Shakir Hussain Bhat; Amir Iqbal; Danish Akbar Itoo; Abdul Rouf Lone; Shoeb Hussain
Speed Control of Hybrid Electric Vehicle using cascade control of Fractional order PI and PD controllers tuned by PSO	Ashruti Upadhyaya; Purna Gaur
A Framework for Digital PID Controller for Undergraduate Control Systems Laboratory Usage	Pranabendra Prasad Chandra
Control of Boost Converter using Internal Model Control scheme in single loop and in cascade control structure	Purnima Verma; Md Nishat Anwar
Application of Robust Nonlinear Model Predictive Control to Unstable Tank Reactor	Sowmya Gupta; Chinmay Rajhans
Sliding Mode Control for Stabilization of a Class of Nonlinear Systems: A Self-Triggered Design with Prescribed Performance Function	Krishanu Nath; Asifa Yesmin; Manas Kumar Bera
Control of a Single Axis Maglev System	Sandeep P V; V R Jisha
Synchronization of Nonlinear Systems in Chain Network Configuration with Parametric Uncertainty	Yashasvi Chauhan; Bharat Sharma; Ravi Kumar Ranjan

### **Track: Devices Circuits and Systems**

Performance Enhancement of AlInGaN Quantum Well based UV-LED	Samadrita Das; Trupti Ranjan Lenka; Fazal Talukdar; Ravi Teja Velpula; Barsha Jain; Hieu Nguyen
Theoretical Insights into Gold Metal Contacts to Monolayer and Bilayer MoSe <sub>2</sub>	Subir Kumar Ghosh; Divya Somvanshi

VIGILANT - A Car Accident Prevention System based on Driver Drowsiness	Ishan Vatsaraj; Yash Jungade; Nitee Kishor Dhuri; Rutwij Abhijit Mulye; Shubham Mahesh Dalvi; Kartik Ajit Bodhankar; Akhil Ulhas Masurkar
Ultra low power self-adaptive Solar Energy Harvesting System for WSN Nodes	Vinod Kumar Yadav; Nishant Singh; Shambhavi Mudra Shukla
High Performance camera electronics for Infrared payloads	Ravi Kumar; Namita Singh; Ashok Kumar; Jalshri Desai; Rajiv Kumaran
A meta-heuristic algorithm-based optimization $\delta p+$ Si-Ge gate-drain underlap n-TFET	Sagarika Choudhury; Neeraj Kumar Niranjan; Krishana Lal Baishnab; Koushik Guha
AMSDAT: Integrated Analog and Mixed-Signal Design Optimization Framework for SoC Applications	Harsha Maddur Venkataswamy
Design Perspective and Theoretical Analysis of Performance Parameters on CZTS Solar Cell	Srest Somay; Saurabh Pandey
Analytical Modeling of a High-Performance Heterojunction TFET with Tunneling Area Modulation	Arpan De; Saptarshi Maiti; Dipanjan Sen; Nilanjan Das; Sharmistha Shee Kanrar; Subir Kumar Sarkar
Performance Improvement of CZTS <sub>Se</sub> Solar Cell by using Mg-doped ZnO as Window Layer	Rabin Paul; Trupti Ranjan Lenka; Fazal Talukdar
Impact of Non-Rectangular Cross-Section on Electrical Performances of GAA FETs	Tripty Kumari; Jawar Singh; P. Tiwari
Simulation and Performance Analysis of Hetero Dielectric Underlap Asymmetrical Double-Gate MOSFET Using Gate Stack	Swapna Sarker; Suddapalli Subba Rao; Nistala Bheema Rao
A ZnO Humidity Sensor integrated with a-IGZO TFT based Preamplifier	Shishir Choudary Ravipati; Kavindra Kandpal
Aluminium Plate Surface Defect Detection and Classification based on Piezoelectric Transducers	Hiramoni Khatun
Machine Learning Approaches for Variability Analysis in Integrated Circuits	Aksh Chordia; Jai Narayan Tripathi
Tuning of threshold voltage in Organic thin film transistors using buried silver nanoparticles distributed floating gated contacts	Nadeem Firoz; Kale P. Vitthal; B. Mazhari

### **Track: Power, Energy and Power Electronics**

Correlation Analysis in Wind Speed and Solar Insolation temporal series in Indian locations	Jani Das
EMD based Detrending of Non-linear and Non-stationary Power System Signals	Mir Khadim Aalam; Shubhanga

An Improved Gain Noncoupled Inductor Modified Sepic Converter With Voltage Multiplier Cell	Sindhuja S; Mageshwari S; Sridharan Moorthi
PSO Optimized Decentralized Secondary Control for Frequency and Voltage Restoration in Islanded AC Microgrid	Sindhura Gupta; Susovan Mukhopadhyay; Ambarnath Banerji; Sujit K. Biswas; Prasun Sanki
A Fast GMPPT Algorithm For PV Array Under Non-uniform Shading Conditions	Devireddy Sivacharan Reddy; S Porpandiselvi; Bhavin Salvi
SCADA WebView: A State-of-the-Art Enterprise Transmission SCADA Engine	Sumit Kumar Saurav; Palem Benny Sudhakar; Katta Jagan Mohan; Senthil Kumar R; Bindhumadhava Bapu S
PI-RLNN Controller for LFC of Hybrid Deregulated Power System Based on SPOA	Milton Kumar Das; Parthasarathi Bera; Partha Sarkar; Krishnendu Chakrabarty
A Novel 15-Level Asymmetric Modified T-Type Inverter with Reduced Device count	Prashant Raj Mishra; Sagar Jha; Tapas Roy
Forecasting of Load and Solar PV Power to Assess Demand Response Potential	Jayesh Priolkar; Aditya Shivanand Shirodkar; Sreeraj E S
Optimizing Neural network Hyperparameters with Swarm Intelligences for Commercial Buildings Load Classification	Akshay Gupta; Rahul Singhal; Rajesh Kumar
An efficient K-SVD based Algorithm for detection of Oscillatory mode from ambient data for synchrophasor application	Manoranjan Sahoo; Shekha Rai
Fuzzy and MBO optimized Load Frequency Control of hybrid Power system	Zahid Farooq; Asadur Rahman; Shameem Lone
Comparative Performance Analysis on Passive and Active Balancing of Lithium-Ion Battery Cells	Rushali R Thakkar; Yerramreddy Srinivasa Rao; Rajendra Sawant
Electric Stress Minimization in Outdoor Contaminated Polymeric Insulators Using an Appropriate Field Grading Material	H Shrimathi; Mithun Mondal
Cascaded Diode Clamped Mid Point Multi-Level Converter towards Enhanced Power Rating and Power Quality with Voltage Balancing	Jami Rajesh; Satya Venkata Kishore Pulavarthi; Jayaram N
Effect of DSTS and HVDC on Multi-Area AGC System Considering BSA Optimized 2DOF-TID Controller	Sanjeev Kumar Bhagat; Lalit Saikia; Naladi Ram Babu; Biswanath Dekaraja; Manoja Kumar Behera; Satish Kumar Ramoji
Instrumentation and Data acquisition system of wave powered navigational buoy	Biren Pattanaik; Yvn Rao; Ashwani Vishwanath; Purnima Jalihal
Cryo Cooler Drive Electronics For Infra-Red Earth Observation payloads	Anuj Srivastava; Namita Singh; Ashok Kumar; Jalshri Desai; Rajiv Kumaran

A Division-less, Low Complexity, Adaptive MPPT Algorithm for Photovoltaic Power Systems	Shubham Jain; Pravin Kondekar
Multi-attribute based prosumers prioritization for energy trading in Smart Grid	Nongmaithem Nandini Devi; Surmila Thokchom
Design and analysis of adaptive neuro-fuzzy inference system based MPPT technology	Manasi Pattnaik; Manoj Badoni; Yogesh Tatte
Ferrite PM- Assisted Synchronous Reluctance Motor for EV Application	Subhendu Mishra; Byamakesh Nayak; B Fernandes
Optimal Charge Scheduling of EVs Using Aggregator Based Charge Controller with Active Power Support to the Grid	Priyanka Ray
A Novel Triple Pulse Test Circuit for Complete Characterization of SiC MOSFET	Swastik Acharya; Nitesh Agrawal; Susovon Samanta
Optimizing the Performance of Solar Photovoltaic Panels using Machine Learning	Sathwik Pothana; Nikhil Deep Gupta
Modeling and Control Implementation of Interleaved Coupled and Uncoupled Boost Converter for EV Drive Applications	Guttula Yedukondalu; Susovon Samanta
Modelling and Analysis of Distribution System Performance with Integration of Electric Vehicle Charging Station in Real-time Environment	Sourav Kumar Sahu; Shubham Kumar; Debomita Ghosh; Suddipto Poddar
Dust effect on energy profile production from hybrid photovoltaic (H-PV) collector	Rohit Tripathi
Stability Criteria of Peak Current Controlled Active Clamp Forward Converter with Input Filter	Maturi Krishnaja; Susovon Samanta
Optimal Placement of PMUs using Binary Bat Algorithm	Phanendra Babu N v; Sumanth Mekala
Enhancement of Power Transfer Capability using Dynamic Model of Unified Power Flow Controller	Nageswarareddy N; Sridharan Moorthi; Raja Pitchaimuthu; Phanendra Babu N v; Saptarshi Roy
A Hybrid Islanding Detection Scheme For Grid-tied PV Microgrid	Vishal S Dixit; Manav Dhanesh Jadhvani; Abhishek Pandey; Faruk Kazi
A New Transmission Line Fault Location Identification using Fault Current DC transients	Adharapurapu Hema Latha; Ravikumar Bhimasingu

### **Track: Robotics and Cybernetics**

Dynamic Analysis of Tracked Mobile Manipulator Used in Agriculture	S Vineet; Deepak Deshmukh; Dilip Pratihar; Alok Deb; Hena Ray; Nabarun Bhattacharyya
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VoiceMojj: A Novel On-Device Pipeline for Seamless Emoji Insertion in Dictation	Sumit Kumar; Bhogaraju Swarajya Sai Harichandana; Himanshu Arora
DSNet-MV: Fast summarization of Surveillance Video's using Deep learning in Compressed Domain using Motion Vectors	Lakshya Lakshya; Shivaank Agarwal; Venkata Suneel Kota; Mallikarjuna Rao Voleti
Adaptive Beam Search to Enhance On-device Abstractive Summarization	Bhogaraju Swarajya Sai Harichandana; Sumit Kumar
Computer Vision-based Social Distancing Surveillance with Automated Camera Calibration for Large-scale Deployment	Sreetama Das; Anirban Nag; Dhruva Adhikary; Ramswaroop Ramswaroop; Aravind Babu Ravichandiran; Sujit Kumar Ojha; Guruprasad Mahabaleshwar
Garbage Detection and Classification using Faster-RCNN with Inception-V2	Asif Iqbal Middy; Debjani Chattopadhyay; Sarbani Roy
Face Verification System with Liveness Detection	Divyansh Srivastava; Priyansh Shukla; Ashish Kumar Sahani
Human Emotion Recognition using EEG Signal in Music Listening	Manasa Pisipati; Anup Nandy
Traffic Management using Computer Vision and SUMO	Bodicherla Digvijay Sri Sai; Ramisetty Nikhil; Payarda Santosh Babu; Srinivas Naik
Hospital Assistant Robotic Vehicle (HARVi)	Yadu Krishnan; Vaisakh Udayan; S Akhil
A Method for Finding Multiple Large Rectangular Free Spaces in a Map with Convex and Concave Obstacles	Aishik Basu; Bappaditya Das; Chintan Kumar Mandal
Implementation and Evaluation of SLAM Systems for a Mobile Robot	Chinmay Nehate; Rutwik Shinde; Saket Naik; Manish Aradwad; Anish Bhurke; Faruk Kazi
A Comparative Study of Deep Learning Methods for Hate Speech and Offensive Language Detection in Textual Data	Yogesh Yadav; Parth Bajaj; Rohan Kumar Gupta; Rohit Sinha
Learning Safe Cooperative Policies in Autonomous Multi-UAV Navigation	Arshdeep Singh; Shashi Shekhar Jha
Knowledge Aided Track Management: Multi-Target Tracking in the Presence of Electromagnetic Absorbers	Pathipati Srihari, Dr; Vikas Kumar Dewangan; Anvith M; Adithya Jayan; Medidi Anurag; Pardhasaradhi Bethi
A Fusion Architecture Model for Human Activity Recognition	Sarosij Bose; Amlan Chakrabarti
Effective Object Detection and Tracking for Holonomic Robot using Deep Neural Architecture	Atharva Vijaydeep Pawar; Sejal Jitendrasingh Rajput; Hima Kamleshbhai Soni; Nirav Ratilal Joshi
On Learning Multi-UAV Policy for Multi-ObjectTracking and Formation Control	Prakarsh Kaushik; Armaan Garg; Shashi Shekhar Jha
ARC�: A Real-time Attention-based Network for Crowd Counting from Drone Images	Subhrajit Nag; Yash Khandelwal; Sparsh Mittal; C Krishna Mohan; A. Kai Qin

Redundancy Analysis using Genetic Algorithm	Helik Kanti Thacker; Atishay Kumar; Ankit Gupta; Keerthi Kiran Jagannathachar; Deokgu Yoon
Machine Learning in Smart Transportation Systems for Mode Detection	Sayandeep Roy; Yash Pratap Singh; Utsab Biswas; Devendra Singh Gurjar; Tripti Goel
OROnto: An Ontology for Recognition of Grasping Objects	Abhijit Boruah; Tazid Ali; Nayan M. Kakoty; M. b. Malarvili
Autopilot Design for Vision Assisted Autonomous Fixed Wing Micro Air Vehicle	Shuvrangshu Jana; Mayur Shewale; Susheel Balasubramaniam; Sidhant Dhall; Seetharama Bhat

### **Track: Security and Privacy**

Securing images using robust chaos based masking and scrambling in the fractional Fourier domain	Vinod Patidar; Gurpreet Kaur
Modeling and Defending against Resource Depletion Attacks in 5G Networks	Gokul Nb; Sriram Sankaran
Moving Towards Blockchain-Based Solution for Ensuring Secure Storage of Medical Images	Ashwini S D; Annapurna P Patil; Savita Shetty
Design and Analysis of Hash Algorithm Using Autonomous Initial Value Proposed Secure Hash Algorithm64	Bhagvant Ram Ambedkar; Pawan Kumar Bharti; Akhtar Husain
Digital watermarking in fractional integral transform domain with chaos based random and partially informed detection	Gurpreet Kaur; Vinod Patidar
An adaptive Weighted Voting Classifier for Botnet Detection in Internet of Things	Deepa Krishnan; Preeja Babu
Proof of Solution: Implementation of Work History as Stake in Blockchain Applications	Kiran M H M; Annapurna P Patil; Harivind Premkumar; Pranav Hegde; Rishi Kumar P S
Generative Adversarial Analysis using U-LSB Based Audio Steganography	Vaishnavi Moorthy; Revathi Venkataraman
Malicious URL Classification Using Deep Neural Network	Mainak Sen; Kumar S Ray; Amlan Chakrabarti
A brief overview of security attacks and protocols in MANET	Bidisha Banerjee; Sarmistha Neogy
Tree-Based Group Diffie-Hellman for subgroup communication in M2M networks	Kousik Rajesh; Manoj Das; Sukumar Nandi
Defending against SQL injection attacks in web applications using Machine Learning and Natural Language Processing	Bronjon Gogoi; Tasiruddin Ahmed; Arabinda Dutta
Graph-Based Channel-Aware Secure-Coding for Cooperative Communication	Kotha Venugopalachary; Vijay Kumar Chakka; Jannie Sanjana

## Track: Signal Processing and Multimedia

An Intelligent Pothole Detection and Alerting System using Mobile Sensors and Deep Learning	Shubhra Rao Kuthyar; Roopashree S; Rasika V; Sahana Manjesh; Ritu Girimaji; Rahul Davis Arjun; Priyadarshini S
Refined Zero Band Filtering for Estimation of Instants of Significant Excitation from Emotive Speech	Ashwini R; Govind D
Effectiveness of Wavelet Synchrosqueezed Transform for Improved Epoch Estimation from Telephonic Speech Signals Using Zero Frequency Filtering	Chandni M; Govind D
Single Image And Video Dehazing: A Dark Channel Prior (DCP)-based Approach	Sajitha Adidela; Sakshi Singh; Tina Sahu; Amrita Mishra
Evaluating Speech Production-based Acoustic Features for COVID-19 Classification using Cough Signals	Bhanu Teja Nellore; Ganji Sreeram; Kunal Dhawan; Balakrishna Pailla
Short Utterances based real time on-Device Spoken Language Identification	Shwetank Choudhary; Kushagra Jain; Tanmay Bansal; Karthik Cr; Punuru Sri Lakshmi; Shubham Sharma
Performance Analysis of Transversal Filter Combination for Feedback Suppression in Hearing Aids	Ravi Vanamadi; Asutosh Kar
Multi-object Foreground Extraction in Streaming Video using Low Rank Sparse Decomposition	Yogesh Sanku; Soumyo Bhattacharjee; Saumik Bhattacharya
An Improved DCT interpolation using Bilateral filter	Jagyanseni Panda; Sukadev Meher
Character Segmentation from Handwritten Gujarati isolated words using Deep Learning	Riya P. Javia; Mukesh M Goswami; Suman Mitra
Removal of Clutter and Random Noise for GPR Images	Buddepu Santhosh Kumar; Ajit Sahoo; Subrata Maiti
Speech Intelligibility Improvement based on Noise Reduction and Frequency Compression Technique	Rajani S. Pujar; Pandurangarao Kulkarni
Reference Information Potential based Closed-form Expressions for Direct Estimation of L <sup>2</sup> based Independence Measure	Bhaveshkumar Choithram Dharmani
Edge-preserving denoising using gradient-based estimation and iterative noise-aided processing	Vineet Kumar; Rajlaxmi Chouhan
Estimation of Depression Anxieties and Stress through Clustering of Sequences of Visual and Thermal Face Images	Satyajit Nayak; Bingi Nagesh; Aurobinda Routray; Monalisa Sarma; Satraupa Uttarkabat

GPU-Accelerated Adaptive Dictionary Learning and Sparse Representations for Multispectral Image Super-resolution	Trishna Barman; Bhabesh Deka; A Prasad
Multimodal Fusion for Segment Classification in Folk Music	Aravind Krishnan; Amal Vincent; Geevar Jos; Rajeev Rajan
Multiview Hand Gesture Recognition using Deep Learning	Mallika Garg; Pyari Mohan Pradhan; Debashis Ghosh
Generating Multiview Hand Gestures with Conditional Adversarial Network	Mallika Garg; Debashis Ghosh; Pyari Mohan Pradhan
Dependency-Based Classification With Multimodal Data Using Regular Vine Copulas	Jahnvi Raman; Apeksha Gaonkar; Yogya Chukkapalli; Sahana Srikanth; Sanjeev Gurugopinath
IITG-INDIGO Submissions for Interspeech-2021 Multilingual and Code-Switching ASR Challenges for Low Resource Indian Languages	Susmita Bhattacharjee; Joyshree Chakraborty; Sanskar Agarwal; Ayul Jain; Priyankoo Sarmah; Rohit Sinha
Measurement and Evaluation of Human Vital Sign using 77GHz AWR1642 FMCW Radar Sensor	Pathipati Srihari, Dr; Vandana G s; Raghavendra B s
VesselXnet - A lightweight and efficient encoder-decoder based model for Retinal Vessel Segmentation	Narasimhadhan AV; Surya prakash Reddy Putluru; Venkat Rohit Merugu
A Robust Zero-attracting Proportionate Logarithmic Hyperbolic Cosine Adaptive Filter against Impulsive Noise for Sparse Systems	Joel Fernandez; Rajib Lochan Das
Design of Unimodular Long Length Polyphase Code for CW Radar for Doppler Tolerance	Paramananda Jena; A Vengadarajan; Pathipati Srihari, Dr
A more generalizable DNN based Automatic Segmentation of Brain Tumors from Multimodal low-resolution 2D MRI	Divya Bhaskaracharya; Rajesh Parameshwaran Nair; Prakashini Koteswara; Girish Menon R; Paul Litvak; Pitchaiah Mandava; Deepu Vijayasenani; Sumam David S.
Evaluating Different Graph Learning Techniques for Mental Task EEG Signal Classification	Priyanka Mathur; Vijay Kumar Chakka
Detection of Speech-based Physical Load Using Transfer Learning Approach	Sibasis Sahoo; Samarendra Dandapat

### **Track: VLSI and Nanotechnology**

LC-VCO with Simple Enhancement to Suppress Flicker Noise Upconversion	Debdut Biswas
A Novel Temperature Compensated On-chip Current Starved Ring Oscillator	Rahul Harish Bhandari; Ashwini Nayak; Sanjay Netagal; Sujata Kotabagi; Shrinidhi Kamalakar
VLSI Architecture Design of Motion Estimation Block with Hexagon-Diamond	Atin Mukherjee

## Search Pattern for Real-Time Video Processing

A 6-bit Low Power Digitally Controlled Oscillator	Rahul Harish Bhandari; Sujata Kotabagi; Ashwini Nayak
Estimating Power Supply Induced Jitter using S-Parameter based modeling of Transmission Media	Diksha Singh; Vinod Verma; Jai Narayan Tripathi
Design Of High Density Memory Cell Library For Low Voltage Operation In 65nm LSTP Technology	Akshat Saxena; Swapnil Bansal; Divisha Sharma; Payal Kumari; Sandeep Kumar Singh; Priya Kapil; Belal Iqbal; Anuj Grover
VLSI Implementation of A Robust Threshold-Based Earthquake Early Warning System	Sudipta Bose; Arijit De; Indrajit Chakrabarti
Label-Free Biosensing using Dielectric Modulated GaAs <sub>1-x</sub> Sb <sub>x</sub> FinFET under Dry/Wet Environment	Ankit Dixit; Dip Prakash Samajdar; Navjeet Bagga
8-bit 2-GS/s 20.5 mW Flash Assisted Time Interleaving SAR ADC for Direct Sampling RF Receivers	Amitesh Kumar Tripathi; Sumit Khalapure; Rajesh Zele
A Novel High RSNM RHBD 16T SRAM Cell at 180nm	Betha Surya Prakash; Ashutosh Yadav; Anand Bulusu; Sudeb Dasgupta
Design Considerations for Low Spur Charge Pump in High Performance Phase Locked Loops	Aniruddh Choudhary; Aniruddha Khade; Rajesh Zele
FGMTL based Low Voltage Current Mode Squarer/Divider Circuit	Aakriti Chhabra; Bhawna Aggarwal; Raj Senani
Adaptively Biased Low dropout regulator with Low input referred noise amplifier for high speed serial Links	Suresh Nagula; Patri Sreeharirao; Ekta Goel
Design of Concurrent Error Detection Techniques for FFT implemented on FPGA platform	Venkata Mohan Krishna Kaza; Kishor Prabhakar Sarawadekar
A Novel Decoder Design for Logic Computation in SRAM: CiM-SRAM	Kanika Monga; Sahil Aggarwal; Nitin Chaturvedi; S Gurunarayanan

# Implementation of Linear Quadratic Regulator in an Isolated Microgrid System

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**Abstract**—This paper elaborates a linear–quadratic–regulator (LQR) technique for an isolated microgrid in presence of electric vehicle (EV) and renewable power system (RPS) participation. Generally, in control theory the state feedback control can place the poles in the desired locations in order to improve stability but many a time, it is observed that the steady state error is appropriately not achieved as well as the overall cost is compromised. In this connection, LQR control theory helps to obtain the feedback gain optimally using quadratic cost function. The weight adjustment matrices in LQR control theory requires to adjust in order to achieve desired system response. Hence, the weight matrices are adjusted to achieve optimal operating condition based on the proposed flow chart. Numerous, test cases are carried out considering different system configurations to validate performance and efficacy of the controller under MATLAB / Simulink environment.

**Keywords**—Automatic generation control (AGC), electric vehicle (EV), islanded microgrid, linear quadratic regulator (LQR), optimal state feed-back control.

## I. INTRODUCTION

Automatic generation control (AGC) is utilized widely in modern power system to improve the dynamic system per-formances. It regulates the power-frequency balance incorpo-rating a synchronism between total generated power and total load demand. The unwanted frequency oscillation is developed when an imbalance is occurred between the generated power and load demand. Sometimes these oscillations are increasing extensively so that the overall system performance is hampered [1], [2]. In the modern power system, renewable power sys-tems (RPSs) like solar power systems (SPSs) and wind power systems (WPSs) are widely used. Additionally, the widespread usage of energy storage devices (ESDs) (like electric vehicles (EVs), battery energy storage (BES) unit, flywheel energy storage (FES) unit) are increased in a greater extent. These RPSs and ESDs are combined to form microgrid. Further, the output power obtained from the RPSs are intermittent in nature and highly environment dependent. Therefore, integration of these RPSs may cause power imbalance in the system and create frequency oscillation in power network. To overcome this situation ESDs become a unique solution to deliver power immediately whenever sudden load demand is occurred or the demanded power exceeds to the generated power [3]. Nowadays, Diesel engine generators are also utilized with RPSs and ESDs to enhance overall system performance and reliability [4].

In the past few decades, a huge development is observed in utilizing ESD units. ESDs store energy when surplus energy is available from RPG units and utilize it whenever required. Among all, EVs got more popularity and a huge application of EVs can be observed in present scenario. EVs are utilized as portable BES units and highly efficient to fulfill sudden power demand [5]–[7]. In current time, microgrid based power systems are more common. Microgrids can be utilized in grid connected mode or isolated mode operations. Isolated microgrid operation are very much sensitive compared to grid connected operation. In this regard, a special attention must be provided to control and protect the microgrid based isolated power system [8], [9].

Over the years, huge attentions are provided for controlling power-frequency balance in order to perform AGC operation. Among various available controllers proportional, integral and derivative (PID) controller, Fuzzy-PID controllers are gaining utmost popularity [10], [11]. A wide application of optimal control (e.g. LQR) theory is also seen in numerous articles. However, the application is restricted to hydro-thermal based RPS integrated interconnected power systems [12]–[15]. Fur-ther, a huge area yet to be revealed to investigate the effect of optimal control in isolated power system. Many a research arti-cle incorporated several metaheuristic optimization techniques to obtain the proper controller gain parameters. Imperialist competitive algorithm (ICA) [1], whale optimization algorithm (WOA) [2], [17], particle swarm optimization (PSO) [4], [16], flower pollination algorithm [7], genetic algorithm (GA), adaptive differential evolution (ADE), hybrid DE-grey wolf optimization (hDEGWO), water cycle algorithm (WCA) [9]–[11] are considered as popular algorithms. Notwithstanding, due to huge popularity, flexibility and wide application LQR technique is utilized here for conducting the test cases.

After inspecting various published research works, the re-search gap as well as the contributions of this paper are furnished as follows.

- Previously, most of the cases optimal control theory is considered in interconnected power system operation. In this article, special attention is given investigating the isolated power system scenario in presence of optimal control theory.
- In the earlier research work, the application of microgrid

**Proceedings of**  
**IEEE VLSI DCS 2022: 3<sup>rd</sup> IEEE Conference on VLSI**  
**Device, Circuit and System**  
**Conference Record: 53788**

26<sup>th</sup> – 27<sup>th</sup> February, 2022, Kolkata, India

Place: Meghnad Saha Institute of Technology, Kolkata

Organised by:

**IEEE Electron Device MSIT Student Branch Chapter**  
**in association with the Department of ECE, MSIT**

Edited by,

**Dr. Manash Chanda**

**Meghnad Saha Institute of Technology**

# 2022 IEEE VLSI DEVICE CIRCUIT AND SYSTEM (VLSI DCS)

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**Part Number: CFP22T84-ART**

**ISBN No.: 978-1-6654-3801-8**

# Table of Contents

	Copyright Message	i
	Message from Chief Patron	ii
	Message from Patron	iii
	Message from Chief Guest	Iv
	Message from General Chair and Editor	v
1	<b>Exploring the Feasibility of Implementing Negative-Capacitance Tunnel-FET (NC-TFET) in Low-Power Digital Circuits</b> <i>Sourav Guha, Prithviraj Pachal</i>	1-4
2	<b>Investigation of MoS<sub>2</sub> Based Dual Gate MOSFET as a H<sub>2</sub> Sensor Considering Catalytic Metal Gate Approach</b> <i>Arpan De, Ananya Karmakar, Rittik Ghosh, Priyanka Saha</i>	5-8
3	<b>All Optical Logic XNOR Gate Using Dual Control Dual SOA TOAD (DCDSTOAD)</b> <i>Kajal Maji, Kousik Mukherjee, Mrinal Kanti Mandal</i>	9-12
4	<b>Backscatter Interrogation Enactment in UHF-RFID for Rayleigh Diminishing Channel</b> <i>Aritra De, Tirthankar Datta</i>	13-18
5	<b>Linearity Performance of Double Metal Negative Capacitance Field-Effect Transistors: A Numerical Study</b> <i>Yash Pathak, Bansi Dhar Malhotra, Rishu Chaujar</i>	19-23
6	<b>Performance Assessment of InGaN Double Gate Stack-Oxide MOSFET Based Phosphine Gas Sensor: A Catalytic Metal Gate Approach</b> <i>Ajay Kumar, Dipanjan Sen, Soumendu Sinha</i>	24-27
7	<b>Magnesium-Silicide (Mg<sub>2</sub>Si)/Silicon (Si) Heterojunction Based TFET for Optical Detection at 1550 nm</b> <i>Manisha Khurana, Upasana, Manoj Saxena, Mridula Gupta</i>	28-33
8	<b>Density Functional Theory (DFT) Analysis on the Structural, Electronic, and Optical Properties of Monoclinic HfO<sub>2</sub></b> <i>Jayanta Kumar Kar, Saurabh Chaudhury, Neerja Dharmale</i>	34-40
9	<b>Study the Sensing Performance with Catalytic Metals of Passivated InAlN/GaN Schottky Diode Gas Sensor</b> <i>Bhaskar Roy, Md. Aref Billaha, Ritam Dutta, Debasis Mukherjee</i>	41-45
10	<b>Temperature Dependence on Fin-FET Electrical Parameters for Al<sub>2</sub>O<sub>3</sub> and HfO<sub>2</sub> Dielectric Materials: A Comparative Study</b> <i>Salini Singh, Bhaskar Roy, Md. Aref Billaha, Ritam Dutta, Santosh K. Choudhary</i>	46-49
11	<b>Impact of Composite Trench Stepped Hetero Channel MOSFET on Analog Performance</b> <i>Soumya S. Mohanty, Sikha Mishra, Guru Prasad Mishra</i>	50-54
12	<b>An Integrated System for Drivers' Drowsiness Detection Using Deep Learning Frameworks</b> <i>Biswarup Ganguly, Debangshu Dey, Sugata Munshi</i>	55-59

13	<b>K Nearest Neighbor and Flexible Neural Tree Based IDS in Mobile Ad- hoc Network</b>	<b>60-64</b>
	<i>Indrajit Das, Piyali Roy, Debanjan Das, Sayan Das, Puja Ghosal</i>	
14	<b>Design and Implementation of Authentication System Using Deep Convoluted Siamese Network</b>	<b>65-69</b>
	<i>Sumagna Dey, Indrajit Das, Soubarna Das, Subhrapratim Nath</i>	
15	<b>DC and Analog/RF Performance Analysis of Gate-Drain Underlapped and Channel Engineered TFET</b>	<b>70-74</b>
	<i>Sudipta Ghosh, Sayan Bose, Wahid Anwar, Madhusree Banerjee, P. Venkateswaran, Subir Kumar Sarkar</i>	
16	<b>Current Sensitivity and Power Dissipation Analysis of Junctionless Double Gate MOSFET Biosensor</b>	<b>75-79</b>
	<i>Bedantika Basu, Debosmita Ghosh, Madhusree Banerjee, Papiya Debnath</i>	
17	<b>DC and Analog/RF Performance Comparison of Renovated GAA JLFET Structures</b>	<b>80-84</b>
	<i>Sudipta Ghosh, Abhiroop Jana, Agni Kumar Agnihotri, Shirsha Kundu, Dyuti Das, Subir Kumar Sarkar</i>	
18	<b>Assessment of Filter Design for 5G Applications</b>	<b>85-88</b>
	<i>Gaurav Bhargava, Shubhankar Majumdar</i>	
19	<b>Partially Depleted Silicon-on-Insulator (PDSOI) MOSFETs for RF Switching Applications</b>	<b>89-92</b>
	<i>T. P. Dash, C. K. Maiti, Devika Jena</i>	
20	<b>RF Analysis of a Fully Gate Covered Junctionless FinFET for Improved Performance</b>	<b>93-97</b>
	<i>Aman Tyagi, Gaurav Mangal, Rishu Chaujar</i>	
21	<b>Economic Analysis for the Players Participating in a Hybrid Solar Virtual Power Plant</b>	<b>98-103</b>
	<i>Epsita Das, Koninika Biswas, Sujit K. Biswas, Ambarnath Banerji, Rajarshi Chakrabarti</i>	
22	<b>Implementation of Linear Quadratic Regulator in an Isolated Microgrid System</b>	<b>104-109</b>
	<i>Prasun Sanki, Mousumi Basu, Partha Sarathi Pal, Debapriya Das</i>	
23	<b>A Survey on Field Effect Transistor Based Hydrogen and Nitrogen Gas Sensors</b>	<b>110-115</b>
	<i>Koushik Ghosh, Arpita Ghosh</i>	
24	<b>An Efficient Approach to Design a Comparator for SAR-ADC</b>	<b>116-122</b>
	<i>Tejender Singh, Suman Lata Tripathi</i>	
25	<b>A Hybrid MILP-GA Algorithm to Optimize Battery Mix System in Active Distribution Networks</b>	<b>123-128</b>
	<i>Subho Paul, Biswarup Ganguly, Upayan Adhikary</i>	
26	<b>Analysis of Constant On-Time Buck Converter with System Verilog Real Number Model Approach</b>	<b>129-133</b>
	<i>Saikat RoyChowdhury, Sudeep Phadikar</i>	
27	<b>Emergency Medical Assistance by Ambulance Drone Using Machine Learning, Lightweight Cryptography and Variable Image Steganography</b>	<b>134-138</b>

	<i>Indrajit Das, Sanjoy Roy, Sumagna Dey, Tulsi Dey, Piyali Roy</i>	
28	<b>Capacitive Memory Using GLAD Synthesized Annealed SnO<sub>2</sub> Nanowire Arrays as a Dielectric</b>	<b>139-142</b>
	<i>Priyanka Chetri, Jay Chandra Dhar</i>	
29	<b>Machine Learning Classifiers for Speech Detection</b>	<b>143-147</b>
	<i>Dasari Lakshmi Prasanna, Suman Lata Tripathi</i>	
30	<b>Selective Run-Length Constrained Encoding Scheme on Extended Nucleic Acid Memory</b>	<b>148-153</b>
	<i>Saptarshi Biswas, Trishita Ghosh, Subhprattim Nath</i>	
31	<b>Design of an Improved Tie-line Power Model for a PEV Based Interconnected Microgrid Under AGC Operation</b>	<b>154-159</b>
	<i>Prasun Sanki, Mousumi Basu, Partha Sarathi Pal, Debapriya Das, Sindhura Gupta</i>	
32	<b>Statistical Analysis of a Low Power Analog Current Source</b>	<b>160-164</b>
	<i>Sneha Upadhyay, Trisha Sau, Susmita Mitra, Arpita Bhowmik, Saheli Sarkhel, Soumya Pandit</i>	
33	<b>A Deep CNN Framework for Distress Detection using Facial Expression</b>	<b>165-169</b>
	<i>Bikramjit Das, Debanjana Ghosh, Ashesh Roy Choudhuri, Ankan Goswami, Avinandan Bhakta, Mahamuda Sultana, Suman Bhattacharya</i>	
34	<b>State of the Art and Future Perspectives in III-V Nanometer-scale MOSFETs</b>	<b>170-175</b>
	<i>Saswati Dey, Kalyan Biswas, Angsuman Sarkar</i>	
35	<b>Effect of Asymmetric Space Charge Region on Current Density of Heterojunction Solar Cell</b>	<b>176-179</b>
	<i>Sayoni Chakraborty, Arpan Deyasi</i>	
36	<b>Electrical Noise Analysis of L-Shaped Gate Tunnel Field Effect Transistor</b>	<b>180-183</b>
	<i>Sweta Chander, Rekha Chaudhary, Sanjeet Kumar Sinha</i>	
37	<b>Multimodal Medical Imaging Using Modern Deep Learning Approaches</b>	<b>184-187</b>
	<i>Rahul Chanumolu, Likhita Alla, Pavankumar Chirala, Naveen Chand Chennampalli, Bhanu Prakash Kolla</i>	
38	<b>Modeling an Energy Efficient Clustering Protocol with Spider Cat Swarm Optimization for WSN</b>	<b>188-193</b>
	<i>T. Saravanan, S. Saravanakumar</i>	
39	<b>Early Alzheimer's Disease Detection using Semi- Supervised GAN Based on Deep Learning</b>	<b>194-198</b>
	<i>S. Saravanakumar, T. Saravanan</i>	
40	<b>Enhanced Prediction of Thyroid Disease Using Machine Learning Method</b>	<b>199-204</b>
	<i>Madhumita Pal, Smita Parija, Ganapati Panda</i>	
41	<b>White Light Photosensitivity and Stable Photoresponse Properties of Tetrapod Shaped CdSe Nanocrystals: Polymer: Fullerene Blend</b>	<b>205-209</b>
	<i>Deep Chandra Upadhyay, Rishibrind Kumar Upadhyay, Abhinav Pratap Singh, Satyabrata Jit</i>	

42	<b>Identifying Differentially Expressed Genes in Different Stages of Lung Cancer – An Application of ARM Model on Gene Expression Data</b>	210-214
	<i>Subir Hazra, Amartya Roy, Rohan Sarkar, Anupam Ghosh</i>	
43	<b>RF/Analog Performance Analysis of Electrostatically Doped Dual Pocket Vertical Tunnel Field Effect Transistor</b>	215-219
	<i>Amit Bhattacharyya, Madhusree Banerjee, Papiya Debnath, Debashis De, Manash Chanda</i>	
44	<b>Application of Soil Sensors for Maximizing Productivity Using IoT Framework</b>	220-224
	<i>Subhprapatim Nath, Anup Dey, Papiya Das, Dyuti Mohapatra, Jamuna Kanta Sing, Subir Kumar Sarkar</i>	
45	<b>Signature Recognition and Detection of Skilled Forgeries Using Image Transformation and Multistream CNN</b>	225-229
	<i>Papiya Das, Swarnabja Bhaumik, Subhprapatim Nath</i>	
46	<b>Method for Enabling RDMA Transport Peer to Peer Transfer with NVMeoF Ethernet SSDs</b>	230-233
	<i>Venkataratnam Nimmagadda, Sandeep Kumar Ananthapalli</i>	
47	<b>Silicide on Oxide Based Carrier Selective Front Contact for 24% Efficient PERC Solar Cell</b>	234-237
	<i>Savita Kashyap, Rahul Pandey, Jaya Madan, Rajnish Sharma</i>	
48	<b>VLSI Routing Optimization Using Hybrid PSO Based on Reinforcement Learning</b>	238-243
	<i>Pradyut Nath, Sumagna Dey, Aditya Shankar, Subhprapatim Nath, Jamuna Kanta Sing, Subir Kumar Sarkar</i>	
49	<b>Study of Electrical Parameters of Strained Si PMOS with High k Dielectric Material Using TCAD</b>	244-247
	<i>Debasish Mohanta, Sruti Suvadarsini Singh</i>	
50	<b>Optical Characteristics of Broadband Raman Amplifier Coupled with Multimode Fiber Designed at 1550 nm in Presence of Doping</b>	248-253
	<i>Rikita Das, Arpan Deyasi</i>	
51	<b>Tweet Classification and Sentiment Analysis of Covid 19 Epidemic by Applying Hybrid Based Techniques</b>	254-260
	<i>Mauparna Nandan, Soma Mitra, Sharmistha Dey</i>	
52	<b>Single Event Transient Effect on Tapered Angle Hetero-junction Dopingless TFET for Radiation-Sensitive Applications</b>	261-264
	<i>Monika Sharma, Rakhi Narang, Manoj Saxena, Mridula Gupta</i>	
53	<b>Dependence of Gate Leakage Current on Efficacy of Gate Field Plate in AlGaIn/GaN HEMT</b>	265-268
	<i>Chanchal, Ajay Kumar Visvkarma, Amit Malik, Robert Laishram, D S Rawal, Manoj Saxena</i>	
54	<b>Design - Development of VEHICLE for Delivery of Goods in Hazardous Areas (VEDHA)</b>	269-274
	<i>Suvargha Ghosh Dastidar, Synthya Haldar, Pratyusha Biswas Deb, Sohini Pal, Ambalika Saha, Ambarnath Banerji, Hiravra Koley, Prithasankar Laskar</i>	
55	<b>Internet of Things (IoT) Based Continuous Growth Rate Monitoring System of Plant Stem</b>	275-279
	<i>Shikha Nayak, Subir Das, Badal Chakraborty, Tanmoy Chakraborty, Kishor Roy</i>	

56	<b>A Novel Computer Vision Model for Recognition and Evaluation of Mathematical Equations using Deep Learning Technique</b>	<b>280-285</b>
	<i>Shaun Oommen Alexander, Chitresh Kansal, Devang Mehrotra, Rohit P, Shashank Mouli Satapathy</i>	
57	<b>ZnO-WO<sub>3</sub> Mixed Metal Thin Film Capacitive Biosensor for Food Quality Measurement</b>	<b>286-289</b>
	<i>Gour Gopal Jana, Jyotirmoy Nandy, Moumita Chakraborty, Subhashis Roy, Bijoy Kantha</i>	
58	<b>Machine Learning-Based Intrusion Detection System for Healthcare Data</b>	<b>290-294</b>
	<i>Amit Kumar Balyan, Sachin Ahuja, Sanjeev Kumar Sharma, Umesh Kumar Lilhore</i>	
59	<b>Comparative Study of Supervised Machine Learning Methods for Prediction of Heart Disease</b>	<b>295-299</b>
	<i>Meghavi Rana, Mohammad Zia Ur Rehman, Srishti Jain</i>	
60	<b>Metamaterial Absorbers for IoT Applications</b>	<b>300-303</b>
	<i>Prince Jain, Shonak Bansal, Piyush Samant</i>	
61	<b>Smart ECG Monitoring and Analysis System Using Machine Learning</b>	<b>304-309</b>
	<i>Sarab Nidhaan Singh, Megha Bhushan</i>	
62	<b>A DFT Study on Sensing Performance of H<sub>2</sub>S and NO<sub>2</sub> Gas Molecules on 2D Pentagonal PdSe<sub>2</sub></b>	<b>310-313</b>
	<i>Prasanna Karki, Bibek Chettri, Bhakta Kunwar, Bikash Sharma</i>	
63	<b>Study of Adsorption Behaviour of Nucleobases on Si and P Doped WSe<sub>2</sub>: DFT Approach</b>	<b>314-317</b>
	<i>Kabita Timsina, Somsher Lepcha, Bibek Chettri, Pronita Chettri, Bikash Sharma</i>	
	<b>Author Index</b>	<b>318-322</b>

# Design of an Improved Tie-line Power Model for a PEV Based Interconnected Microgrid Under AGC Operation

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**Abstract**— Nowadays, microgrid is utilised as a flexible replacement to the conventional power system. Therefore, special attention must be provided for the proper microgrid based power system design. Earlier, various articles presented the interconnected microgrid operation. However, less attention is given towards the proper tie-line modeling considering high resistance-inductive reactance (R/X) ratio in the interconnected microgrid operation. Considering the research gap, towards the proper designing of tie-line modeling, this paper presents an improved power tie-line model in an interconnected microgrid in presence of plug-in electric vehicle. Various case studies are carried out for validating the proper designing technique under various load disturbances in presence of uncertain output power from intermittent power generating units. The functioning of the proposed work is validated, connecting the proposed model in a 12-node distribution network. The proposed model shows its effectiveness and superiority compared to other available designing conditions.

**Keywords**- Automatic generation control (AGC), distribution network, interconnected microgrid, modified PID, plug-in electric vehicle (PEV), tie-line design.

## NOMENCLATURE

$\Delta f$	= Frequency Deviation	$T_{DEG}$	= DEG time constant
$K_{SPG}$	= SPG gain	$T_D$	= Delay time constant
$T_{SPG}$	= SPG time constant	$K_{SOC}$	= State of charge of PEV
$K_{WPG}$	= WPG gain	$T_{BCU}$	= BCU time constant
$T_{WPG}$	= SPG time constant	$K_P$	= Proportional controller gain
$K_{LIC}$	= LIC gain	$K_I$	= Integral controller gain
$T_{LIC}$	= LIC time constant	$K_D$	= Derivative controller gain

## I. INTRODUCTION

In modern power system, renewable power generators (RPGs) are gaining tremendous popularities among the researchers and industrialists because it can generate green and clean power without harming the environmental conditions. Now-a-days, solar power generators (SPGs), wind power generators (WPGs), plug-in electric vehicles (PEVs) are gaining more popularities, among various available RPGs. Furthermore, employment of diesel engine generators (DEGs) in combine with mix of RPGs become a suitable option for accurate load demand mitigation [1][2]. Therefore, this paper presents the

combined operation of RPGs for suitable power balance between generation and load.

Last few decades, a special attention is given to the microgrid operation as a massive growth of utilisation of RPGs in power grids is observed. Mostly, RPGs are environment dependent and intermittent in nature [3]. This characteristic cause a generation-load power mismatches which results oscillations in the power grids. If this oscillation sustain for a longer duration and not controlled, that may result power system instability [4]. In this connection automatic generation control (AGC) is incorporated to maintain the balance between generation and demanded power [5][6]. This results proper and synchronized power system operation

In recent years, a significant growth of utilisation of PEVs in power system operation is observed. PEVs are utilised both in islanded mode [5][7]-[11] as well as interconnected mode [2][12]-[15]. A PEV based islanded AC microgrid is proposed in presence of system uncertainties [7][8]. Khalghani et al. investigated the effect of false data injection in power-frequency balance in an islanded microgrid operation under real-time test scenario [9]. Further, the effect of participation of PEV in power system stability under islanded mode operation was investigated in [10][11]. Hydro-thermal power system including PEV is examined in [12][13]. The effect of PEV in system performance under interconnected deregulated power system is investigated in [14][15].

A substantial number of controllers and metaheuristic techniques are implemented in AGC studies under isolated and interconnected power system operation. Some of the notable controller can be mentioned as, model free sliding mode controller (MFSMC) [1], fractional order proportional integral and derivative (FOPID) controller [2][14], model predictive control (MPC) [5], cascaded PD-PI [7], fuzzy logic controller (FLC) [7][12][15], PID controller [16][17]. Moreover, some of the notable metaheuristic techniques are presented as, modified black hole algorithm (MBHA) [1], water cycle algorithm (WCA) [2], Whale Optimization Algorithm (WOA) [7], imperialist competitive algorithm (ICA) [12][15], particle swarm optimization [16]-[18].

After analyzing all the previously presented literatures, the specific research gaps can be pointed out for conducting this research work as follows. The resistance / inductive reactance (R/X) ratio is higher in the RES based interconnected microgrid

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**Part Number: CFP22T84-ART**

**ISBN No.: 978-1-6654-3801-8**

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13	<b>K Nearest Neighbor and Flexible Neural Tree Based IDS in Mobile Ad- hoc Network</b>	<b>60-64</b>
	<i>Indrajit Das, Piyali Roy, Debanjan Das, Sayan Das, Puja Ghosal</i>	
14	<b>Design and Implementation of Authentication System Using Deep Convoluted Siamese Network</b>	<b>65-69</b>
	<i>Sumagna Dey, Indrajit Das, Soubarna Das, Subhrapratim Nath</i>	
15	<b>DC and Analog/RF Performance Analysis of Gate-Drain Underlapped and Channel Engineered TFET</b>	<b>70-74</b>
	<i>Sudipta Ghosh, Sayan Bose, Wahid Anwar, Madhusree Banerjee, P. Venkateswaran, Subir Kumar Sarkar</i>	
16	<b>Current Sensitivity and Power Dissipation Analysis of Junctionless Double Gate MOSFET Biosensor</b>	<b>75-79</b>
	<i>Bedantika Basu, Debosmita Ghosh, Madhusree Banerjee, Papiya Debnath</i>	
17	<b>DC and Analog/RF Performance Comparison of Renovated GAA JLFET Structures</b>	<b>80-84</b>
	<i>Sudipta Ghosh, Abhiroop Jana, Agni Kumar Agnihotri, Shirsha Kundu, Dyuti Das, Subir Kumar Sarkar</i>	
18	<b>Assessment of Filter Design for 5G Applications</b>	<b>85-88</b>
	<i>Gaurav Bhargava, Shubhankar Majumdar</i>	
19	<b>Partially Depleted Silicon-on-Insulator (PDSOI) MOSFETs for RF Switching Applications</b>	<b>89-92</b>
	<i>T. P. Dash, C. K. Maiti, Devika Jena</i>	
20	<b>RF Analysis of a Fully Gate Covered Junctionless FinFET for Improved Performance</b>	<b>93-97</b>
	<i>Aman Tyagi, Gaurav Mangal, Rishu Chaujar</i>	
21	<b>Economic Analysis for the Players Participating in a Hybrid Solar Virtual Power Plant</b>	<b>98-103</b>
	<i>Epsita Das, Koninika Biswas, Sujit K. Biswas, Ambarnath Banerji, Rajarshi Chakrabarti</i>	
22	<b>Implementation of Linear Quadratic Regulator in an Isolated Microgrid System</b>	<b>104-109</b>
	<i>Prasun Sanki, Mousumi Basu, Partha Sarathi Pal, Debapriya Das</i>	
23	<b>A Survey on Field Effect Transistor Based Hydrogen and Nitrogen Gas Sensors</b>	<b>110-115</b>
	<i>Koushik Ghosh, Arpita Ghosh</i>	
24	<b>An Efficient Approach to Design a Comparator for SAR-ADC</b>	<b>116-122</b>
	<i>Tejender Singh, Suman Lata Tripathi</i>	
25	<b>A Hybrid MILP-GA Algorithm to Optimize Battery Mix System in Active Distribution Networks</b>	<b>123-128</b>
	<i>Subho Paul, Biswarup Ganguly, Upayan Adhikary</i>	
26	<b>Analysis of Constant On-Time Buck Converter with System Verilog Real Number Model Approach</b>	<b>129-133</b>
	<i>Saikat RoyChowdhury, Sudeep Phadikar</i>	
27	<b>Emergency Medical Assistance by Ambulance Drone Using Machine Learning, Lightweight Cryptography and Variable Image Steganography</b>	<b>134-138</b>

	<i>Indrajit Das, Sanjoy Roy, Sumagna Dey, Tulsi Dey, Piyali Roy</i>	
28	<b>Capacitive Memory Using GLAD Synthesized Annealed SnO<sub>2</sub> Nanowire Arrays as a Dielectric</b>	<b>139-142</b>
	<i>Priyanka Chetri, Jay Chandra Dhar</i>	
29	<b>Machine Learning Classifiers for Speech Detection</b>	<b>143-147</b>
	<i>Dasari Lakshmi Prasanna, Suman Lata Tripathi</i>	
30	<b>Selective Run-Length Constrained Encoding Scheme on Extended Nucleic Acid Memory</b>	<b>148-153</b>
	<i>Saptarshi Biswas, Trishita Ghosh, Subhprattim Nath</i>	
31	<b>Design of an Improved Tie-line Power Model for a PEV Based Interconnected Microgrid Under AGC Operation</b>	<b>154-159</b>
	<i>Prasun Sanki, Mousumi Basu, Partha Sarathi Pal, Debapriya Das, Sindhura Gupta</i>	
32	<b>Statistical Analysis of a Low Power Analog Current Source</b>	<b>160-164</b>
	<i>Sneha Upadhyay, Trisha Sau, Susmita Mitra, Arpita Bhowmik, Saheli Sarkhel, Soumya Pandit</i>	
33	<b>A Deep CNN Framework for Distress Detection using Facial Expression</b>	<b>165-169</b>
	<i>Bikramjit Das, Debanjana Ghosh, Ashesh Roy Choudhuri, Ankan Goswami, Avinandan Bhakta, Mahamuda Sultana, Suman Bhattacharya</i>	
34	<b>State of the Art and Future Perspectives in III-V Nanometer-scale MOSFETs</b>	<b>170-175</b>
	<i>Saswati Dey, Kalyan Biswas, Angsuman Sarkar</i>	
35	<b>Effect of Asymmetric Space Charge Region on Current Density of Heterojunction Solar Cell</b>	<b>176-179</b>
	<i>Sayoni Chakraborty, Arpan Deyasi</i>	
36	<b>Electrical Noise Analysis of L-Shaped Gate Tunnel Field Effect Transistor</b>	<b>180-183</b>
	<i>Sweta Chander, Rekha Chaudhary, Sanjeet Kumar Sinha</i>	
37	<b>Multimodal Medical Imaging Using Modern Deep Learning Approaches</b>	<b>184-187</b>
	<i>Rahul Chanumolu, Likhita Alla, Pavankumar Chirala, Naveen Chand Chennampalli, Bhanu Prakash Kolla</i>	
38	<b>Modeling an Energy Efficient Clustering Protocol with Spider Cat Swarm Optimization for WSN</b>	<b>188-193</b>
	<i>T. Saravanan, S. Saravanakumar</i>	
39	<b>Early Alzheimer's Disease Detection using Semi- Supervised GAN Based on Deep Learning</b>	<b>194-198</b>
	<i>S. Saravanakumar, T. Saravanan</i>	
40	<b>Enhanced Prediction of Thyroid Disease Using Machine Learning Method</b>	<b>199-204</b>
	<i>Madhumita Pal, Smita Parija, Ganapati Panda</i>	
41	<b>White Light Photosensitivity and Stable Photoresponse Properties of Tetrapod Shaped CdSe Nanocrystals: Polymer: Fullerene Blend</b>	<b>205-209</b>
	<i>Deep Chandra Upadhyay, Rishibrind Kumar Upadhyay, Abhinav Pratap Singh, Satyabrata Jit</i>	

42	<b>Identifying Differentially Expressed Genes in Different Stages of Lung Cancer – An Application of ARM Model on Gene Expression Data</b>	210-214
	<i>Subir Hazra, Amartya Roy, Rohan Sarkar, Anupam Ghosh</i>	
43	<b>RF/Analog Performance Analysis of Electrostatically Doped Dual Pocket Vertical Tunnel Field Effect Transistor</b>	215-219
	<i>Amit Bhattacharyya, Madhusree Banerjee, Papiya Debnath, Debashis De, Manash Chanda</i>	
44	<b>Application of Soil Sensors for Maximizing Productivity Using IoT Framework</b>	220-224
	<i>Subhprapatim Nath, Anup Dey, Papiya Das, Dyuti Mohapatra, Jamuna Kanta Sing, Subir Kumar Sarkar</i>	
45	<b>Signature Recognition and Detection of Skilled Forgeries Using Image Transformation and Multistream CNN</b>	225-229
	<i>Papiya Das, Swarnabja Bhaumik, Subhprapatim Nath</i>	
46	<b>Method for Enabling RDMA Transport Peer to Peer Transfer with NVMeoF Ethernet SSDs</b>	230-233
	<i>Venkataratnam Nimmagadda, Sandeep Kumar Ananthapalli</i>	
47	<b>Silicide on Oxide Based Carrier Selective Front Contact for 24% Efficient PERC Solar Cell</b>	234-237
	<i>Savita Kashyap, Rahul Pandey, Jaya Madan, Rajnish Sharma</i>	
48	<b>VLSI Routing Optimization Using Hybrid PSO Based on Reinforcement Learning</b>	238-243
	<i>Pradyut Nath, Sumagna Dey, Aditya Shankar, Subhprapatim Nath, Jamuna Kanta Sing, Subir Kumar Sarkar</i>	
49	<b>Study of Electrical Parameters of Strained Si PMOS with High k Dielectric Material Using TCAD</b>	244-247
	<i>Debasish Mohanta, Sruti Suvadarsini Singh</i>	
50	<b>Optical Characteristics of Broadband Raman Amplifier Coupled with Multimode Fiber Designed at 1550 nm in Presence of Doping</b>	248-253
	<i>Rikita Das, Arpan Deyasi</i>	
51	<b>Tweet Classification and Sentiment Analysis of Covid 19 Epidemic by Applying Hybrid Based Techniques</b>	254-260
	<i>Mauparna Nandan, Soma Mitra, Sharmistha Dey</i>	
52	<b>Single Event Transient Effect on Tapered Angle Hetero-junction Dopingless TFET for Radiation-Sensitive Applications</b>	261-264
	<i>Monika Sharma, Rakhi Narang, Manoj Saxena, Mridula Gupta</i>	
53	<b>Dependence of Gate Leakage Current on Efficacy of Gate Field Plate in AlGaIn/GaN HEMT</b>	265-268
	<i>Chanchal, Ajay Kumar Visvkarma, Amit Malik, Robert Laishram, D S Rawal, Manoj Saxena</i>	
54	<b>Design - Development of VEHICLE for Delivery of Goods in Hazardous Areas (VEDHA)</b>	269-274
	<i>Suvargha Ghosh Dastidar, Synthya Haldar, Pratyusha Biswas Deb, Sohini Pal, Ambalika Saha, Ambarnath Banerji, Hiravra Koley, Prithasankar Laskar</i>	
55	<b>Internet of Things (IoT) Based Continuous Growth Rate Monitoring System of Plant Stem</b>	275-279
	<i>Shikha Nayak, Subir Das, Badal Chakraborty, Tanmoy Chakraborty, Kishor Roy</i>	

56	<b>A Novel Computer Vision Model for Recognition and Evaluation of Mathematical Equations using Deep Learning Technique</b>	<b>280-285</b>
	<i>Shaun Oommen Alexander, Chitresh Kansal, Devang Mehrotra, Rohit P, Shashank Mouli Satapathy</i>	
57	<b>ZnO-WO<sub>3</sub> Mixed Metal Thin Film Capacitive Biosensor for Food Quality Measurement</b>	<b>286-289</b>
	<i>Gour Gopal Jana, Jyotirmoy Nandy, Moumita Chakraborty, Subhashis Roy, Bijoy Kantha</i>	
58	<b>Machine Learning-Based Intrusion Detection System for Healthcare Data</b>	<b>290-294</b>
	<i>Amit Kumar Balyan, Sachin Ahuja, Sanjeev Kumar Sharma, Umesh Kumar Lilhore</i>	
59	<b>Comparative Study of Supervised Machine Learning Methods for Prediction of Heart Disease</b>	<b>295-299</b>
	<i>Meghavi Rana, Mohammad Zia Ur Rehman, Srishti Jain</i>	
60	<b>Metamaterial Absorbers for IoT Applications</b>	<b>300-303</b>
	<i>Prince Jain, Shonak Bansal, Piyush Samant</i>	
61	<b>Smart ECG Monitoring and Analysis System Using Machine Learning</b>	<b>304-309</b>
	<i>Sarab Nidhaan Singh, Megha Bhushan</i>	
62	<b>A DFT Study on Sensing Performance of H<sub>2</sub>S and NO<sub>2</sub> Gas Molecules on 2D Pentagonal PdSe<sub>2</sub></b>	<b>310-313</b>
	<i>Prasanna Karki, Bibek Chettri, Bhakta Kunwar, Bikash Sharma</i>	
63	<b>Study of Adsorption Behaviour of Nucleobases on Si and P Doped WSe<sub>2</sub>: DFT Approach</b>	<b>314-317</b>
	<i>Kabita Timsina, Somsher Lepcha, Bibek Chettri, Pronita Chettri, Bikash Sharma</i>	
	<b>Author Index</b>	<b>318-322</b>

# A Hybrid Compensator for Mitigation of Power Quality Issues in Distribution Systems

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**Abstract**—This paper proposes a hybrid compensator for mitigating power quality problems in distribution systems. The hybrid compensator constitutes of Thyristor Switched Capacitor (TSC), Thyristor Controlled Reactor (TCR), a lower rating D-STATCOM and a 5<sup>th</sup> harmonic tuned passive LC filter. The Static var Compensator (SVC) or the TCR-TSC combination works in a coordinated way for the base var compensation. The D-STATCOM works in a coordinated scheme with the SVC and the single tuned LC filter to compensate fundamental var, reduce voltage flicker and also attenuate harmonic currents at the Point of Common Coupling (PCC). The D-STATCOM thus serves a dual role as a var compensator and as an active filter in Selective Harmonic Compensation (SHC) mode to attenuate the 7<sup>th</sup> harmonic current, hence improving the var compensation and harmonic current filtering at PCC. The proposed hybrid configuration exhibits very low line current THD in accordance with the relevant standards. Also the chance of resonance of the fixed passive filter with the source inductance has been eliminated in the coordination scheme. The simulation results show that the proposed hybrid system compensates var, reduces voltage flicker and harmonic currents at the PCC effectively. The proposed control and coordination scheme is simple to execute besides the hybrid system being highly robust in performance.

**Keywords**—hybrid var compensator,  $\Delta$ -TCR, tuned passive filter, hybrid filter, power quality.

## I. INTRODUCTION

The line-commutated thyristor based Static var Compensator (SVC) [1-2] has been widely accepted for utilization in AC transmission and distribution systems owing to its high power handling capability, reliability, robust performance, simple control and economic feasibility. The SVC may comprise of combinations [3] of Thyristor Controlled Reactor (TCR), Fixed Capacitor (FC) and Thyristor Switched Capacitor (TSC). The SVC can provide reactive power support to the distribution system, maintain bus voltage levels and improve power factor. On the contrary, self-commutated Pulse Width Modulation (PWM) based devices viz., D-STATCOM, exhibits better performance to reduce voltage flicker compared to SVC [4-5] and can also control harmonic currents at the PCC [6-7].

The issue of harmonic currents in the system can be addressed using fixed passive filters. However, such filters increase the possibility of resonance with the source inductance and may lead to high current transients at lower harmonic frequencies. The active filter does not involve the use of large reactors and also eliminates the possibility of resonance with the source inductance. However, there are still some limitations and associated costs with using of active filter at very high bus voltage and power ratings. An active filter in Overall Harmonic Compensation (OHC) [4] mode can create great computational burden on the microcontroller due to the effect of phase delay of higher order harmonics in the low pass filter and consequent need

for compensation of delay. Hence, a hybrid filter by combination of shunt active filter in selective harmonic compensation (SHC) mode and a passive filter is the right choice to enhance the function of filter.

There are different hybrid filters and hybrid var compensators mentioned in the literature, some of which are briefly discussed in this section. A scheme based on TCR with a combination of passive LC tuned filter and an active filter [8-9] had been presented involving coordination between multiple devices. Another scheme of hybrid active power filters (HAPF) mentioned in the literature comprises of thyristor controlled LC module with active inverter part [10-12]. The LC coupling module reduces the voltage rating of the active inverter part and parallel SVC reduces the current rating. The thyristor controlled part achieves var compensation while the harmonic control is done by the active part. Although the above yields good results, a solution simultaneously addressing the problems of harmonic control, var burden & voltage flicker is yet to be explored.

Some work based on hybrid var compensators have been observed to be constituting of multiple 1<sup>st</sup> & 2<sup>nd</sup> generation series and shunt FACTS devices operating in coordination to enhance available transfer capability of line [13-15]. Other work on hybrid var compensators mentioned in the literature have been observed to be constituting of TSC & TCR banks along with self-commutating PWM based converters working in coordination [16-19]. Use of a coordination control system driven by a decision making system has been found in the above work. In these cases, the harmonic compensation at the PCC is not being addressed and hence does not provide a complete and simpler solution to the most significant power quality issues.

In this paper, a 3-phase hybrid system with a simple configuration and control scheme is proposed to cater to the issues of voltage flicker, var demand and harmonic control. The dominant line current harmonics at the PCC due to non-linear loads or PWM based drives are 5<sup>th</sup> harmonic with negative sequence effect and 7<sup>th</sup> harmonic with positive sequence effect on the system. The proposed hybrid system comprises of a SVC, a lower rating D-STATCOM and tuned LC filter. The SVC compensates base var demand to maintain unity power factor and voltage level at the PCC. The D-STATCOM works in a combined way with the SVC to mitigate voltage flicker at the PCC and attenuates harmonic currents in coordination with the tuned passive filter. The hybrid system meets the relevant harmonic standards and flicker margins [5-6]. The details of the control and performance indices of the proposed hybrid system have been presented.

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IEEE ISBN: 978-1-6654-4837-6

Paper ID	Title	Authors
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19	Design and Implementation of Five Level Inverter Topology for More Electric Aircraft Application	Himanshu Saini*; Sandeep N; Anil Jakhar; Dr. Arun Verma
20	Analysis on Power Oscillation Smoothing Techniques for 1MWp PV plant	Dinumol Varghese*; Dr. K.C. Sindhu Thampatty
21	Comparative Analysis of Voltage Control Techniques for Single Phase AC-AC Buck Converter	NAIRA JEELANI*; Abdul Bhat; Tabish Nazir Mir
24	Integrated DC-DC Converter For Stand-alone Single Phase Photovoltaic Supply System	Pemendra Kumar Pardhi*; Shailendra Sharma; Rakesh Saxena
25	Optimal Placement of a PV-DSTATCOM in a Radial Distribution System	SOHAM CHAKRABORTY*; SUSOVAN MUKHOPADHYAY; Sujit Kumar Biswas
26	Predictor Based Stability Control of Four-Wheel Independent Drive Electric Vehicle with Bounded Input Delay	Vinod R Chiliveri*; Kalpana R; PADMAVATHI L

27	Optimal Placement of Electric Vehicle Charging Stations in Utility Grid - A Case Study of Kerala State Highway Network	Aneesh Rajendran*; HARI KUMAR R
29	Renewable Energy Resources Forecasting Model for Virtual Power Plant in the Deregulated Electricity Market using Machine Learning	Tirunagaru V Sarathkumar; Arup Kumar Goswami*
30	Analysis of Protection Device Sensitivity in a Facility-Power System Due to Integration of Onsite Renewable Energy Sources	Jawadul H Saad*; Pranjal Goswami Pranta; Asif Anwar
31	Experimental Validation of PI Controllers And Modelling of DC Servo Motor by FOPDT Model	PRAVIN KUMAR*; Vishal Kumar; Barjeev Tyagi
32	Observer Based Current Control of Dual Active Bridge Converter	GOURAHARI NAYAK; Anindya Dasgupta*
33	A Novel Single Phase Three Level Triple Boost CG Switched-Capacitor Based Grid-Connected Transformerless PV Inverter	ANKUR SRIVASTAVA*; Dr. Jeevanand Sheshadrinath
34	A New Auxiliary Pulse Multiplication Scheme for Harmonic Suppression of the 12-Pulse Rectifier	jingfang wang*; Anchen Chen; Xuliang Yao
39	Quantification of inertia contribution from non-conventional sources in AC microgrid	Apurti Jain*; Narayana Prasad Padhy; Mukesh kumar Pathak
40	Emulation of induction machines subject to industrial grid harmonics	Gayathri Tanuku*; Pragasen Pillay
41	Electric Propulsion System Powertrain Estimation for Houseboats using Backward Simulation	SREEDEVI M L*; Sigi C Joseph; Mohammed Ajlif A; Jayan P P; Dhanesh P Raghavan; MINEESHMA G R; Renji Chacko
42	Design a robust AC coil contactor with different ferromagnetic materials for improving the voltage sag ride-through capability	AMIT KUMAR BAGHEL; Chinmaya Behera; Dr. Sisir Kumar Nayak*; Arup Kumar Goswami

43	Bivariate Modelling of Normalized Energy Intensity of Oil and Paper for Accessing the Fault Severity of Transformer and Reactors	Devaprasad Paul; Arup Kumar Goswami*
44	Proportional Load Sharing in an Autonomous Hybrid Micro-grid Using Interlinking Converter	Archna Aggarwal*; Anwar Shahzad Siddiqui; Sukumar Mishra
45	Coordinated Control of DC-Nanogrid Cluster	Subhas Parajuli; Anuradha Tomar*; P.H. Nguyen
46	Performance analysis of concentrated semitransparent photovoltaic thermal-thermoelectric generator (CSPVT-TEG) hybrid system under varying concentration ratio	Abhishek Tiwari*; Shruti Aggarwal
48	A Novel Approach to Implement FPPT Considering Load side Coordination Control	Gopal Chandra Mahato; Tanmoy Roy Choudhury*; Byamakesh Nayak; Soumya Ranjan Biswal
49	A Solar PV System with Resilient Operation at Weak Grid Conditions With Flexible Adjustment of DC Link Voltage for Improved Power Quality	Syed Bilal Qaiser Naqvi*; Bhim Singh
50	Harmonic Reduction in a Microgrid using modified Asymmetrical Inverter for Hybrid Renewable Applications	Mamatha Sandhu*
53	Power-Loss Ride-Through in a Cascaded H-Bridge Inverter Fed Vector Controlled Induction Motor Drive	Himanshu Patel*; Jose Titus; Kamalesh Hatua; Eswara Rao S
56	Small-Signal Modeling of Two - Switch Enhanced Gain Modified SEPIC Converter	SINDHUJA S SELVAM*; S Mageshwari; Dr. Moorthi Sri
57	Four-Dimensional 24-Sector SVPWM Techniques for Split-Phase Induction Motor Drives: Analysis of Modulation Process and Efficient Implementation	LALGY GOPI*; Gopalaratnam Narayanan
60	A Hybrid Compensator for Mitigation of Power Quality Issues in Distribution Systems	SOHAM CHAKRABORTY*; SUSOVAN MUKHOPADHYAY; Sujit Kumar Biswas

62	A Neural Network Approach For Evaluating Levelized Cost Of Electricity For Generating Electricity Across Various Generation Technologies	Arindam Sanyal*; Arup Kumar Goswami; Prashant Tiwari
63	Open Circuit Fault Detection for a Grid-tied Hybrid Multi-level Inverter	Dheeraj Etta; Richa Goel; Anubrata Dey*
64	Single-Phase to Three-Phase AC-AC Converter Fed Low Speed Induction Motor Drive With Encoderless Control	Tabish Nazir Mir*; Bhim Singh; Abdul Hamid Bhat
66	Power System Stability Augmentation with Flywheel Energy Storage and DFIG Kinetic Energy	Asima Syed*; Mairaj ud-din Mufti; Hailiya Ahsan
68	Energy Performance Improvement in House Boat Tourism through Clean Energy Route Interfaced with Energy Efficient Power Conversion Techniques and Energy Storage	Aneesh Rajendran*; Mohammed Ajlif A; Johnson Daniel; Jayan PP; Aby Joseph; Anoop Surendran
69	Microgrid Feeder Protection Scheme utilizing $\mu$ PMU Data	GAGANDEEP SINGH DUA*; Barjeev Tyagi; Vishal Kumar
71	Performance of Lithium-ion Battery on-board a spacecraft and estimation of deliverable capacity with Genetic Algorithm-driven Generic Estimation model	Ananda S*; Piyush Sharma; Sushma H R; M Pramod; N. Lakshmi Narasamma; Radhakrishna Vatedka
75	A Five-Level Switched-Capacitor Boosting Inverter With Reduced Switch Current Stress	Sandeep N*
77	A Novel Single Phase Nine Level Quadruple Boost Grid-Connected Transformerless PV Inverter	ANKUR SRIVASTAVA*; Jeevanand S
78	3ph qZSI Controller Design using PI for DC side and PR for AC side Controller including Droop Characteristic in standalone mode	Shwetank Agrawal*; Barjeev Tyagi; Vishal Kumar; Pawan Sharma
81	Hosting Capacity of an Australian Low-Voltage Distribution Network for Electric Vehicle Adoption	Joshua Then*

82	An Overview of Distributed Energy Resources Management System Guidelines and Functional Coverage	Alvaro R Albertini*; Vitor T Yabe; Silvio G Di Santo; Giovanni Manassero Junior
83	Online Soft Restart of a Cascaded H-Bridge Inverter fed Induction Motor Drive After Cell Faults	Jose Titus*; Himanshu Patel; Manoj B Anurag; Shekhar Bhawal; Shuvankar Dey; Saravanan D; Kamalesh Hatua; Eswara Rao S
87	Fault Tolerant Inverter for Grid Connected Photovoltaic System	Azra Malik; Ahteshamul Haque*; Varaha Satya Bharath Kurukuru
89	Modeling of Series Resonant Converter in Synchronous Rotating Frame	Vivek Thomas Chacko*; N. Lakshmi Narasamma
91	Stator Vibration Comparison for DFIM under the Influence of Sinusoidal and Converter Excitation to Rotor Circuit	JAVED ALI*; THANGA CHELLIAH; PRAMOD AGARWAL
92	A Novel Switched Capacitor DC-DC Converter Topology for High Voltage and High Gain Application	Ashwin K.*; Nakul Narayanan K; L. Umanand; B. Subba Reddy
93	Analysis of Sub-Synchronous Oscillations in Asynchronous Generator Serving to Hydropower Systems	VIJAY MOHALE*; THANGA CHELLIAH
95	Switched-Capacitor Based Five-Level Inverter with Ground Connection	Sangeeta Nehra*; Sandeep N; Dr. Arun Verma
96	Performance evaluation of Two Hysteresis Current Controllers' PWM Techniques for a Grid Connected VSI	Ravivarma Chavali; Anubrata Dey*; Biswarup Das; Apurv Kumar Yadav
98	Synchronous Rectification for LCLC Resonant Converter	NAGESHA C*; N. Lakshmi Narasamma
105	A Fault Tolerant Nine-level Inverter Topology With Full DC Utilization for Electric Vehicle Application	Aditya Kancharapu*; Suresh Y; Banavath Shiva Naik; BHUKYA NAGESWAR RAO

106	Low-Cost BLDCM Ceiling Fan with Improved Power Quality and Efficiency	Amit Kumar*; Bhim Singh
107	Minimization of Low Frequency Current Oscillation in Resonant Link of a Solid State Transformer by Passive Filters	Surja Sekhar Chakraborty*; Shekhar Bhawal; Kamalesh Hatua
109	Integration of a Wind-Wave Hybrid Energy System with the Distribution Network	Safdar Rasool*; Kashem M Muttaqi; Danny Sutanto
111	A Single-Phase Transformer-less Five-Level Inverter Based on AC Decoupling with reduced Leakage Current.	Anil Jakhar*; Sandeep N; Dr. Arun Verma
114	Single-phase to Six-phase Matrix Converter for Low Power Induction Motor Application	Manoj A Waghmare*; Bhimrao Umre; Mohan Aware; Anup Kumar
117	Parasitics triggered stress analysis in Active Clamp Synchronous Forward converter	Prajakta Ghatage; Anindya Dasgupta*
119	A Hybrid Shunt FACTS Topology for Unbalance Mitigation and Reactive Power support in Traction Load Systems	Chandrasekhar Roy*; Prof Dheeman Chatterjee; Tanmoy Bhattacharya
120	Design of different classical controllers in the voltage control loop of a virtual synchronous machine in standalone mode	VIKASH GURUGUBELLI*; ARNAB GHOSH; Anup Kumar Panda
121	A Golden Eagle Optimization Based MPPT Control For Partial Shading Conditions	Zubayer Alam Khan; Fahim Akhter; Sakib Islam; Fahim Abid*
123	Regenerative Braking System for Fuel Cell-Battery Hybrid Sources	HARITHA T K*; Sooraj Suresh Kumar; Jayaprakash P; Asokan O V
124	A Novel DC-DC Converter with Extended Range of Gain for Buck-Boost Applications	Shubham Agrawal*; Atmanandmaya .; Toshali Mohapatra; L. Umanand; B. Subba Reddy

125	Comparative Evaluation of SiC based Two-Level Inverter With Passive EMI Filter Against Dual Two-Level Inverter Under PWM Schemes	Tushar Janarao Nistane; Manish Kumar*; Kalaiselvi J
127	Droop controlled voltage source converter with different classical controllers in voltage control loop	VIKASH GURUGUBELLI*; ARNAB GHOSH; Anup Kumar Panda
128	A Self-Balanced High Gain Multi-Port Converter for Photovoltaic and Fuel Cell based Power Generation Systems	RAGHAVENDRAN S*; Sateesh kumar Kuncham
129	Active-Network with Passive Capacitor based High Gain DC-DC Converter	AAKASH SINGH*
131	Improved Two Stage Commutation for Effective Vibration Reduction in Switched Reluctance Motor using Particle Swarm Optimization	Veena Wilson*; Latha P G; Vnida K
132	An Improved Open Switch Fault Diagnosis Strategy for Variable Speed Drives	Manikandan R; Raghu Selvaraj; Raja Singh R*
134	Three-Port Isolated Hybrid Converter for Power Supply Systems in EV	Sofiya S*; Dr. Shelas Sathyan
135	Design of a 3-Phase Stator for Improving the Performance of the Ceiling Fan Motors	Shivam Chakraborty*; Jitendra Veer Singh; Kamalesh Hatua
136	A Common Ground Switched-Capacitor High Gain Boost Converter For Wide Voltage Regulation	AJIT KUMAR UPADHIYA*; N. Lakshmi Narasamma; Mahesh K. Mishra
141	Review of Voltage Regulation of a Doubly-Fed Induction Generator Based Wind Power Plant under Grid Faults	Pradip Khatri*; Khagendra Thapa; Kishan Jayasawal; Asha Khanal; Rabin Mahat
143	Optimal scheduling of multi-energy systems with load scheduling in multiple energy streams	Ashok Krishnan*; Prakash K Ray

145	Analysis of Advanced Space Vector PWM Techniques Extended to Over-Modulation Region for Induction Machine Drive	Sahu Mithun; Dipankar De*; Burle Tulasi Rao; Akshat Vijaywargiya; Niladri B Puhan
152	XGBoost Based Synthetic Battery Parameter Generation to Overcome Limited Battery Dataset Challenges	Nida Naaz; Janamejaya Channegowda*
155	Placement of Electric Vehicle Fast Charging Stations using Grey Wolf Optimization in Electrical Distribution Network	Fareed AHMAD*; Atif Iqbal; Imtiaz Ashraf; Mousa Marzband; Irfan Khan
157	Design Considerations for a Symmetric Dual Three-Phase IPMSM for Battery Electric Vehicles	Sandeep V Nair*; Veena P; Shivam Chakraborty; Kunal Layek; Kamalesh Hatua
158	Performance Evaluation of Mode Transition Strategy for 3P4W Microgrid Utilizing SOAP-FLL and LMLS Filtering Approach	farheen chishti*; Bhim Singh
163	Techno-economic evaluation of maximum penetration capacity of grid connected Solar Photo voltaic system with dynamic load and generation	Sreena Sreekumar*; Savier J S
164	Distribution Grid Phasor Estimation and $\mu$ PMU Modeling	ahmed A.Elaziz Elsayed*
165	A Robust and Simple Temporal Data Imputation Technique for Estimating Missing Battery Parameter Measurements	Aditya Raj; Janamejaya Channegowda*
167	A Novel Protection Scheme for Low Voltage DC Microgrid Based on Localized Measurement of Transient Reactor Voltage	SAURABH SHARMA*; Manoj Tripathy; Li Wang
168	Modeling and Control of a Multiport Converter based Integrated On-board Charger for Electric Vehicle Powertrains	Arka Basu; Subhajyoti Mukherjee*
169	Performance Evaluation of TCSC and GCSC for Damping of Torsional Oscillations	Priyank Gandhi*; Pranav Darji

170	Circulating Current Mitigation in Parallel Inverters by Dynamic Carrier Changing Technique.	Gollapalli G D V Sai Pavan*; Sudharshan Kaarthik
172	Interleaved High-Gain DC-DC Converter with Soft-Switching Capability	Tohid Rahimi*; Lei Ding; Josep Pou
174	Co-ordinated Control of Combination of SSSC and SVC for Enhancement of Power System Voltage Stability	Suraj Ankush Dahat*; Ashwin Dhabale
176	Structural Design & Energy Balance Conceptualization for PV Based Protective Environment Controlled Farming	Anuradha Tomar*
180	Parallel Operation of IBCs for All Wheel Drive Electric Vehicles	Vidya V*; Sudharshan Kaarthik
183	Data Mining Methods for Bad Data Detection and Event Data Acquisition in Microgrids	Sudarshan R Khond*; Kale VS; Makarand Ballal
184	A combined Data Mining and Machine Learning approach for High Impedance Fault Detection in Microgrids	Sudarshan R Khond*; Kale VS; Makarand Ballal
185	Performance study of ADRC and PID for concurrent Frequency-Voltage Control of Electric Vehicle Incorporated Hybrid Power System	Sheikh Mr. Safiullah; ASADUR RAHMAN*; Dr Mohd Asim Aftab; S.M. Suhail Hussain
186	Probabilistic Optimal Power Flow In The Presence of Uncertainties Related With Load Wind And PV Considering Different Load Models	Shaik Mahmmadsufiyan*; Dattatraya N Gaonkar
187	Adaptive power management in PV/Battery integrated hybrid micro grid system	SUCHISMITA PATEL*; ARNAB GHOSH; Pravat Ray
188	Multi-Sensor Fault Diagnosis for Misalignment and Unbalance Detection Using Machine Learning	Tauheed Mian*; Anurag Choudhary; Shahab Fatima

189	Common ground based transformer-less high gain basic switched boost inverter	Ravitheja Rage*; Manoranjan Sahoo; Karthik Thirumala
190	Performance Evaluation of a 500 W Bidirectional Converter for DC Microgrid	Aashish Ranjan*; Anand Abhishek
191	Adaptive Active Islanding Detection Strategy Enhanced with Fault Ride-Through Capability for Grid-Tied Inverters	Deepthi Sivadas*; Vijaymahantesh V Surkod; Amrutha K Haridas; ARUN CHITHRABHANU; KRISHNA VASUDEVAN
192	A Current Difference Based Protection Technique for Low Voltage DC Microgrid.	Pooja chauhan*; C.P Gupta; Manoj Tripathy
193	An Accurate Method For Steady State Initialization of Doubly Fed Induction Generator	D R KARTHIK*; Shashidhara Mecha Kotian; Narayan Manjarekar
195	Analytical Closed-Loop Response of Discrete-PI-Controlled High-Bandwidth Current Loop in PWM Converters & Drives	Kapil Upamanyu*; Gopalaratnam Narayanan
198	A PFC Hysteresis Current Controller for Totem-pole Bridgeless Bi-directional EV Charger	P SUBRAHMANYA ADIGA*; Arjun Mudlapur; B Venkatesa Perumal
200	Bayesian Optimization based Random Forest method for State-of Charge Prediction for Congestion Management in Distribution System considering Charging Coordination of Plug-in Electric Vehicle	Subhasish Deb; Arup Kumar Goswami*; Rahul Lamichane Chetri; Rajesh Roy
201	Wireless Power Transfer to Electric Vehicles along with Regenerative Braking using battery-supercapacitor combination	Sai Sushma P*; Narasareddy T; Himanshu Misra
204	An Intelligent Bidding Strategy based on Social Welfare of Virtual Power Plant considering Carbon Trading	Kumari Nutan Singh; Nabendu Das; Mansi Maurya; Arup Kumar Goswami*; Nalin Behari Dev Chudhury
205	Dual Active Half Bridge Converter with Integrated Active Power Decoupling for On-Board EV Charger	Akshay Laturkar*; Nachiketa Deshmukh; Sandeep Anand

206	Online Prediction of DGA Results for Intelligent Condition Monitoring of Power Transformers	G Nandagopan; Dr Sabeena Beevi K*; Vishnupriya KJ; KUNJU LEKSHMI A.S; Deepa S Kumar; Abhijith S; Rishika K K
208	A DTC Strategy for Five-phase Induction Motor Drive with Reduced Torque Ripple and Improved Low Speed Performance	A GAURI*; Shiny G; Sreeni K G
209	Multiphase Induction Motor with Different Speed Ratio for Gearless Electric vehicles	PRIYANKA C C P*; Jagadanand G
213	Non-Fragile Observer Based Sliding Mode Control of Non-Isolated On-Board Battery Charger	Mrinal Kanti Sarkar*; ANIL K BONELA
214	Reliability Centered Capacity Management in Deregulated Power Market	Bipul Kumar Talukdar; Bimal Chandra Deka; Arup Kumar Goswami*
216	Modified Parallel Inverter Topology of a Grid Connected Wind Energy Conversion System for Power Quality Improvement	Aswathi M E; NIRMAL C M MUKUNDAN*; Manoj Kumar M V; JAYAPRAKASH P.
219	Forecasting and Classification Of Power Quality Disturbance In Smart Grid Using Hybrid Networks	Krishnendhu Murali; Dr Sabeena Beevi K*; Jibin Abraham Varughese; Visakh S; Neethu Mohan; THASNEEM A
220	Uncertainty based Electric Vehicle Charging Scheduling with V2G feature considering Photovoltaic and Battery Energy Storage	Sourav Das*; Arnab Pal; Parimal Acharjee; Ajoy Kumar Chakraborty; Aniruddha Bhattacharya
222	Impact of PWM and Duty Ratio Control on Voltage for Sic Fed Three Phase BLDC Motor Drive	Dhawal Dwivedi*; Samarjeet Singh Mr. Singh; Kalaiselvi J
227	Novel Non-isolated Boost-Zeta Interleaved DC-DC Converter for Low Voltage Bipolar DC Micro-grid Application	Vaishali Chapparya*; S P Singh; Anubrata Dey
229	Analytical Prediction of Static Flux-Linkage Characteristics of Switched Reluctance Machine	ANUPAM VERMA*; Syed Shahjahan Ahmad; Gopalaratnam Narayanan

233	3P4W Grid Interactive PV-BES System with Seamless Transition Capability	PAVITRA SHUKL*; Bhim Singh
240	An Intelligent System for Domestic Appliance Identification Using Deep Dense 1-D Convolutional Neural Network	Subho Paul*; Nitin Upadhyay; Apurti Jain; Narayana Padhy
241	Analysis of a PM-Assisted Synchronous Reluctance Machine for Electric Vehicles	Dwaipayan Barman*; Vikram Roy Chowdhury; tauquir iqbal; Debabrata Barman
244	Electrolyte based Equivalent Circuit Model of Lithium ion Batteries for Intermittent Load Applications	Chalukya Bhat; Janamejaya Channegowda*; Kali Narahariseti
253	Analysis and control of SEIG-based wind energy conversion system supplying low voltage dc microgrid	Mahaboob Subahani A*; Senthil Kumar; Kumaresan N.
254	Investigating Accurate Electrochemical Battery Models for Intermittent Discharge Applications	Chalukya Bhat; Janamejaya Channegowda*
256	Management of Energy Storage Dispatch in Unbalanced Distribution Networks using OpenDSS	Tripti Gangwar*; Narayana Prasad Padhy; Premalata Jena
260	Non-Isolated Multi-Port High Gain Interleaved Boost DC-DC Converter for Base Transceiver Station Application	Dr. Saravana Prakash P*; Kalpana R
261	Design & Analysis of Push-pull Converter Fed Battery Charger for Electric Vehicle Application	SUPRABHA PADIYAR*; Kalpana R
263	Power Management of Hybrid Storage using Rule Based Adaptive Filtering in Electric Vehicle	ABHISEK PANDA*; Mahesh K. Mishra
264	PI Controlled Synchronization Converter using SHO in Grid-Interactive Three-Phase Solar PV System	Kingsuk Majumdar*; Nishant Kumar; Provas Kumar Roy; Subrata Banerjee

265	A Robust and Fast Solving Approach to improve Relays Coordination considering variable sizes of DGs and their outages	Ekta Purwar*
269	Advanced 24-Sector Bus-Clamping PWM Techniques for Dual Inverter-fed Split-Phase Induction Motor Drives	LALGY GOPI*; Gopalaratnam Narayanan
271	Transient Performance Improvement of a Solid State Transformer Integrated DC Microgrid System using Virtual Inertia Control	Naveed Ishraq*; Md. Raihan Ali; Md. Shamim Reza; Md. Maruf Hossain
273	BEMF-MRAS Based Sensorless PMSM for Solar Irrigation Pump with Ancillary Load Services	Mohd Kashif*; Bhim Singh
275	Load following on a deregulated power system with PID controller optimized using Rao algorithm	Sony MG*; Dr. Deepak M; Abraham T Mathew
276	Frequency Regulation of PMSG Based Wind Turbine Considering Location Identification Technique in High Penetration of Renewable Generation System	Rashmi Prasad*; gururaj M vishwanath; Narayana Prasad Padhy
277	Dual Mode Operation of a Switched Reluctance Generator Based Wind Energy Conversion System and a Battery Integrated MG under Abnormal Utility Grid Conditions	Vivek Narayanan*; Bhim Singh
280	Battery Parameter Evaluation Using Unscented Kalman Filter for Electric Vehicle Drive Cycles	Chalukya Bhat; Aniruddh S Herle; Janamejaya Channegowda*; Kali Naraharisetti
284	Performance Analysis of N40 Permanent Magnet Using PMSLG for Wave Energy Conversion	Mubeena Parveen S*; I. Nelson I; Sakthivel Murugan Santhanam
285	A Speed Range Extension Scheme for Induction Motor Drive with Open-end Stator Windings with Maximum Torque Per Ampere Control	RAJEEVAN P P *; Kaninika Pant
287	Neural-Network-Based Wide-Area Damping Control Considering Communication Delays	FAISAL JAMSHEED*

292	Novel Bidirectional DC-DC Converter with Battery Temperature Modulation Capability using High Frequency Resonant Network	Nitin Chauhan*
293	A GMPPT Algorithm for PV Systems Using Current Reference and P-I Curve Under Partial Shading Conditions	Bhavin Salvi*; Sivacharan Reddy; Dr. S P Selvi
294	Fast Frequency Support from Doubly Fed Induction Generators in Coordination with Super-conducting Magnetic Energy Storage Systems	ATHUL JOSE P*; Dr. Deepak M
295	Comparative Analysis of Outer Rotor Five Phase Switched Reluctance Motor with Higher Rotor Poles Configurations for EV Application	Zeeshan Rayeen*; Saifullah Payami
298	Consideration of Dynamic Cross Saturation in Mathematical Modeling of an Asymmetrical Six-Phase SEIG for Wind Energy Applications	MOHD RIZWAN KHAN; Mohd. Faisal Khan; MOHD SARTAJ*
299	Optimum High Frequency Transformer Design using Iterative Algorithm and Validation of the Design by Finite Element Analysis Method	Ajay Koshy Abraham; SHERIN JOSEPH*; Pinkymol K.P; Jineeth Joseph; K.R.M NAIR
300	Parameter Estimation of Variable Leakage Resistance Model of Supercapacitor	Reema Narayanan*; Jagadanand G; nikhil sasidharan; Shreelakshmi MP
301	A New Inverter Fault Detection Scheme for Nine-Phase Induction Motor Drive System	Nithin S Nair*; Jagadanand G
302	Effective Battery Parameter Data Augmentation Techniques to Resolve Sparse Dataset Challenges	Falak Naaz; Janamejaya Channegowda*
303	Simplified Predictive Flux Control for Neutral Point Clamped Converter fed IM Drive	Anil Kumar Bonala*; Vishnu Prasad Muddineni
304	Power Management Strategy Considering the Mountainous Terrain Driving Pattern for Three Wheeler Electric Vehicle	MD Irshad Ansari*; Himanshu Misra

307	Reduced switch multilevel converter topology to improve magnetization and demagnetization characteristics of an SRM	Suraj Kumar Chaurasiya; Avik Bhattacharya*; Sharmili Das
309	Supervised Learning based Demand Response Simulator with RTP and PTR in Context of Smart Grid	ANKIT KUMAR SHARMA*; Akash Saxena; Dheeraj Kumar Palwalia
310	Design of Optimal MLP-Neural Network-based Induction Motor Fault Classifier	Ujwala V Dongare*; Bhimrao Umre; Makarand Ballal; Vikas Dongare
315	Islanding Detection of Inverter based Distributed Generations using Wavelet Transform and KNN	Ajith M A*; SHEREEF R. M.
318	Centralized Charging Approach to Manage Electric Vehicle Fleets For Balanced Grid	Ali Aygun; Sukumar Kamalasan*
319	An Optimal Approach to Manage Electric Vehicle Fleets Routing	Ali Aygun; Sukumar Kamalasan*
320	A Simplified Functional Hybrid Operation Mode for Grid-Interactive Building Energy Management	Raheem Ariwoola; Sukumar Kamalasan*
321	Alternative SDP Relaxed Optimal Power Flow Formulation for Radial Distribution Networks	Biswajit Biswas; Sukumar Kamalasan*
322	Active Power Dispatch and Tracking Mechanism for DFIG Wind Turbine Generator in Wind Farm Considering Wake Effect	Rashmi Prasad*; Narayana Prasad Padhy
324	Electricity Pricing, Distribution Networks and Utilities - A Case for MCDM Approach Using ANP ?	Vinod V Nair*; Usha Nair
326	Electric Faults Detection Technique for DC Microgrids	SATYAVARTA KUMAR PRINCE*; DEEPAK KUMAR; Shaik Affijulla; Gayadhar panda

327	Multi-Time Scale Mixed System Modeling and Stability Prediction of Phase-shifted Single-phase Dual Active Bridge DC-DC Converter	tauquir iqbal*; Ali I Maswood; Dwaipayan Barman; Debabrata Barman
330	Planar and Spatial Analysis of Transients in Impedance Angle during Faults and Power Swing	Aldrich Zeno*
331	Modified Worst-Case Excess Minimization for Value Sharing in Energy Communities	Amir Safdarian*; Poria Hasanpor Divshali; Marius Baranauskas; Antti Keski-Koukkari; Anna Kulmala
333	Decentralized Primary Control of PV-Battery System Integrated With DC Microgrid in Off-Grid Mode	RAVI RANJAN*; Anand Panchbhaj; Amritesh Kumar
338	Generation of 24-Sided Polygonal Voltage Space Vector Structure with Reduced Hardware Complexity for Induction Motor Drives	RAJEEVAN P P *; Ishank Shekhar
339	Current Hysteresis Control of a Single Phase Integrated Battery Charger With Active Power Decoupling	Mohit Kumar*; Chunduri Sai Abhishek; Sudharshan Kaarthik
340	An Empirical Observability Gramian based Binary Search Algorithm for State Estimation in Microgrid	Mohd Aquib*; Suryanarayana Doolla; Mukul Chandorkar
341	Power Sharing Enhancement Strategy for Parallel-Connected Voltage-Source Inverters with Common DC and AC Buses	Vijay A. S.; Mohd Aquib; Suryanarayana Doolla*; Mukul Chandorkar
342	Value creation and sharing methods in household energy communities	Marius Baranauskas*; Amir Safdarian; Antti Keski-Koukkari; Poria Divshali; Anna Kulmala
343	Security Constrained two Stage Scheduling of Virtual Power Plant under Distributed Locational Marginal Prices	FURQUAN NADEEM*; Arup Kumar Goswami; Prashant Tiwari
344	Model Predictive Sliding Surface Control of Voltage Source Inverter	Ozan Gulbudak*; MUSTAFA G?KDA; Hasan Komurcugil

345	Model Predictive Sliding Surface Control of Induction Motor fed by Direct Matrix Converter	Ozan Gulbudak*; MUSTAFA G?KDA; Hasan Komurcugil
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## Skill Oriented Career Goal Recommendation Using Fuzzy Assignment Problem

Sonali Banerjee, Kaustuv Deb, Atanu Das, Rajib Bag

**Abstract**— Learners choose the career path to achieve their goals in lives depending on their individual competency factors like knowledge, skill, interests and abilities. Young learners often find difficulty and confusion due to lack of experience to reach their desired goals. Analyzing the learners' competencies at a personalized level can be vital factor to provide a solution of these problems. This analysis may be conducted using a Fuzzy Assignment Problem (FAP) based on skill analysis. This paper defines a FAP for finding the career path for the learners. FAP is then converted to a crisp assignment problem using the Magnitude Ranking Method which is further solved by the Hungarian Assignment Method. This method is explored to identify goals or career paths according to learners' different skill sets. It is anticipated that this method shall help learners by providing a relevant optimal career path suggestions, maybe in multiple numbers, based on their skills.

**Index Terms**— Carrier Path Recommendation, Fuzzy Assignment Problem, Hungarian Assignment Method, Magnitude Ranking Method.

## A New Analytical Approach for Smart Retail Shopping Using IOT

Joy Chatterjee, Manab Kumar Das, Sayon Ghosh, Rajib Bag, Atanu Das

**Abstract**— Big data management systems that include data reservoirs have greater benefits in the areas of retail shopping. Personalization in physical shopping using Bluetooth enable device connected with mobile devices is introduced to increase the ability to access, analyze, and manage vast volumes of data while rapidly evolving the information from any particular customer. The proposed work represents the current trends and architecture in the field of physical retail shopping using smart system. This proposal helps the retailers to improve business efficiency and performance by employing k-means algorithms to determine which products are really searched. This information is also used to predict the top products across categories for a specific customer. Beacon a most popular Bluetooth device which is introduced to make smart shopping more popular without any internet connectivity from customers end during physical visit. But Beacons are connected to internet to give updated information to the customer regarding the products standing by or searching remotely. The main objective is to improve the analysis of customers' sentiment and to provide the best product with less effort and less time consumption. With the right tools, organizations can run smart retail analytics which help them tackle real-time challenges at different levels. Some retail analytics software can even recommend discounts and recognize associated products by analyzing transactions of customer.

**Index Terms**— Beacon, Internet of Things (IoT), k-means algorithms, Retail Shopping, Sentiment analysis

# A Thermodynamic Study of a Conventional 500 MW Coal Fired Power Plant Hybridized with Solar Energy

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## Abstract

*In this work, an effort is made to evaluate the performance improvement and harmful emission reduction of a 500 Megawatt conventional coal-fired thermal power plant by installing a parabolic solar trough at the low pressure heater for regeneration. Here, parabolic solar troughs are used in place of LP heaters for heating the feed water before it enters the economizer of the boiler. As a result, the steam flow rate through turbines will increase, which boosts the work output and also decreases the overall coal consumption, resulting in a huge reduction of harmful emissions of various gases as well as a reduction in the investment cost on coal. As an outcome, the objective of this research is to develop a thermodynamic model that can be used to quantify improvements in network output, total thermal efficiency, and daily coal consumption while reducing ash generation, SO<sub>2</sub>, and CO<sub>2</sub> emissions.*

## 1.0 Introduction

Nowadays, the increasing demand of energy has been met mostly by coal-fired thermal power plants. The power conversion efficiency of coal to electrical energy in steam power plants is low and toxic pollutants from the combustion of fossil fuels like coal have a major detrimental impact on the environment and humans. Moreover, inefficient use of coal creates different negative impacts on environment. The primary objective in today's world is to harness the power of the sun. The sun's energy is free, and it's also environmentally friendly, meaning it won't pollute the environment significantly. Solar energy can be used in thermal power stations to reduce the need for coal, which will not only save nature but also save us. Therefore, a strategy is taken to use solar energy in a 500 Megawatt conventional coal-fired thermal power plant for regeneration by installing parabolic solar

troughs in place of low pressure heaters. As a result steam flow rate through low pressure turbine will increase with the increase of electricity generation as well as reduction of coal requirement.

Some related research literature has been studied in this work initially in order to comprehend the principles of solar hybridising by parabolic solar trough at the position of LP heater and its thermodynamics performance analysis by thermodynamic 1st and 2nd law.

In a study by Sorour Alotaibi et al. [1], the performance of a 300-megawatt traditional steam power plant in Kuwait was analysed after it was fitted with a solar-aided regenerative system using Parabolic Trough Solar Collectors (PTC) with an aperture area of 25,850 m<sup>2</sup> by eliminating low-pressure (LP) turbine extractions without changing other features. The system study showed that removing the LP turbine extractions increased the



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# Investigation of Strain Effect on Cleavage Fracture for Reactor Pressure Vessel Material

Reviewed: 15 October 2021 , Published: 08 December 2021

DOI: 10.5772/intechopen.101245

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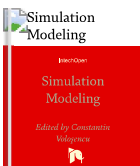
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## Abstract

Failure mechanism of 20MnMoNi55 steel in the lower self of ductile to brittle transition (DBT) region is considered as brittle fracture but it has been observed from the experimental analysis of stress-strain diagram that clear plastic deformation is shown by the material before failure. Therefore, strain correction is implemented in the cleavage fracture model proposed by different researchers in the lower self of the DBT region with the help of finite element analysis. To avoid a huge number of experiments being performed, Monte Carlo simulation is used to generate a huge number of random data at different temperatures in the lower self of the DBT region for calibration of the cleavage parameters with the help of the master curve methodology. Fracture toughness calculated after strain correction through different models are validated with experimental results for the different probability of failures.

### Keywords

fracture toughness

plastic strain

reactor pressure vessel

master curve

finite element analysis

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## 1. Introduction

Regular maintenance of the reactor pressure vessel (RPV) is an important criterion that has to be considered where safety is the prime requirement for any country. In that respect embrittlement of the RPV material has to be quantified concerning reference temperature  $T_0$ . In the last few decades, several researchers tried to quantify this embrittlement nature of ferritic steel in RPV materials. Among them, the work done by Kim Wallin with the development of ASTM E1921 and master curve [1, 2] proved to be quite impressive and acceptable in quantifying embrittlement for different ferritic steels used in reactor pressure vessels with the help of reference temperature  $T_0$ .

It has been observed in our previous work that references temperature ( $T_0$ ) predicted for 20MnMoNi55 steel is constraint dependent [3] and it varies with different crack length, thickness, and geometry of the specimen. It also shows the variation with test temperature and censor parameter “m”.

This observation is also predicted by different researchers [4, 5, 6, 7, 8] working in this field of ductile to brittle transition (DBT) region for different RPV materials.

Therefore, in the last few years, the main aim of the researchers was focused to study the constraint effects of reference temperature  $T_0$  for RPV materials. Finite element analysis is considered a useful tool to study the stress distribution near the crack tip of the specimen at different temperatures in the

### Chapter sections

the loss of constraint effect on the reference temperature  $T_0$  for these RPV materials with the help of these three stress-based parameters in his earlier work [9]. A satisfactory correlation of the constraint

Basabi Chakraborty · Arindam Biswas ·  
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ISSN 1876-1100

ISSN 1876-1119 (electronic)

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ISBN 978-981-99-3655-7

ISBN 978-981-99-3656-4 (eBook)

<https://doi.org/10.1007/978-981-99-3656-4>

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# Contents

<b>Fertilizer Recommendation System for High Crop Yield based on Prediction Model: A Comparative Analysis</b> .....	1
Bhuvaneswari Swaminathan, P. Saravanan, and V. Subramaniaswamy	
<b>Prediction of Future Career Course of Students Through RF Algorithm</b> .....	9
Sukarna Dey Mondal, Dipendra Nath Ghosh, and Pabitra Kumar Dey	
<b>Survey of Various Machine Learning Techniques for Analyzing IoMT-Based Remote Patient Monitoring System</b> .....	27
Sayyed Johar and G. R. Manjula	
<b>A Novel Approach to Predicting the Cardiovascular Sickness</b> .....	33
Debabrata Swain, Meet Kava, Ranjana Jadhav, and Santosh Satapathy	
<b>Intelligent System for Detecting Spam Emails Using Machine Learning Classifiers</b> .....	43
Debabrata Swain, Naresh Chillur, Meet Kava, and Amol Bhilare	
<b>Optical Flow-Based Movement Alert System for Assisting Visually Impaired People</b> .....	51
Jyoti Madake, Rohan Aparajit, Pranjali Balikai, Akhil Bhalgat, Shripad Bhatlawande, and Swati Shilaskar	
<b>Detection of Fallen Trees and Vehicles Plying on the Road for Safety of Visually Impaired People</b> .....	63
Swati Shilaskar, Raturaj Desai, Shripad Bhatlawande, Nishit Chaudhari, Soham Bugad, and Jyoti Madake	
<b>Electronic Travel Aid for Bus Detection and Bus-Route Number Recognition for Blind People</b> .....	71
Shripad Bhatlawande, Harshita Agrawal, Adhiraj Jagdale, Anusha Agrawal, and Swati Shilaskar	

<b>LSTM-Based Encoder–Decoder Model for Transliteration of English, Marathi, and Hindi Query</b> .....	79
Ranjana Jadhav, Adwait Bhosale, Tejas Gadi, Sanskruti Bahure, Akshay Bargaje, and Amey Chopde	
<b>A Study on Hiding Internet of Things (IoT) Communication</b> .....	89
Ujjal Dey Sarkar, Namrata Samanta, and Pabak Indu	
<b>Automatic Speech Recognition Using Acoustic Modeling</b> .....	109
Deepali Joshi, Pratik Waso, Rushikesh Shelke, Swapnil Jadhav, Kaustubh Bhale, and Akshada Padalkar	
<b>Effect of Dropout on Convolutional Neural Network for Hyperspectral Image Classification</b> .....	121
Somenath Bera and Vimal K. Shrivastava	
<b>State Derivative Optimal Control Law for Submersible Autonomous Robotic Vehicle in Steering Plane</b> .....	133
Siddhartha Vadapalli and Subhasish Mahapatra	
<b>ASR for Indian Regional Languages Using Fine-Tuned Wav2Vec2 Model</b> .....	141
Premanand Ghadekar, Khushi Jhanwar, Ameya Karpe, Akash Sivanandan, Tanishka Shetty, and Prannay Khushalani	
<b>Intelligent Online Voting System for Twenty-First Century and Smart Cities 5.0: An Empirical Approach through Blockchain with ML Techniques</b> .....	151
Rohit Rastogi, Priyanshu Arora, Luv Dhamija, and Rajat Shrivastava	
<b>An Empirical Study on Credit Risk Assessment Using Ensemble Classifiers</b> .....	157
Arijit Bhattacharya, Souvik Kumar Parui, Saroj Kr. Biswas, and Ardhendu Mandal	
<b>Audio Based Text Summarization Using Natural Language Processing</b> .....	171
Premanand Ghadekar, Divsehaj Singh Anand, Aryan Kumar Gupta, Preeti Oswal, Dheeraj Sharma, and Shreyas Khare	
<b>Blockchain-Enabled Security in Vehicular Ad Hoc Network</b> .....	181
Sharad Pratap Singh and G. Hanumat Sastry	
<b>Stock Selection Using Ontological Financial Analysis</b> .....	191
Bikram Pratim Bhuyan and Hanumat Sastry	
<b>Components of Information Diffusion and Its Models in Online Social Networks; a Comparative Study</b> .....	199
Aaquib Hussain Ganai, Rana Hashmy, and Hilal Ahmad Khanday	

**Development of a Residual Neural Network Architecture for the Detection of Diabetic Retinopathy in Retinal Fundus Images . . . .** 207  
 Sachin S. Bhat

**Prediction Markets Using Machine Learning . . . . .** 219  
 Tarun Kharkwal and Shweta Meena

**Evaluation of Optimum Batting Order Based on Partnership Analysis Using Ant Colony Optimization Technique . . . . .** 227  
 Mousumi Tarafder, Soumen Santra, Sweta Sharma, and Arpan Deyasi

**Identification of Rock Images in Mining Industry: An Application of Deep Learning Technique . . . . .** 235  
 Soumyadeep Paty and Supreeti Kamilya

**Evaluation of Teachers’ Performance Using Fuzzy Inferences System . . . . .** 243  
 Ashadul Haque and Md Firoj Ali

**A Detailed Analysis on Intrusion Detection Systems, Datasets, and Challenges . . . . .** 259  
 Chetan Gupta, Amit Kumar, and Neelesh Kumar Jain

**Object Detection Under Low-Lighting Conditions Using Deep Learning Architectures: A Comparative Study . . . . .** 269  
 Arrun Sivasubramanian, J. Arun Prakash, K. S. Dharshan Kumar, V. R. Prashanth, V. Sowmya, and V. V. Sajith Variyar

**Terahertz Image Processing: A Boon to the Imaging Technology . . . . .** 277  
 Jayashree Karmakar, Debabrata Samanta, Amit Banerjee, and M. P. Karthikeyan

**Developing a Talent Identification Model for Predicting Player Position in Football Using Machine Learning Algorithms . . . . .** 285  
 R. Sujatha, B. Uma Maheswari, D. Kavitha, and Kiran Kandaswamy

**Implementation of Anticipated Technique in Digital Mammography for Piloting Classification of Breast Cancer Using CNN . . . . .** 295  
 Sarbjit Kaur Dhillon and Jasmeen Gill

**Three-Layered Hybrid Analysis Technique for Android Malware Detection . . . . .** 303  
 Tejpal Sharma and Dhavleesh Rattan

**A Survey on LSB Replacement-Based Statistical Image Steganalysis Techniques . . . . .** 313  
 Bibek Ranjan Ghosh, Siddhartha Banerjee, and Joytsna Kumar Mandal

<b>Emotion Recognition Using Text and Speech Through Machine Learning</b> .....	321
Chaitanya Singla and Sukhdev Singh	
<b>Condition-Based Monitoring of Power Transformer with Graphical Analysis of Incipient Faults Using Fuzzy Inference Expert System</b> .....	331
Rahul Soni and Bhinal Mehta	
<b>Disease Classification in the Cotton Using Convolution Neural Networks</b> .....	341
Aviral Sharma and Gunjan Chhabra	
<b>A Short Review on XAI Techniques in Text Data</b> .....	353
Mahuya Ghosh, Amit Kumar Das, and Amlan Chakrabarti	
<b>Performance of Multi Hop, Multi Link CRN with Energy Harvesting in Presence of CCI</b> .....	365
Souvik Manna, Chanchal Kumar De, and Debasis De	
<b>Performance Evaluation of Path Restoration Techniques in a Network</b> .....	375
Vidhu Baggan, Jyoti Snehi, Manish Snehi, and Varinder Kaur Attri	
<b>An Insight to Bitcoin Price Using Weber's Law</b> .....	385
Manan Roy Choudhury, Anurag Dutta, and Arnab Kumar De	
<b>Named Entity Recognition Using Deep Learning and BERT for Tamil and Hindi Languages</b> .....	395
Sreelekshmi Menon, J. P. Sanjanasri, B. Premjith, and K. P. Soman	
<b>Brain Signal Classification Using Decomposition Techniques and Deep Learning</b> .....	405
T. R. Karthik, Rohith Ramakrishnan, Anirudh Vadakedath, V. Sowmya, E. A. Gopalakrishnan, and G. Jyothish Lal	
<b>PSO-Based Traffic Signals in a Real-World City</b> .....	411
Vandana Singh, Sudip Kumar Sahana, and Vandana Bhattacharjee	
<b>BERT-Based Dependency Parser for Hindi</b> .....	421
Aparna Nambiar, B. Premjith, J. P. Sanjanasri, and K. P. Soman	
<b>Game Theory Strategies in Cloud Security with Implementation</b> .....	429
Saurjyadeep Das, Sugandha Sharma, Sudhanshu Srivastava, Shelly Garg, and Ratna Rajpal	
<b>Detection of Phishing Attack Using Machine Learning</b> .....	441
Uttkarsh Rastogi, Tanu, Vinayak Singhal, Ankush Gupta, and Vimal Kumar	
<b>An Efficient Framework to Maximize Street Lighting Coverage</b> .....	451
Tanmoy Dey and Parag Kumar Guha Thakurta	

**Traveling Tournament Problem and the Different Methods of Solutions: A Brief Review** ..... 461  
 Rajarshi Basu, Pratik Chowdhury, Baisakhi Das, Shyama Mondal, Kingshuk Chatterjee, and Alok Mukherjee

**Application of Binary Flower Pollination Optimization in Radial Distribution System** ..... 469  
 Nasim Ali Khan, Sanjib Deb, Mir Abubakkar Siddik, Prabir Mondal, Swarnali Bhar, Sourav Majumdar, and Soumya Basu

**Development of a Natural Calamity Alert System for Tourists: An Application of PEAS Technology** ..... 481  
 Goldina Ghosh, Anwesa Das, Anasuya Dev, Abhinandan Das, Birol Roy, Debapriya Bhowmick, and Prasenjit Saha

**Resource Allocation and Optimization Scheduling Scheme of Edge Resources in Fog Computing Access Network** ..... 491  
 Balajee Maram, T. Daniya, and Veerraju Gampala

**On Multi-objective Fuzzy Shortest Path Problem** ..... 499  
 Swapna Halder, Saibal Majumder, Arindam Biswas, Bijoy Kumar Mandal, and Sheng-Lung Peng

**Design and Simulation of Microstrip Patch Antennas with Textile Dielectrics for Body Sensor Networks (BSNs) and Wearable IoT Applications** ..... 511  
 Chaitanya Vijaykumar Mahamuni

**An Investigation into the Efficacy of Interactive Tools in the Online Teaching-Learning Process** ..... 523  
 Subhechha Majumdar, Tanmay Bhowmik, Amitava Choudhury, and Rajesh Srivastava

**Steganography Tools and Their Analysis Concerning Distortion in Stego Image** ..... 531  
 Urmila Paliana, Rohit Tanwar, and Keshav Kaushik

**Density-Based Spatio-Temporal Clustering Model for Earthquake Analysis and Seismo-Tectonic Zoning** ..... 539  
 Ashish Sharma, Sandeep Vyas, and Anand Nayyar

**Reconfigurable Intelligent Surface-Based Cooperative Spectrum Sensing Over Noisy Reporting Channel** ..... 547  
 Girraj Sharma, Sandeep Vyas, Anand Nayyar, and Ritu Sharma

**Optimization of Crystalline Silicon Solar Cell Parameters Using PC1D** ..... 557  
 Md. Irfan, Sudipta Banerjee, Hasnain Rza, and Abhigyan Maji

<b>Machine Learning-Based Approach for Prediction of Forest Fire Using Ensemble Learning</b> .....	567
Tanuj Bhatt and Arun Malik	
<b>Artificial Intelligence in Military Applications of 21st Century</b> .....	575
Sugandha Sharma, Kaushik Ghosh, Ratna Rajpal, Ishan Bhalla, Parul Gupta, Digambar Ranakit Dutta, and Saya Garg	
<b>Quality of Service of the Internet of Things—A Survey of Current Research Trends for Evolving 5G-IoT Scenario</b> .....	585
Dipankar Chatterjee and A. C. Mondal	
<b>Optimization of Classification Algorithm for Improving Semantic-Based Text Classification</b> .....	593
Rahul Bhandari, Anuj Kumar Jain, Mukund Pratap Singh, and Kamal Deep Garg	
<b>Meme-Text Analysis: Identifying Sentiment of Memes</b> .....	605
P. Aditya Krishna Rohit, S. Sachin Kumar, and K. P. Soman	
<b>Augmented Reality in Chemistry Education: An Exploratory Analysis</b> .....	613
Priyanka Datta, Amanpreet Kaur, and Archana Mantri	
<b>Survey of Pedestrian Trajectory Prediction Techniques Using Surveillance Videos</b> .....	623
Adya Bansal, Aroma Agarwal, Muskan Lalit, and K. R. Seeja	
<b>Oil Spill Detection from Images Using Deep Learning</b> .....	631
Vignesh Gopinath, S. Sachin Kumar, Neethu Mohan, and K. P. Soman	
<b>An Efficient 8T GDI Enable Full Adder Design for Data Path Subsystem</b> .....	641
Dolly Thakur, Hemant Patidar, Vikas Maheshwari, Rajib Kar, and Prashant Upadhyay	
<b>A Transfer-Learning-Based Deep Network for Detecting Violence in Real-Time Videos</b> .....	659
Soma Hazra, Sounak Saha, Sunirmal Khatua, and Banani Saha	
<b>Detection of Chaotic Cellular Automata Using Convolutional Neural Networks: A Comparative Study</b> .....	667
Supreeti Kamilya and Soumyadeep Paty	
<b>Bird Species Identification and Classification Based on Feature Analysis Using VGG19 Framework</b> .....	677
Nilanjana Adhikari, Bikramjit Das, Biplab Roy, Suman Bhattacharya, and Mahamuda Sultana	

**Exploring the Human USP Gene Family and Its Association with Cancer: An In Silico Study** ..... 685  
Sujay Ray and Arundhati Banerjee

**AI in Pervasive Healthcare: A Survey** ..... 695  
Kaushik Ghosh, Sugandha Sharma, Sulagna Sarkar, and Alka Kaushik

**Analysis and Detection of Alzheimer’s Disease Using Machine Learning Approach** ..... 703  
Raghubir Singh Salaria and Neeraj Mohan

**Design of Cost-Effective WSN by Minimizing Energy Consumption Using Hybrid Algorithm** ..... 711  
Avishek Banerjee, Nitin Arvind Shelke, Navneet Pratap Singh, Tanmay Bhowmik, Bishwajit Roy, and Arindam Biswas

**Isolating Brain Tissue from Abnormal Tissue Using MRI-Based U-Net Convolutional Neural Network** ..... 721  
Brijit Bhattacharjee, Bikash Debnath, Jadav Chandra Das, and Debashish De

**Plant Disease Identification Through Study of Leaf Images** ..... 729  
Aniket Das, Piyasi Das, Amlan Chakrabarti, Rik Das, and Chira Dutta

**An Analysis of Random Non-deterministic Signals Using Recursive Methods and Stochastic Control System** ..... 737  
Tanmoy Singha, Lisha Misra, Joydeep Dutta, Rudra Sankar Dhar, and Arindam Biswas

**A Machine Learning-Based Approach to Identify Hand Gestures** ..... 749  
Kunal Bhardwaj, Sakshi Bansal, and Kaushik Ghosh

# Plant Disease Identification Through Study of Leaf Images



## Consolidated Handcrafted and Automated Features for Enhanced Feature Generalization

Aniket Das , Piyasi Das, Amlan Chakrabarti , Rik Das ,  
and Chira Dutta

### 1 Introduction

Enhancements in global population, higher food security, and demand have become a predominant challenge in the field of agriculture and science for the last 5–6 decades. According to the research statistics, by 2050, the world will face massive demographic changes as about two third of the population will migrate to cities [1]. Meeting the food demand and quality requires agricultural development to play a humongous role in upcoming days. But the threats of famine and disease infestations are also increasing due to rapid climate change. Poor disease control, lack of early detection, diversity of pathogens and symptoms, and rapid genetic changes in the pathogens are the key features in the calamity of dwindled food production. The major bottleneck in the sector is the lack of expertise and training of the farmers and the ever-changing genomic nature of the pathogens [2]. Our goal is to analyse a method of computer-aided diagnosis (CAD) of affected crops. The disease detection involves identification of visual patterns on plant leaves and monitoring it. The process is reliant on the feature vector extraction from the leaf images. The high accuracy assurance comes with the challenge of the generalization of feature descriptors. The use of pre-trained models has been done to extract essential feature data from

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Editors

# Proceedings of International Conference on Frontiers in Computing and Systems

COMSYS 2021

 Springer

*Editors*

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ISSN 2367-3370

ISSN 2367-3389 (electronic)

Lecture Notes in Networks and Systems

ISBN 978-981-19-0104-1

ISBN 978-981-19-0105-8 (eBook)

<https://doi.org/10.1007/978-981-19-0105-8>

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# Contents

## Artificial Intelligence

<b>Experimental Face Recognition Using Applied Deep Learning Approaches to Find Missing Persons</b> .....	3
Nsikak Imoh, Narasimha Rao Vajjhala, and Sandip Rakshit	
<b>MultiNet: A Diffusion-Based Approach to Assign Directionality in Protein Interactions Using a Consensus of Eight Protein Interaction Datasets</b> .....	13
Kaustav Sengupta, Anna Gambin, Subhadip Basu, and Dariusz Plewczynski	
<b>An Irrigation Support System Using Regressor Assembly</b> .....	21
Gouravmoy Banerjee, Uditendu Sarkar, and Indrajit Ghosh	
<b>Does Random Hopping Ensure More Pandal Visits Than Planned Pandal Hopping?</b> .....	31
Debojyoti Pal, Anwesh Kabiraj, Ritajit Majumdar, Kingshuk Chatterjee, and Debayan Ganguly	
<b>Consensus-Based Identification and Comparative Analysis of Structural Variants and Their Influence on 3D Genome Structure Using Long- and Short-Read Sequencing Technologies in Polish Families</b> .....	41
Mateusz Chiliński, Sachin Gadakh, Kaustav Sengupta, Karolina Jodkowska, Natalia Zawrotna, Jan Gawor, Michal Pietal, and Dariusz Plewczynski	
<b>On the Performance of Convolutional Neural Networks with Resizing and Padding</b> .....	51
Mosammath Shahnaz and Ayatullah Faruk Mollah	

**Analysis of Vegetation Health of the Sundarbans Region Using Remote Sensing Methods** ..... 63  
 Soma Mitra and Saikat Basu

**You Reap What You Sow—Revisiting Intra-class Variations and Seed Selection in Temporal Ensembling for Image Classification** ..... 73  
 Manikandan Ravikiran, Siddharth Vohra, Yuichi Nonaka, Sharath Kumar, Shibashish Sen, Nestor Mariyasagayam, and Kingshuk Banerjee

**Light U-Net: Network Architecture for Outdoor Scene Semantic Segmentation** ..... 83  
 Aleazer Viannie Sunn, Aiden Langba, Hamebansan Mawlong, Alexy Bhowmick, and Shyamanta M. Hazarika

**Framework of Intelligent Transportation System: A Survey** ..... 93  
 Ratna Mandal, Ankita Mandal, Soumi Dutta, Munshi Yusuf Alam, Sujoy Saha, and Subrata Nandi

**Convolutional Neural Networks-Based VQA Model** ..... 109  
 Himanshu Sharma and Anand Singh Jalal

**Signal Processing**

**A Deep Convolution Neural Networks Framework for Analyzing Electroencephalography Signals in Neuromarketing** ..... 119  
 Shrasti Vyas and Ayan Seal

**Semantic Segmentation of Road Scene Using Deep Learning** ..... 129  
 Ritesh Kumar and Khwairakpam Amitab

**Edge Detection and Segmentation Type Responses in Primary Visual Cortex** ..... 141  
 Satyabrat Malla Bujar Baruah, Uddipan Hazarika, and Soumik Roy

**Hand Gesture Based Computer Vision Mouse** ..... 149  
 Bibekananda Buragohain, Dhritiman Das, Bhabajyoti Baishya, and Minakshi Gogoi

**A Novel Time-Stamp-Based Audio Encryption Scheme Using Sudoku Puzzle** ..... 159  
 Sunanda Jana, Neha Dutta, Arnab Kumar Maji, and Rajat Kumar Pal

**MathIRs: A One-Stop Solution to Several Mathematical Information Retrieval Needs** ..... 171  
 Amarnath Pathak, Partha Pakray, and Ranjita Das

**Model Structure from Laser Scanner Point Clouds** ..... 181  
 Bara’ W. Al-Mistarehi, Ahmad H. Alomari, Maad M. Mijwil,  
 Taiser S. Khedaywi, and Momen Ayasrah

**Feature Extraction Techniques for Gender Classification Based  
 on Handwritten Text: A Critical Review** ..... 191  
 Monika Sethi, M. K. Jindal, and Munish Kumar

**Rice Disease Identification Using Deep Learning Models** ..... 203  
 Sk Mahmudul Hassan and Arnab Kumar Maji

**Convexity Defects-Based Fingertip Detection and Hand Gesture  
 Recognition** ..... 213  
 Soumi Paul, Shrouti Gangopadhyay, Ayatullah Faruk Mollah,  
 Subhadip Basu, and Mita Nasipuri

**Variable-Length Genetic Algorithm and Multiple Entropic  
 Functions-Based Satellite Image Segmentation** ..... 223  
 Ramen Pal, Somnath Mukhopadhyay, and Debasish Chakraborty

**Skeletonization and Its Application to Quantitative Structural  
 Imaging** ..... 233  
 Punam K. Saha

**Healthcare**

**Voting-Based Extreme Learning Machine Approach  
 for the Analysis of Sensor Data in Healthcare Analytics** ..... 247  
 Tanuja Das, Ramesh Saha, and Vaskar Deka

**U-Shaped Xception-Residual Network for Polyps Region  
 Segmentation** ..... 255  
 Pallabi Sharma, Bunil Kumar Balabantary, and P. Rangababu

**Motion Sensor-Based Android Game to Improve Fine Motor  
 and Working Memory Skills of Children** ..... 263  
 Sudipta Saha, Saikat Basu, Koushik Majumder,  
 and Debashish Chakravarty

**Specular Reflection Removal Techniques for Noisy and Non-ideal  
 Iris Images: Two New Approaches** ..... 277  
 Md. Amir Sohail, Chinmoy Ghosh, Satyendranath Mandal,  
 and Md. Maruf Mallick

**Analyzing Behavior to Detect Cervical Cancer** ..... 291  
 Rup Kumar Deka

**Rapid Diagnosis of COVID-19 Using Radiographic Images** ..... 301  
 Debangshu Chakraborty and Indrajit Ghosh

<b>BUS-Net: A Fusion-based Lesion Segmentation Model for Breast Ultrasound (BUS) Images</b> .....	313
Kaushiki Roy, Debotosh Bhattacharjee, and Christian Kollmann	
<b>Breast Cancer Detection from Histology Images Using Deep Feature Selection</b> .....	323
Susovan Das, Akash Chatterjee, Samiran Dey, Shilpa Saha, and Samir Malakar	
<b>Using Cellular Automata to Compare SARS-CoV-2 Infectiousness in Different POIs and Under Different Conditions</b> .....	331
Agnieszka Motyka, Aleksandra Bartnik, Aleksandra Źurko, Marta Giziewska, Paweł Gora, and Jacek Sroka	
<b>Classification of Breast Tumor from Ultrasound Images Using No-Reference Image Quality Assessment</b> .....	341
Ratnadeep Dey, Debotosh Bhattacharjee, Christian Kollmann, and Ondrej Krejcar	
<b>Computer Networks, Communication and Security</b>	
<b>A Switchable Bandpass Filter for Multiple Passband and Stopband Applications</b> .....	353
Anjan Bandyopadhyay, Pankaj Sarkar, and Rowdra Ghatak	
<b>Optimization of BBU-RRH Mapping for Load Balancing in 5G C-RAN Using Swarm Intelligence (SI) Algorithms</b> .....	359
Voore Subba Rao and K. Srinivas	
<b>Using Game Theory to Defend Elastic and Inelastic Services Against DDoS Attacks</b> .....	371
Bhupender Kumar and Bubu Bhuyan	
<b>Outage Probability of Multihop Communication System with MRC at Relays and Destination Over Correlated Nakagami-<math>m</math> Fading Channels</b> .....	383
Rajkishur Mudoi and Hubha Saikia	
<b>Outage Probability Analysis of Dual-Hop Transmission Links with Decode-and-Forward Relaying over Fisher–Snedecor <math>F</math> Fading Channels</b> .....	391
Hubha Saikia and Rajkishur Mudoi	
<b>Simultaneous Wireless Information and Power Transfer for Selection Combining Receiver Over Nakagami-<math>M</math> Fading Channels</b> .....	399
Nandita Deka and Rupaban Subadar	

**A High-Selective Dual-Band Reconfigurable Filtering Antenna for WiMax and WLAN Application** ..... 409  
 Sangeeta Das and Pankaj Sarkar

**Synthesis and Characterization of Uniform Size Gold Nanoparticles for Colorimetric Detection of Pregnancy from Urine** ..... 419  
 Shyamal Mandal and Juwesh Binong

**A Data Hiding Technique Based on QR Code Decomposition in Transform Domain** ..... 425  
 Sakhi Bandyopadhyay, Subhadip Mukherjee, Biswapati Jana, and Partha Chowdhuri

**ADT-SQLi : An Automated Detection of SQL Injection Vulnerability in Web Applications** ..... 433  
 Md. Maruf Hassan, Rafika Risha, and Ashrafia Esha

**Fuzzy Logic with Superpixel-Based Block Similarity Measures for Secured Data Hiding Scheme** ..... 445  
 Prabhash Kumar Singh, Biswapati Jana, Kakali Datta, Prasenjit Mura, Partha Chowdhuri, and Pabitra Pal

**Security Aspects of Social Media Applications** ..... 455  
 Ankan Mallick, Swarnali Mondal, Soumya Debnath, Sounak Majumder, Hars h, Amartya Pal, Aditi Verma, and Malay Kule

**Electronics, VLSI and Computing**

**Button Press Dynamics: Beyond Binary Information in Button Press Decisions** ..... 469  
 Peter Bellmann, Viktor Kessler, André Brechmann, and Friedhelm Schwenker

**Dynamic Time Warping-Based Detection of Multi-clicks in Button Press Dynamics Data** ..... 479  
 Peter Bellmann, Viktor Kessler, André Brechmann, and Friedhelm Schwenker

**VLSI Implementation of Artificial Neural Network** ..... 489  
 Swarup Dandapat, Sheli Shina Chaudhuri, and Sayan Chatterjee

**A Novel Efficient for Carry Swipe Adder Design in Quantum Dot Cellular Automata (QCA) Technology** ..... 501  
 Suparba Tapna

**A Novel Dual Metal Double Gate Grooved Trench MOS Transistor: Proposal and Investigation** ..... 511  
 Saheli Sarkhel, Riya Rani Dey, Soumyarshi Das, Sweta Sarkar, Toushik Santra, and Navjeet Bagga

<b>Application of Undoped ZnS Nanoparticles for Rapid Detection of <i>E. coli</i> by Fabricating a Mem-Mode Device Sensor After Conjugating Antibody</b> .....	519
Himadri Duwarah, Neelotpal Sharma, Kandarpa Kumar Saikia, and Pranayee Datta	
<b>Swift Sort: A New Divide and Conquer Approach-Based Sorting Algorithm</b> .....	529
Tanmoy Chaku, Abhirup Ray, Malay Kule, and Dipak Kumar Kole	
<b>Natural Language Processing</b>	
<b>Speech Recognition System of Spoken Isolated Digit in Standard Khasi Dialect</b> .....	541
Fairriky Rynjah, Bronson Syiem, and L. J. Singh	
<b>Sentiment Analysis on COVID-19 News Videos Using Machine Learning Techniques</b> .....	551
S. Lekshmi and V. S. Anoop	
<b>Bengali POS Tagging Using Bi-LSTM with Word Embedding and Character-Level Embedding</b> .....	561
Kaushik Bose and Kamal Sarkar	
<b>A Comparative Study on Effect of Temporal Phase for Speaker Verification</b> .....	571
Doreen Nongrum and Fidalizia Pyrtuh	
<b>An Acoustic/Prosodic Feature-Based Audio Dataset for Assamese Speech Summarization</b> .....	579
Priyanjana Chowdhury, Swarnav Das Barman, Catherina Basumatary, Sandeep Deva Misra, Sanghamitra Nath, and Utpal Sharma	
<b>Influential Node Detection in Online Social Network for Influence Minimization of Rumor</b> .....	589
Maitreyee Ganguly, Paramita Dey, Swarnesha Chatterjee, and Sarbani Roy	
<b>Author Index</b> .....	597

# A Novel Dual Metal Double Gate Grooved Trench MOS Transistor: Proposal and Investigation



Saheli Sarkhel, Riya Rani Dey, Soumyarshi Das, Sweta Sarkar, Tushik Santra, and Navjeet Bagga

**Abstract** Through this paper, we have propounded and investigated a novel structure of a grooved trench MOS transistor with double gate architecture using TCAD simulations. To date, only a single metal trench MOSFET has been reported which having weaker control of the gate bias over the channel charge, unlike improved in our propounded structure. The propounded dual metal double gate grooved trench (DMDGGT) structure incorporated the advantages of enhanced gate controllability and subdued the drain-induced barrier lowering (DIBL) owing to the presence of a bi-metal gate with dissimilar work functions. In addition, due to the inherent advantage of a grooved trench gate device of having a longer effective channel length by the trench gate geometry, the device results in a significant reduction in short-channel effects (SCEs). The acquired results from the SILVACO ATLAS simulation exhibit a significant improvement of the propounded DMDGGT MOSFET as compared to its single metal counterpart for surface potential, electric field, threshold voltage, and drain characteristics, thereby substantiating the efficacy of the propounded device structure.

**Keywords** Trench gate MOSFET · Double gate · Drain-induced barrier lowering · Short-channel effect · Threshold voltage roll-off

## 1 Introduction

The ever-increasing demand for improved speed and better as well as higher integration capability has enabled the scaling of the MOSFETs to satisfy the demands. This downscaling has brought down the device dimensions to sub-micron order, which has introduced us to some unavoidable problems in fabricating, realizing, and utilizing

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# Statistical Analysis of a Low Power Analog Current Source

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**Abstract** - This paper presents a low power PTAT (proportional to absolute temperature) current reference circuit, designed in 180nm scl technology and simulated using LTspice software. A resistor less circuit is designed to generate 1nA reference current ( $I_{ref}$ ) at a supply voltage ( $V_{dd}$ ) of 0.44 V. Monte Carlo analysis of the circuit is performed with respect to two process parameters, namely, oxide thickness ( $t_{ox}$ ) and threshold voltage ( $v_{th}$ ). Individual variations as well as simultaneous variations of these parameters have been considered while analyzing the performance of the circuit. Statistical analysis, of the current values obtained, has been performed and the results have been verified through software like Python and SPSS (Statistical Package for the Social Sciences). At a later part of the project, Python automation is performed, where the LTspice software can be accessed and simulated without actually opening the software, but through Python codes.

**Keywords** - low power, weak-inversion region, power supply sensitivity, Monte-Carlo, python automation, skewness, kurtosis, mean, standard deviation.

## I. INTRODUCTION

Current reference circuits are one of the most important building blocks in analog and mixed-mode circuit systems. These circuits generate a reference current and are used in op-amps, oscillators, phase-locked loops, and A/D and D/A converters. As the demand for efficient low-power circuits has significantly increased in recent times owing to the demand for long-lasting batteries in handheld devices, low-voltage current reference circuits have been investigated. For ultra low power analog circuits where the supply voltage is limited to 1.8V or less than that, it becomes essential to design a stable reference current source of 1nA or less. Circuits with reference currents of only several nano-amperes have also been reported. We have designed the circuit in LTspice software in scl 180 nm technology. The region of operation of MOSFET chosen for our work is sub-threshold or weak inversion region. A resistorless circuit has been designed, with W/L values such that it works efficiently in the weak inversion region. This circuit provides a reference current of 1 nA and operates at a supply voltage of 0.44 V.

Thereafter, the circuit has been simulated in LTspice to check its functioning at various conditions. The design of CMOS reference is very challenging as the parameters, such as threshold voltage and mobility, are greatly dependent on temperature. To observe the performance of the circuit with variations in these parameters, the Monte Carlo Analysis in LTspice and in Python has been done and verified through SPSS analysis. Statistical analysis includes determining the values of mean, standard deviation, kurtosis and skewness of the current values obtained from the designed circuit and to measure the correctness or extent of performance of the reference circuit. The aim of this work is to perform the statistical analysis of the designed circuit and integrate Python with LTspice, to make the entire analysis independent of any particular circuit simulating software.

## II. CIRCUIT DESIGN

This work is laid out in scl 180nm technology. The technology node is operated at a maximum of 1.8 V supply voltage. The value of the resistor in the beta multiplier circuit comes in Mega Ohm range if we want to obtain the drain current value in nano-ampere (nA) range. But, this large valued resistor is very difficult to fabricate on chip as the sheet resistance of the silicon is very less. Hence, we have implemented such a high value of resistance by connecting three MOSFETs in parallel giving a high effective output impedance. Table I presents the W/L ratio of various transistors used in the proposed circuit as shown in Fig1.

TABLE I. W/L RATIO FOR DIFFERENT MOSFETS

TRANSISTORS	W/L( $\mu\text{m}/\mu\text{m}$ )	NUMBER OF PARALLEL DEVICES(m)
M1,M2	0.5/10	-
M3,M4	10/10=20*M1	-
M7	0.5/10	-
M5	10/10=20*M7	-
M8	1.5/10=3*M7	-
M6	30/10=3*M5	-
M9	10/0.22	8
M10	10/0.22	8
M11	10/0.22	8

**Proceedings of**  
**IEEE VLSI DCS 2022: 3<sup>rd</sup> IEEE Conference on VLSI**  
**Device, Circuit and System**  
**Conference Record: 53788**

26<sup>th</sup> – 27<sup>th</sup> February, 2022, Kolkata, India

Place: Meghnad Saha Institute of Technology, Kolkata

Organised by:

**IEEE Electron Device MSIT Student Branch Chapter**  
**in association with the Department of ECE, MSIT**

Edited by,

**Dr. Manash Chanda**

**Meghnad Saha Institute of Technology**

# 2022 IEEE VLSI DEVICE CIRCUIT AND SYSTEM (VLSI DCS)

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**Part Number: CFP22T84-ART**

**ISBN No.: 978-1-6654-3801-8**

# Table of Contents

	Copyright Message	i
	Message from Chief Patron	ii
	Message from Patron	iii
	Message from Chief Guest	Iv
	Message from General Chair and Editor	v
1	<b>Exploring the Feasibility of Implementing Negative-Capacitance Tunnel-FET (NC-TFET) in Low-Power Digital Circuits</b> <i>Sourav Guha, Prithviraj Pachal</i>	1-4
2	<b>Investigation of MoS<sub>2</sub> Based Dual Gate MOSFET as a H<sub>2</sub> Sensor Considering Catalytic Metal Gate Approach</b> <i>Arpan De, Ananya Karmakar, Rittik Ghosh, Priyanka Saha</i>	5-8
3	<b>All Optical Logic XNOR Gate Using Dual Control Dual SOA TOAD (DCDSTOAD)</b> <i>Kajal Maji, Kousik Mukherjee, Mrinal Kanti Mandal</i>	9-12
4	<b>Backscatter Interrogation Enactment in UHF-RFID for Rayleigh Diminishing Channel</b> <i>Aritra De, Tirthankar Datta</i>	13-18
5	<b>Linearity Performance of Double Metal Negative Capacitance Field-Effect Transistors: A Numerical Study</b> <i>Yash Pathak, Bansi Dhar Malhotra, Rishu Chaujar</i>	19-23
6	<b>Performance Assessment of InGaN Double Gate Stack-Oxide MOSFET Based Phosphine Gas Sensor: A Catalytic Metal Gate Approach</b> <i>Ajay Kumar, Dipanjan Sen, Soumendu Sinha</i>	24-27
7	<b>Magnesium-Silicide (Mg<sub>2</sub>Si)/Silicon (Si) Heterojunction Based TFET for Optical Detection at 1550 nm</b> <i>Manisha Khurana, Upasana, Manoj Saxena, Mridula Gupta</i>	28-33
8	<b>Density Functional Theory (DFT) Analysis on the Structural, Electronic, and Optical Properties of Monoclinic HfO<sub>2</sub></b> <i>Jayanta Kumar Kar, Saurabh Chaudhury, Neerja Dharmale</i>	34-40
9	<b>Study the Sensing Performance with Catalytic Metals of Passivated InAlN/GaN Schottky Diode Gas Sensor</b> <i>Bhaskar Roy, Md. Aref Billaha, Ritam Dutta, Debasis Mukherjee</i>	41-45
10	<b>Temperature Dependence on Fin-FET Electrical Parameters for Al<sub>2</sub>O<sub>3</sub> and HfO<sub>2</sub> Dielectric Materials: A Comparative Study</b> <i>Salini Singh, Bhaskar Roy, Md. Aref Billaha, Ritam Dutta, Santosh K. Choudhary</i>	46-49
11	<b>Impact of Composite Trench Stepped Hetero Channel MOSFET on Analog Performance</b> <i>Soumya S. Mohanty, Sikha Mishra, Guru Prasad Mishra</i>	50-54
12	<b>An Integrated System for Drivers' Drowsiness Detection Using Deep Learning Frameworks</b> <i>Biswarup Ganguly, Debangshu Dey, Sugata Munshi</i>	55-59

13	<b>K Nearest Neighbor and Flexible Neural Tree Based IDS in Mobile Ad- hoc Network</b>	<b>60-64</b>
	<i>Indrajit Das, Piyali Roy, Debanjan Das, Sayan Das, Puja Ghosal</i>	
14	<b>Design and Implementation of Authentication System Using Deep Convoluted Siamese Network</b>	<b>65-69</b>
	<i>Sumagna Dey, Indrajit Das, Soubarna Das, Subhpraprim Nath</i>	
15	<b>DC and Analog/RF Performance Analysis of Gate-Drain Underlapped and Channel Engineered TFET</b>	<b>70-74</b>
	<i>Sudipta Ghosh, Sayan Bose, Wahid Anwar, Madhusree Banerjee, P. Venkateswaran, Subir Kumar Sarkar</i>	
16	<b>Current Sensitivity and Power Dissipation Analysis of Junctionless Double Gate MOSFET Biosensor</b>	<b>75-79</b>
	<i>Bedantika Basu, Debosmita Ghosh, Madhusree Banerjee, Papiya Debnath</i>	
17	<b>DC and Analog/RF Performance Comparison of Renovated GAA JLFET Structures</b>	<b>80-84</b>
	<i>Sudipta Ghosh, Abhiroop Jana, Agni Kumar Agnihotri, Shirsha Kundu, Dyuti Das, Subir Kumar Sarkar</i>	
18	<b>Assessment of Filter Design for 5G Applications</b>	<b>85-88</b>
	<i>Gaurav Bhargava, Shubhankar Majumdar</i>	
19	<b>Partially Depleted Silicon-on-Insulator (PDSOI) MOSFETs for RF Switching Applications</b>	<b>89-92</b>
	<i>T. P. Dash, C. K. Maiti, Devika Jena</i>	
20	<b>RF Analysis of a Fully Gate Covered Junctionless FinFET for Improved Performance</b>	<b>93-97</b>
	<i>Aman Tyagi, Gaurav Mangal, Rishu Chaujar</i>	
21	<b>Economic Analysis for the Players Participating in a Hybrid Solar Virtual Power Plant</b>	<b>98-103</b>
	<i>Epsita Das, Koninika Biswas, Sujit K. Biswas, Ambarnath Banerji, Rajarshi Chakrabarti</i>	
22	<b>Implementation of Linear Quadratic Regulator in an Isolated Microgrid System</b>	<b>104-109</b>
	<i>Prasun Sanki, Mousumi Basu, Partha Sarathi Pal, Debapriya Das</i>	
23	<b>A Survey on Field Effect Transistor Based Hydrogen and Nitrogen Gas Sensors</b>	<b>110-115</b>
	<i>Koushik Ghosh, Arpita Ghosh</i>	
24	<b>An Efficient Approach to Design a Comparator for SAR-ADC</b>	<b>116-122</b>
	<i>Tejender Singh, Suman Lata Tripathi</i>	
25	<b>A Hybrid MILP-GA Algorithm to Optimize Battery Mix System in Active Distribution Networks</b>	<b>123-128</b>
	<i>Subho Paul, Biswarup Ganguly, Upayan Adhikary</i>	
26	<b>Analysis of Constant On-Time Buck Converter with System Verilog Real Number Model Approach</b>	<b>129-133</b>
	<i>Saikat RoyChowdhury, Sudeep Phadikar</i>	
27	<b>Emergency Medical Assistance by Ambulance Drone Using Machine Learning, Lightweight Cryptography and Variable Image Steganography</b>	<b>134-138</b>

	<i>Indrajit Das, Sanjoy Roy, Sumagna Dey, Tulsi Dey, Piyali Roy</i>	
28	<b>Capacitive Memory Using GLAD Synthesized Annealed SnO<sub>2</sub> Nanowire Arrays as a Dielectric</b>	<b>139-142</b>
	<i>Priyanka Chetri, Jay Chandra Dhar</i>	
29	<b>Machine Learning Classifiers for Speech Detection</b>	<b>143-147</b>
	<i>Dasari Lakshmi Prasanna, Suman Lata Tripathi</i>	
30	<b>Selective Run-Length Constrained Encoding Scheme on Extended Nucleic Acid Memory</b>	<b>148-153</b>
	<i>Saptarshi Biswas, Trishita Ghosh, Subhprattim Nath</i>	
31	<b>Design of an Improved Tie-line Power Model for a PEV Based Interconnected Microgrid Under AGC Operation</b>	<b>154-159</b>
	<i>Prasun Sanki, Mousumi Basu, Partha Sarathi Pal, Debapriya Das, Sindhura Gupta</i>	
32	<b>Statistical Analysis of a Low Power Analog Current Source</b>	<b>160-164</b>
	<i>Sneha Upadhyay, Trisha Sau, Susmita Mitra, Arpita Bhowmik, Saheli Sarkhel, Soumya Pandit</i>	
33	<b>A Deep CNN Framework for Distress Detection using Facial Expression</b>	<b>165-169</b>
	<i>Bikramjit Das, Debanjana Ghosh, Ashesh Roy Choudhuri, Ankan Goswami, Avinandan Bhakta, Mahamuda Sultana, Suman Bhattacharya</i>	
34	<b>State of the Art and Future Perspectives in III-V Nanometer-scale MOSFETs</b>	<b>170-175</b>
	<i>Saswati Dey, Kalyan Biswas, Angsuman Sarkar</i>	
35	<b>Effect of Asymmetric Space Charge Region on Current Density of Heterojunction Solar Cell</b>	<b>176-179</b>
	<i>Sayoni Chakraborty, Arpan Deyasi</i>	
36	<b>Electrical Noise Analysis of L-Shaped Gate Tunnel Field Effect Transistor</b>	<b>180-183</b>
	<i>Sweta Chander, Rekha Chaudhary, Sanjeet Kumar Sinha</i>	
37	<b>Multimodal Medical Imaging Using Modern Deep Learning Approaches</b>	<b>184-187</b>
	<i>Rahul Chanumolu, Likhita Alla, Pavankumar Chirala, Naveen Chand Chennampalli, Bhanu Prakash Kolla</i>	
38	<b>Modeling an Energy Efficient Clustering Protocol with Spider Cat Swarm Optimization for WSN</b>	<b>188-193</b>
	<i>T. Saravanan, S. Saravanakumar</i>	
39	<b>Early Alzheimer's Disease Detection using Semi- Supervised GAN Based on Deep Learning</b>	<b>194-198</b>
	<i>S. Saravanakumar, T. Saravanan</i>	
40	<b>Enhanced Prediction of Thyroid Disease Using Machine Learning Method</b>	<b>199-204</b>
	<i>Madhumita Pal, Smita Parija, Ganapati Panda</i>	
41	<b>White Light Photosensitivity and Stable Photoresponse Properties of Tetrapod Shaped CdSe Nanocrystals: Polymer: Fullerene Blend</b>	<b>205-209</b>
	<i>Deep Chandra Upadhyay, Rishibrind Kumar Upadhyay, Abhinav Pratap Singh, Satyabrata Jit</i>	

42	<b>Identifying Differentially Expressed Genes in Different Stages of Lung Cancer – An Application of ARM Model on Gene Expression Data</b>	210-214
	<i>Subir Hazra, Amartya Roy, Rohan Sarkar, Anupam Ghosh</i>	
43	<b>RF/Analog Performance Analysis of Electrostatically Doped Dual Pocket Vertical Tunnel Field Effect Transistor</b>	215-219
	<i>Amit Bhattacharyya, Madhusree Banerjee, Papiya Debnath, Debashis De, Manash Chanda</i>	
44	<b>Application of Soil Sensors for Maximizing Productivity Using IoT Framework</b>	220-224
	<i>Subhprapatim Nath, Anup Dey, Papiya Das, Dyuti Mohapatra, Jamuna Kanta Sing, Subir Kumar Sarkar</i>	
45	<b>Signature Recognition and Detection of Skilled Forgeries Using Image Transformation and Multistream CNN</b>	225-229
	<i>Papiya Das, Swarnabja Bhaumik, Subhprapatim Nath</i>	
46	<b>Method for Enabling RDMA Transport Peer to Peer Transfer with NVMeoF Ethernet SSDs</b>	230-233
	<i>Venkataratnam Nimmagadda, Sandeep Kumar Ananthapalli</i>	
47	<b>Silicide on Oxide Based Carrier Selective Front Contact for 24% Efficient PERC Solar Cell</b>	234-237
	<i>Savita Kashyap, Rahul Pandey, Jaya Madan, Rajnish Sharma</i>	
48	<b>VLSI Routing Optimization Using Hybrid PSO Based on Reinforcement Learning</b>	238-243
	<i>Pradyut Nath, Sumagna Dey, Aditya Shankar, Subhprapatim Nath, Jamuna Kanta Sing, Subir Kumar Sarkar</i>	
49	<b>Study of Electrical Parameters of Strained Si PMOS with High k Dielectric Material Using TCAD</b>	244-247
	<i>Debasish Mohanta, Sruti Suvadarsini Singh</i>	
50	<b>Optical Characteristics of Broadband Raman Amplifier Coupled with Multimode Fiber Designed at 1550 nm in Presence of Doping</b>	248-253
	<i>Rikita Das, Arpan Deyasi</i>	
51	<b>Tweet Classification and Sentiment Analysis of Covid 19 Epidemic by Applying Hybrid Based Techniques</b>	254-260
	<i>Mauparna Nandan, Soma Mitra, Sharmistha Dey</i>	
52	<b>Single Event Transient Effect on Tapered Angle Hetero-junction Dopingless TFET for Radiation-Sensitive Applications</b>	261-264
	<i>Monika Sharma, Rakhi Narang, Manoj Saxena, Mridula Gupta</i>	
53	<b>Dependence of Gate Leakage Current on Efficacy of Gate Field Plate in AlGaIn/GaN HEMT</b>	265-268
	<i>Chanchal, Ajay Kumar Visvkarma, Amit Malik, Robert Laishram, D S Rawal, Manoj Saxena</i>	
54	<b>Design - Development of VEHICLE for Delivery of Goods in Hazardous Areas (VEDHA)</b>	269-274
	<i>Suvargha Ghosh Dastidar, Synthya Haldar, Pratyusha Biswas Deb, Sohini Pal, Ambalika Saha, Ambarnath Banerji, Hiravra Koley, Prithasankar Laskar</i>	
55	<b>Internet of Things (IoT) Based Continuous Growth Rate Monitoring System of Plant Stem</b>	275-279
	<i>Shikha Nayak, Subir Das, Badal Chakraborty, Tanmoy Chakraborty, Kishor Roy</i>	

56	<b>A Novel Computer Vision Model for Recognition and Evaluation of Mathematical Equations using Deep Learning Technique</b> <i>Shaun Oommen Alexander, Chitresh Kansal, Devang Mehrotra, Rohit P, Shashank Mouli Satapathy</i>	280-285
57	<b>ZnO-WO<sub>3</sub> Mixed Metal Thin Film Capacitive Biosensor for Food Quality Measurement</b> <i>Gour Gopal Jana, Jyotirmoy Nandy, Moumita Chakraborty, Subhashis Roy, Bijoy Kantha</i>	286-289
58	<b>Machine Learning-Based Intrusion Detection System for Healthcare Data</b> <i>Amit Kumar Balyan, Sachin Ahuja, Sanjeev Kumar Sharma, Umesh Kumar Lilhore</i>	290-294
59	<b>Comparative Study of Supervised Machine Learning Methods for Prediction of Heart Disease</b> <i>Meghavi Rana, Mohammad Zia Ur Rehman, Srishti Jain</i>	295-299
60	<b>Metamaterial Absorbers for IoT Applications</b> <i>Prince Jain, Shonak Bansal, Piyush Samant</i>	300-303
61	<b>Smart ECG Monitoring and Analysis System Using Machine Learning</b> <i>Sarab Nidhaan Singh, Megha Bhushan</i>	304-309
62	<b>A DFT Study on Sensing Performance of H<sub>2</sub>S and NO<sub>2</sub> Gas Molecules on 2D Pentagonal PdSe<sub>2</sub></b> <i>Prasanna Karki, Bibek Chettri, Bhakta Kunwar, Bikash Sharma</i>	310-313
63	<b>Study of Adsorption Behaviour of Nucleobases on Si and P Doped WSe<sub>2</sub>: DFT Approach</b> <i>Kabita Timsina, Somsher Lepcha, Bibek Chettri, Pronita Chettri, Bikash Sharma</i>	314-317
	<b>Author Index</b>	318-322

# A 0.6 V 1.6 nA Constant Current Reference Circuit with Improved Power Supply Sensitivity

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**Abstract**—This paper presents a low power current reference circuit with improved power supply sensitivity. The proposed circuit is designed in SCL 180 nm CMOS technology and simulated using Cadence Virtuoso. It generates a reference current ( $I_{ref}$ ) of 1.6 nA at 0.6 V supply voltage ( $V_{dd}$ ) at room temperature (27° C) with a total power consumption of 10 nW (0.6 V). A new circuit configuration based on composite transistor operating in weak inversion has been proposed in this work. The proposed circuit is an improvisation on beta-multiplier circuits proposed earlier. The circuit improves the power supply sensitivity of the current source and provides a better performance in terms of process variability.

**Keywords** -- low power, weak-inversion region, composite transistor, power supply sensitivity.

## I. INTRODUCTION

The demand for on chip current and voltage reference circuits are rising day by day. Manufacturers greatly rely upon the on chip current and voltage references to obtain desired characteristic due to its area optimization factor and also because each reference circuit is integrated with the chip and requires only a single voltage source to operate the entire circuit. The on chip current reference circuit the flexibility to adjust the parameters and to obtain a vast variation in output from a single reference circuit. Design of a stable current reference circuit is challenging with new CMOS technology having reduced technology nodes. The reduced scale current design in the order of nano amperes and pico amperes using process node of 180nm and less is a challenging task and also essential as it suffices the biasing need of the on chip IC Designs [1]. The current source must be well adapted to process variation and temperature. Depending upon the application, circuit may require the three major classes of current references which include Proportional to Absolute Temperature (PTAT), Complementary to Absolute Temperature (CTAT) or Bandgap Current Reference (BGR).

PTAT current reference circuit are essentially used in cases where the transconductance varies with temperature due the effect of thermal voltage. This helps to nullify the variation by producing current – temperature characteristic in another direction. Several efforts have been made so as to reduce the temperature coefficient [2] in the biasing circuit. Also current reference circuits are used to bias the voltage reference circuit in the quantizer of Analog to Digital Converter. The PVT (Process – Voltage – Temperature) variation of the circuit must be as low as possible and also predictable.

The main aim of this work is to design a current reference circuit for use in ultra-low power analog integrated circuit design. The power supply sensitivity (% line sensitivity) of the circuit is attempted to be low and also to reduce its process variability. The large value of on chip resistor is reduced by the help of self cascode structure as mentioned in [3]. The proposed current reference is designed to operate at 0.6 V to 1.8 V due to the reason that the operating voltage for 180 nm CMOS process is 1.8 V, thus any circuit with process node of 180 nm requiring current reference can easily be integrated with this current reference and different bias will not be required. The advancement in the design of current and voltage references have been considerable in the past few years with references that responds to low VDD (sub 1-V design) [4] with improved supply sensitivity and other parameters which makes newer designs to consider upon those parameters and in the proposed circuit we have constant reference up to 0.6 V of Supply Voltage.

The Theoretical Formulation is presented in section II and the Circuit description in section III, Analysis Result in section IV followed by conclusion in section V.



Proceedings of  
**4th International Conference**  
on  
**2021 Devices for Integrated Circuit (DevIC)**

19-20 May, 2021, Kalyani, Nadia, India

Organized by

**IEEE KGEC Student Branch Chapter**

In association with

**Department of ECE, Kalyani Government Engineering College**

Technically co-sponsored by

**IEEE EDS Kolkata Chapter**

Edited by

**Dr. Angsuman Sarkar**

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## **2021 Devices for Integrated Circuit (DevIC)**

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Part Number: CFP21K13-ART

ISBN: 978-1-7281-9955-9

# Table of Contents

	Page No.
<b>Message from the General Chair</b>	xiii
<b>Message from the Editors</b>	xiv
<b>1. Hard and Soft Switching Geometries For Operations of the MOSFET Used For the SMPS</b>	
<i>Tapas Halder</i>	1-6
<b>2. Suitability of the Static Converters For the Power Factor Correction (PFC)</b>	
<i>Tapas Halder</i>	7-12
<b>3. Generation of Tunable Low-noise Millimeter-wave Signal using Optical Frequency Comb through Electrical Mixing at 94 GHz</b>	
<i>Rajarshi Dhar, Arpan Deyasi and Angsuman Sarkar</i>	13-18
<b>4. Swastika Shaped Broadband Dielectric Resonator Antenna for S,C,X &amp; Ku Band</b>	
<i>Debjit Dey and Sukla Basu</i>	19-22
<b>5. Study of 2D Electron Mobility in AlGa<sub>N</sub>/Ga<sub>N</sub> Quantum well Structure</b>	
<i>Shwetapadma Panda, Kshirabdhree T. Dora, Ajit K. Panda and Trinath Sahu</i>	23-26
<b>6. Oscillating Electron Mobility in DoubleV-shaped Quantum Well based Field Effect Transistor Structure</b>	
<i>Devika Jena, S. K. Palo, T. Sahu and A. K. Panda</i>	27-30
<b>7. Analytical Investigation of Trenched Multi-layered Gate Silicon on Nothing MOSFET with Graded Work-function</b>	
<i>Sikha Mishra and Soumya S Mohanty</i>	31-35
<b>8. Design and Comparative analysis of a Two-Stage Ultra-Low-Power Subthreshold Operational Amplifier in 180nm, 90nm, and 45nm technology</b>	
<i>Sumukh Nitundil, Nihal Singh, Rushabha Balaji and Pankaj Arora</i>	36-40
<b>9. Impact of Source Side Cavity on Sensitivity of Hetero Channel Double Gate MOSFET Biosensor</b>	
<i>S. S. Mohanty, S. Mishra, M. Mohapatra and G. P. Mishra</i>	41-44
<b>10. Investigation of TF-FinFET Based Biosensor for Early Diagnosis of Protein Carrying Diseases</b>	
<i>Harshal Gudaghe, Mridul Kashyap, and Rishu Chaujar</i>	45-49
<b>11. Computing Electromagnetic Bandgap for Parallel Nanorod Structure with Double Negative Refractive Index inside Triangular Lattice</b>	

# DESIGN OF BAND-PASS FIR FILTER USING MODIFIED SOCIAL GROUP OPTIMIZATION ALGORITHM AND ITS IMPLEMENTATION ON FPGA

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**Abstract**—This paper proposes a method for the design of a type-I band-pass Finite Impulse Response (FIR) filter using Modified Social Group Optimization. To achieve better performance in filter response, few modifications were made in the basic SGO algorithm. When compared with the well-known Parks- McClellan (PM) and improved Sine Cosine algorithm, this modified version shows better results in terms of pass-band ripple and stop-band attenuation. Moreover, this paper discusses the hardware implementation aspect of filters in the FPGA platform.

**Keywords**—FIR filter, Social Group Optimization, stop-band attenuation, pass-band ripple, FPGA

## I. INTRODUCTION

In the domain of signal processing, a signal represents any time-varying electromagnetic wave that carries information. These waves are prone to various sources of noise. Traditionally analog circuits were used to limit these noises but accompanied several disadvantages such as bulkiness, response deterioration with time, etc. The introduction of digital signal processing has overcome some issues of the analog signal. Filtering is one of the few topics of discussion related to digital signal processing. Filters mainly allow only a specific frequency band and drop the rest. Thus, it plays a vital role in noise reduction. Digital filter is of two types – IIR (Infinite Impulse Response) filter and FIR (Finite Impulse Response) filter. IIR filters are also known as recursive filters which depend on the previous inputs as well as outputs in addition to the present input. It is considered to be unstable due to the presence of a few poles outside the unit circle. On the other hand, the output response of the FIR filter depends only on the current and previous inputs and it is stable due to the presence of poles at the origin. FIR filter has exactly linear phase response, easy to implement as it deals with only real arithmetic and provides no distortion, only a fixed amount of delay [1-2]. So, FIR filters prove to be more suitable than IIR filters in various engineering applications.

FIR filter design methods have been explored for quite a long time. It basically involves finding the coefficients of the filter such that the resulting pass-band ripple is minimized and stop-band attenuation is maximized [1-2]. The first design method was based on the Windowing

technique, which utilized a window function to truncate the Fourier series expansion of the desired frequency response. Initially, the rectangular window was used. But in order to reduce the Gibbs phenomenon, windows lacking abrupt discontinuities like Bartlett, Blackman, Hamming, Kaiser, Lanczos were used. Then the frequency sampling method was developed by Gold and Jordan et al. [4-5, 7]. Here the frequency samples in the pass-band region of desired response are fixed in terms of discrete Fourier Transform coefficients. To reduce side-lobes, linear programming (LP) was used which optimized the frequency specification in the transition region. Instead of its effectiveness, LP is relatively slow, and hence designed filter will be of limited length. Both of these methods are simple but lack precise control of the pass-band and stop-band frequencies. Thus, to limit the drawbacks of the above methods an optimal FIR filter using an iterative approach was proposed by Herrmann et al. [6] by assuming the frequency response as equiripple in both the pass-band and stop-band. The catch was that it is not able to specify the location of cut-off frequencies a priori and the length was limited to 40 [7]. Parks and McClellan utilized a Chebyshev approximation-based method. It involved the Remez Exchange algorithm in order to get optimal parameters [2, 7]. Presently due to the advent of numerous optimization algorithms, the problem of FIR filter design can be easily solved by generating a fitness function based on the Chebyshev approximation problem and then optimizing the same by using meta-heuristic techniques.

Metaheuristic algorithms are strategies that are independent of the problem and can be used to solve a wide range of issues to find an approximate solution more quickly when classical methods are slow or fail to find any exact solution. They offer the advantage of local optima avoidance and require gradient-free cost function [24]. As per the ‘No free lunch theorem’, there is no such algorithm to solve all optimization problems. Thus, researchers can either improve/adapt/hybridize or propose new ones for solving different problems [9]. The above techniques operate in two important stages: the exploration stage, where the whole search space is explored in order to narrow down the solution region. Second is the exploitation stage, wherein each run of the algorithm moves towards the best answer. Both play a very vital role and a balance needs to be sequentially maintained to find an optimal solution to a problem [21]. There are mainly four different types of metaheuristic approaches: (a) swarm intelligence-based

2022 IEEE International Conference on Signal Processing, Informatics, Communication and Energy Systems (SPICES) 1078-1665/4040-2022 IEEE DOI: 10.1100/SPICES2022.9774137



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INFORMATICS, COMMUNICATION AND ENERGY SYSTEMS 2022**

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IEEE Catalog Number: CFP22A74-ART  
ISBN: 978-1-6654-4940-3

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Curran Associates, Inc.  
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<b>Paper Index</b>				
<b>Sl No:</b>	<b>Paper ID</b>	<b>Paper Title</b>	<b>Authors</b>	<b>Page No.</b>
1	4	Current Control with Hysteresis Controller and Sliding mode Controller in SRM	Stella Kurian, Nisha G.K.	1-6
2	10	Performance study of Capacitor Clamped Multilevel Inverter fed Induction Motor Drive for Electric Vehicle Application	Praveen O, Nisha G. K	7-11
3	11	BER-SNR Evaluation using Phase Shift Keying with OSTBC in MIMO Environment	Satya Singh, Milind Thomas Themalil	12-16
4	13	Area efficient implementation of short length QC-LDPC codes for Ultra-Reliable Low-Latency Communication (URLLC) application	Lakshmi J L, Jayakumari J	17-21
5	18	Vehicle Accident Detection and Prevention using IoT and Deep Learning	Lakshmy S, Renjith Gopan, Meenakshi M L, Adithya V, Mariya R Elizabeth	22-27
6	23	Modelling and Performance Estimation of All Inorganic Double Perovskite Solar Cells	Deepthi Jayan K.	28-32
7	30	Design of a Dual Processor Based Single Board GNSS Receiver Embedded Navigation Computer for Low Cost Launch Vehicles	Vinoj V S, Aneesh K Thampi, Biju VS, Anand Shankar OT, C Radhakrishna Pillai	33-37
8	33	Design considerations for selecting GNSS antenna mounting location in launch vehicles	Anand Shankar O T, Aneesh K Thampi, Biju V S, Vinoj VS, Radhakrishna Pillai C	38-42
9	35	Design Methodology of Solid State C-Band Transponder for Radar Calibration	Indu Gopan, Muhammed Suhail S, Sherly Joy, Mukundan KK	43-48
10	38	WaterHCI Part 1: Open Water Monitoring with Realtime Augmented Reality	Steve Mann, Faraz Sadrzadeh-Afsharazar, Samir Khaki, Zhao Lu, Christina Mann and Jaden Bhimani	49-54
11	40	Aquila Optimizer based Deep Neural Network for Automatic Diabetic Retinopathy detection and classification	V. Desika Vinayaki, R. Kalaiselvi	55-60

12	46	A set of novel stress tests for high dynamic NavIC/GPS receiver software with RF signal input, observations and mitigation strategies	Biju V S, Anand Shankar O T, Aneesh K Thampi, Vinoj VS, Radhakrishna Pillai C	61-65
13	47	Development of a New Portable Test Station for Remote testing of Inertial Navigation Systems for Launch Vehicles	Anwar K Backer, Deepa Sara John, Aneesh K Thampi, Renjis Mathew	66-71
14	48	A Heuristic Approximation Algorithm to Design Power and Area Efficient FIR Filters in the Canonic Signed Digit Space	Sreegul G, Hareesh V, Bindiya T. S	72-76
15	49	SPV Panel Hotspot Thermal Profile Modeling and Characterization with Active Cooling Employing CAD Simulation	Polaka Divya Reddy, Pranavi Kakani, Ketan Ramaneti, Surya Prakash	77-80
16	50	Supervised Fan Beam Computed Tomography Image Synthesis using 3D CycleGAN	Jiffy Joseph, Pournami P. N., Jayaraj P. B.	81-86
17	52	Open-Circuit Switch Fault-Tolerant Half-Bridge LLC Resonant Converters for Satellite Applications	Abraham Mathews, Jagadanand G	87-91
18	53	Graph Based Document Model and its Application in Keyphrase Extraction	Sincy V. Thambi, P. C. ReghuRaj	92-98
19	54	Design of Computationally Efficient IFIR based Filter Structure for Digital Channelizer*	Rinu C Varghese, Amir A	99-104
20	56	Design and Performance Analysis of Various 32-bit Hybrid Adders using Verilog	Renjith R, Ancy Joy, Benson Biju, Vaishnavi Ganeshan, Sivasankar R	105-112
21	57	Comparison of Different Machine Learning Algorithms for Cardiac Auscultation	Indu T, Ashin Prakash, S Rishikesh Chandran, Nevin Babu, Soorya R	113-117
22	59	Cross Spectral Image Registration for Fever Detection	Joseph Mathew, Sudhish N. George	118-122
23	61	Performance Evaluation of DFT Based Channel Estimation for Spatial Modulated FBMC-COQAM systems on Multipath Fading Channels	Anetha Mary Soman, R. Nakkeeran, Shinu Mathew John	123-128

24	64	Comparison of GSEIM with Simulink with respect to simulation speed	Akhil Nandan, Mahesh B. Patil	129-134
25	65	Design of Band-Pass FIR Filter Using Modified Social Group Optimization Algorithm and Its Implementation On FPGA	Arijit Nag, Supriya Dhabal, Tania Paul Das, Palaniandavar Venkateswaran	135-140
26	66	Design of Quadrature Mirror Filter using Grasshopper Optimization Algorithm	Aritra Ghosh, Supriya Dhabal, Palaniandavar Venkateswaran	141-145
27	67	A Survey on Various Combination of Breast Cancer Biomarkers	Ms. Sheethal Aji Mani, T. K. Thivakaran	146-151
28	70	Performance Analysis of Path Tracking Controllers for Robotaxi Manoeuvres	Anurag R, V R Jisha	152-157
29	71	Passive Control of Annealing in Polymerase Chain Reaction Using Phase Changing Materials	B. Indulakshmi, Nikhil Prasad, Ranjith S. Kumar	158-161
30	73	Regenerative Braking of Switched Reluctance Motor for Electric Vehicle Application	Aaliya Farzana P. A, Bindu V. R.	162-167
31	74	Steering Angle Estimation for an Autonomous Car	Shalu George K, Abhiram A, Amal Jose, Ajay Soorya Madhav, Najiya N, S Aswin	168-173
32	81	A study of Change Impact Analysis Techniques based on Requirement Defects during the Software Development Process	Anjali C, Julia Punitha Malar Dhas, J. Amar Pratap Singh	174-179
33	82	Torque Ripple Reduction and Speed Control of PMSM Using Fuzzy Logic for Propulsion Application	Lekshmi P. Nair, Nisha G.K.	180-186
34	83	A Survey of Metadata Retrieval through Sentiment Analysis	M. Thanga Subha Devi, R. Suji Pramila	187-191
35	89	SnO <sub>2</sub> Thin Film Coated Fiber Optic VC Sensor based on Intensity Modulation Technique	A. Prasanth, Athira C, Kanzul T A, M. Velumani, S. Narasimman, Z. C. Alex	192-194
36	92	Implementation of Testing Accreditation Analytical Framework for Higher Education System	Sushitha S, Niveditha B	195-200
37	98	Design of an Optimized Controller for Docking System for Space Application	Navya S Warriar, Ann Elizabeth Babu, Shyju Susan Mathew, Aswin R B	201-206

38	103	Design and Development of a Simulation Environment for IoT Devices	Srivatsan V, Vinod Pathari	207-211
39	108	Design and Numerical Analysis of a Compact Microstrip Antenna Sensor for Wireless Body Area Networks	Sreelekshmi.S, S.Perumal Sankar	212-216
40	109	Voltage Profile Improvement of a Multi Microgrid Interconnection Scheme using Synchronverters	Charivil Sojy Rajan, Mabel Ebenezer	217-222
41	110	A blockchain-based platform for smart contracts and intellectual property protection for the additive manufacturing industry	Abhiram Haridas, Adil Abdul Samad, Vysakh D, Deepak Lawrence K, Vinod Pathari	223-230
42	113	Social media monitoring using ELK Stack	Perumal Sankar, Deepa Elizabeth George, Aparna Sankar N S	231-235
43	118	Measurement of chaos and quantum decoherence in H&E stained images of oral epithelium for early detection Oral Submucous Fibrosis	Aparajita Karmakar, Reetoja Nag, Mousumi Pal, Ranjan Rashmi Paul, Jyotirmoy Chatterjee, Raunak Kumar Das	236-242
44	125	Parametric Analysis on Charge Scheduling and Pricing of Electric Vehicles	Lakshmi M Nair, Mary Synthia Regis Prabha D M	243-248
45	126	An Efficient Analysis of E-Commerce Site using Big Data Assisted Modified Learning Strategy based on Novel Customer Recommendations	HO CHI MINH PERUMAL, BALA SUBRAMANIAN CHOKKALINGAM	249-256
46	127	Performance Assessment of a Hybrid Islanding Detection Scheme for PV Based Distributed Generators Combining Total Harmonic Distortion and Bidirectional Reactive Power Injection	Praveen Raj R S, Sreejaya	257-262
47	129	A cellular IoT based sensor system for atmospheric studies using UAVs	Rajesh K, Laxma Reddy Ch, Varaprasad G, Muralikrishnan S	263-267
48	130	IPMSM Drive with Interleaved Bidirectional Converter for Electric Vehicle Application	Chandni Asok, Deepa M. U.	268-273
49	132	Analysis of Mental Task Ability in Students based on Electroencephalography Signals	T. Ananda Babu, Sridevi Gadde, S. Ravi, K. V. Venkateswara Rao, Y. Mamillu, D. Krishna	274-278

50	134	Smart Bridges Based on Bridge Information Modelling	Saju S	279-284
51	136	A Comparative Analysis of Localization Techniques in Wireless Sensor Network	Akshay A, Arlene Davidson	285-289
52	137	Investigation of Choice of State Space for Reinforcement Learning Based Battery Scheduling in Microgrid	Imthias Ahamed T P, Rahul Roy, Sajin Siyad, Sarin Santhosh, Vaishak Rajeev	290-295
53	139	LSTM based Synthesis of 12-lead ECG Signal from a Reduced Lead Set	Ato Kapfo, Sumit Datta, Samarendra Dandapat, Prabin Kumar Bora	296-301
54	140	Decentralized Crowdfunding Platform using Smart Contracts	Sujaritha M, Arun Bharath S, Inderajith K, Shunmugapriya S, Hariharan S	302-307
55	141	An efficient approach for spammer detection on Twitter and their behavior analysis	Anaswara K, Saleema A, Indu V	308-313
56	142	Star identification in night sky images using mobile phone camera	Harsh Gupta, Dhruv Balkrishna Salvadi, Anu Shaju Areeckal, Sujay Udupa	314-319
57	144	Modelling of Power Flow Dynamics for Congestion Control	Chakravarthi Kotakonda, Pratyasa Bhui	320-325
58	147	A Comparative Study of State-of-the-art Image Splicing Localization Methods Using Fully Convolutional Networks	Vidya K.R., Shajimon K. John, M Wilscy, Remya Revi K., Rahul Antony	326-332
59	150	Emotion Classification using Physiological Signals: A Recent Survey	Amita Dessai, Hassanali Virani	333-338
60	167	High Power Microwave Rectifier for Lower Variation to Input Power and Phase	Vivek Kumar, Amit Kumar Baghel, Shashank S. Kulkarni, Niraja Pravin Sanghai, Sisir Kumar Nayak	339-342
61	168	New Mixed Model Order Reduction Approach for Linear System	Kishan Mushar, Yogesh V. Hote, G. N. Pillai	343-348
62	169	Fractional Order Modelling and Controller Design for Non-ideal DC-DC Buck Converter	Deeksha Mittal, Yogesh V. Hote	349-354
63	173	Exhibiting the Effect of Time Delays on Load Frequency Control of Multi Area Interconnected Hybrid Power System	P V N S Harideep, P V S Gowtham, P. Sri Harsha, P. Mahesh Babu, V. Pavan Sai Reddy, CH.Naga Sai Kalyan	355-360

64	181	Shallow SegNet with bilinear interpolation and weighted cross-entropy loss for Semantic segmentation of brain tissue	Pranav Goyal	361-365
65	183	Cost Analysis of a Smart Home Energy Management System-A Case Study	Reshmi K M, Divya N A	366-371
66	188	Revocable and Scalable Access to Personal Health Records in a Cloud Computing Environment	F. Sammy, S. Maria Celestin Vigila	371-377
67	190	WaterHCI Part 2: Open water sensing, meta-sensing, and observing with drones and augmented reality	Steve Mann, Zhao Lu, Faraz Sadrzadeh-Afsharazar, Christina Mann, Samir Khaki, Jaden Bhimani	378-383
68	192	A holistic approach towards detection, tracking, and recognition of face	Kuldeep Singh Yadav, Naseem Ahmad, Anish Monsley K, Saharul Alom Barlaskar, Naragoni Saidulu, Rabul Hussain Laskar	384-388
69	194	Automated Alert Generation Ensuring Women Safety Using Heartbeat Detection	Anindya Kumar Patro, Anusha Jhampri, S. Metilda Florence	389-394
70	201	Review of Battery Charging Methods for Electric Vehicle	Sandhya.P, Nisha.G.K	395-400
71	203	Alzheimer's Disease Classification from Cross-sectional Brain MRI using Deep Learning	Sreelakshmi S, Malu G , Elizabeth Sherly	401-405
72	207	Fraud Detection and Analysis for Insurance Claim using Machine Learning	Abhijeet Urunkar, Amruta Khot, Rashmi Bhat, Nandinee Mudegol	406-411
73	208	Sensor-less Vector Control of Surface PM Synchronous Motor Using Reduced -Order Cubature Kalman Filter Based Estimator	Arabindo Chandra, Soumyajit Datta, Aritro Dey, Sumana Chowdhuri	412-417
74	211	FEM analysis and experiments of a Double-sided Axial Flux Switched Reluctance Motor for two alternative phase winding terminal connections	Sabarni Pal, Mainak Sengupta	418-424
75	218	An Overview on Handling Anti Forensic Issues in Android Devices Using Forensic Automator Tool	H. Hemanth Bharath Bhushan, S Metilda Florance	425-430
76	219	On some issues in Kalman filter based trilateration algorithms for indoor localization problem	Hena Kausar, Suwendu Chattaraj	431-435

77	223	Gain Scheduled LQR Control of a Two Wheeled Mobile Robot with Heavy Payloads	Anu Gopinath, V. R. Jisha	436-441
78	224	Decentralized Control of a Slow Moving Mobile Manipulator	Shyju Susan Mathew, V.R. Jisha	442-447
79	225	Patch-based All Convolutional Neural Network Model for Classification of Benign and Malignant Mammograms	Gurpreet Kaur, Annie Julie Joseph, Pournami P N	448-455
80	227	A solution to power balancing in high renewable penetration power system: Use of Abandoned Generating Units	Athul Jose P, Arun V Jose, Deepak M, Sunitha R	456-462
81	229	Achieving Market Segmentation from B2B Insurance Client Data Using RFM & K-Means Algorithm	Srijith J Kumar, Abin Oommen Philip	463-469
82	231	Radial force reduction of Switched Reluctance Motor for EV application	Rani S, Jayapragash R	470-475
83	235	A Single-Phase Hybrid Seventeen Level Multilevel Inverter Topology	Sahana B K, Rupesh K C	476-480
84	239	Maximizing Strategy in Customer Segmentation Using Different Clustering Techniques	Pavithra M, Ayushman Prashar, Abirami	481-485
85	240	Performance Comparison of Classifiers of MR Brain Tumor Images on Various Datasets	Divya Mohan, V. Ulagamuthalvi, Nisha Joseph	486-490
86	242	A Disturbance Observer Based Control for Quadrotor Aircraft Subject to Wind Gusts	Sini S, T Ananthan	491-496
87	243	Design, Fabrication, Analysis and Testing of a Planar Inductor on a High Frequency Buck Converter using SiC Device	Arnab Dey, Kousik Ghosh, Abhishek Kar, Mainak Sengupta	497-502
88	245	Virtual Smart Canteen System	Tanay Bagayatkar, Shivam Pawar, Vishal Salvi, Kiran Gawande	503-508
89	247	A Secured Key Management Scheme for Mobile Ad Hoc Networks with Modified Montgomery Modular Arithmetic	Janani.V. S, M S K Manikandan	509-512

90	248	Space syntax analysis of Total connectivity through the evolution of Bag Bazar Street, Kolkata (1746-2020)	Shilpi Chakraborty, Shiva Ji	513-518
91	249	Techno-Economic Feasibility Analysis of LVDC System to Retrofit an Existing AC System: Case Study	R. P. Nishitha, Akhil Sabu, Lijo Joseph O, Rani Chacko, Jaimol Thomas, Victor Jose	519-524
92	251	Detailed FEM-based Analysis of Vibration in a 3-phase Switched Reluctance Motor and its Experimental Validation	Samrat Das, Devraj Roy, Mainak Sengupta	525-530
93	252	Investigations on Performance Parameters of Hybrid Perovskite Solar Cells	Kiran Susan Pavu, Sreelekshmi P. S, Jobymol Jacob	531-535
94	253	Analyzing Tone of the Annual Report - An Indian Context	Prakash K. Aithal, Dinesh Acharya U., Geetha M.	536-542
95	257	Gate Matching Algorithm for Early False Path Detection in Statistical Static Timing Analysis	Sachin K Bhat Agni, R. Jayagowri	543-548
96	259	Hot Carrier Effect on Base Resistance of SiGe Heterojunction Bipolar Transistors	Ann Mary Alex, Jobymol Jacob	549-552
97	261	Performance Analysis of Code Hopping Multiple Access using Orthogonal Complementary Codes under Rician Fading Channels	D. Judson, K. A. Aswathy	553-558
98	262	Transfer learning for Speech Based Emotion Recognition	Meenu S Nair, Deepa P Gopinath	559-564
99	263	A Novel State Space Model of an Interleaved Boost Converter operating over a wide range of duty ratio	Frieda Mohan, Nikhil Sasidharan	565-570
100	268	Parameter Independent Backstepping Controller for Bidirectional Buck-Boost Converter in DC Grid Battery Interface with CPL	Renuka V. S, Nikhil Sasidharan, Abraham T. Mathew	571-576
101	269	A Real-Time IoT and Cloud System for Carbon Dioxide Monitoring in Dhaka City's Buildings with Rooftop Garden and without Rooftop Garden	Md. Hasan Imam Bijoy, Aysha Siddika, Md. Mahbubur Rahman, Md Rabin Mia, Fizar Ahmed, Fahad Faisal	577-583

102	276	Effective Software Effort Estimation using Heterogeneous Stacked Ensemble	Somya Goyal	584-588
103	278	Dual Stepped Line Impedance Antenna for 8 GHz Communication	Ankita Bagri, Mukesh Yadav	589-594
104	279	Residual Network based Single Object Tracking	Shiv Kumar, Sandeep Kumar Singh	595-600

# Design of Quadrature Mirror Filter using Grasshopper Optimization Algorithm

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**Abstract**— Nature-inspired algorithms have been recently identified as efficient methods of solving complex computational problems. The application of these algorithms is being extended also towards solving the problems of signal processing in the digital diaspora. The Grasshopper Optimization Algorithm (GOA) is a new development of a nature-inspired algorithm with meta-heuristic features. Quadrature Mirror Filters are very important and useful for multi-rate signal processing. This paper renders an alternate method of designing a quadrature mirror filter bank using the GOA. The performance of this design algorithm is demonstrated and simulation results are compared with existing methods.

**Keywords**—Optimization, digital filter, multi-rate signal processing, QMF, Grasshopper Optimization Algorithm.

## I. INTRODUCTION

Quadrature Mirror Filter (QMF) [1-6] banks are very useful components of a multi-rate digital signal processing system [7]. Since its inception in 1977, numerous design proposals have been introduced. Multi-rate filters have a widespread application in the areas of sub-band coding, processing of audio signals, processing of images, synthesis of communication networks, and synthesis of power networks. A multi-rate system is perfectly exemplified by the QMF filter. Sub-band coding is a signal analysis technique in which the signal is divided into multiple frequency bands and digital encoders are used for each band. The two-channel filter bank was the first to be utilized for speech signal sub-band coding. Thus, QMF bank is a two-channel filter bank that lies at the heart of every multi-rate system.

Optimization is the method of obtaining the suitable values for the parameters of a specific problem to either maximize or minimize the value of an objective function. Optimization problem solving requires several steps. Based on the type of variable utilized in the problem, optimization problems may be divided into many types. Discrete optimization problems deal with variables of discrete nature and continuous optimization problems deal with variables of continuous nature. The problems can be classified also based on the nature of constraints applied to the problem. According to the variables, constraints, and other parameters used in the problem, a suitable optimization method should be selected. Broadly, optimization problems can be solved in two different ways, the traditional gradient-based approach [8] and the modern nature-inspired approach [9]. The function that represents the gradient of the objective cost function is used in gradient-based methods. Due to the widespread use of multi-

rate systems, several optimization approaches have been adopted for the design of the QMF bank. In recent years, methods from nature are constantly being put to use in the optimization and design of QMF banks. These nature-inspired methods are of stochastic nature and have meta-heuristic properties. For this reason, these algorithms are very efficient in obtaining solutions to linear and non-linear problems globally. Ant Colony Optimization, Artificial Bee Colony optimization, Dragonfly Algorithm, Salp Swarm Optimization, Cuckoo Search Algorithm, Whale Optimization Algorithm, and more current nature-inspired algorithms are accessible in the literature [10-23]. For example, in Ant Colony Optimization the ant is considered as an agent and it finds the optimal solution in the vicinity of food sources. Recently, the Grasshopper Optimization Algorithm (GOA) has been proposed by Saremi et al. [24]. GOA strikes a delicate balance between exploration and exploitation, resulting in excellent convergence in the search for the best solution.

The rest of the paper's content is arranged as follows: the analysis of a two-channel filter bank is shown in Section II. The design problem is formulated in Section III. The Grasshopper Optimization Algorithm is discussed in Section IV. Section V shows the simulation findings and Section VI concludes this paper.

## II. TWO-CHANNEL FILTER BANK ANALYSIS

The most elementary form of the multi-rate filter bank is given by a two-channel filter bank. It subdivides the incoming input signal into two different sub-bands by utilizing the analysis system it possesses. Further, the processing of these two sub-divided signals is performed by establishing the necessary operation and these two different signals are recombined using the synthesis system. In ideal conditions, the signal reconstructed should be a perfect replica of the incoming input signal having some delay introduced. In reality, while reconstructing the signal faces primarily three types of distortion problem and exact reconstruction becomes impossible. The types of distortions that primarily occur are of three types: (a) amplitude distortion, (b) phase distortion, and (c) aliasing distortion.

In the real world, a reasonable near-perfect reconstruction is a preferred approach. By selecting the appropriate synthesis filters in line with the analysis filter, aliasing distortion may be entirely avoided. Incorporating linear phase filters with limited impulse responses can also help to eliminate phase distortion. Thus, the system becomes exempted from aliasing

2022 IEEE International Conference on Signal Processing, Information, Communication and Energy Systems (SPICES) 1078-1665/4040-2022 IEEE DOI: 10.1100/SPICES2022.9774137



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# IEEE SPICES 2022

IEEE International Conference on  
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10 - 12 March 2022 | Thiruvananthapuram, Kerala, INDIA

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**IEEE INTERNATIONAL CONFERENCE ON SIGNAL PROCESSING,  
INFORMATICS, COMMUNICATION AND ENERGY SYSTEMS 2022**

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IEEE Catalog Number: CFP22A74-ART  
ISBN: 978-1-6654-4940-3

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Red Hook, NY 12571 USA  
+1 845 758 0400  
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<b>Paper Index</b>				
<b>Sl No:</b>	<b>Paper ID</b>	<b>Paper Title</b>	<b>Authors</b>	<b>Page No.</b>
1	4	Current Control with Hysteresis Controller and Sliding mode Controller in SRM	Stella Kurian, Nisha G.K.	1-6
2	10	Performance study of Capacitor Clamped Multilevel Inverter fed Induction Motor Drive for Electric Vehicle Application	Praveen O, Nisha G. K	7-11
3	11	BER-SNR Evaluation using Phase Shift Keying with OSTBC in MIMO Environment	Satya Singh, Milind Thomas Themalil	12-16
4	13	Area efficient implementation of short length QC-LDPC codes for Ultra-Reliable Low-Latency Communication (URLLC) application	Lakshmi J L, Jayakumari J	17-21
5	18	Vehicle Accident Detection and Prevention using IoT and Deep Learning	Lakshmy S, Renjith Gopan, Meenakshi M L, Adithya V, Mariya R Elizabeth	22-27
6	23	Modelling and Performance Estimation of All Inorganic Double Perovskite Solar Cells	Deepthi Jayan K.	28-32
7	30	Design of a Dual Processor Based Single Board GNSS Receiver Embedded Navigation Computer for Low Cost Launch Vehicles	Vinoj V S, Aneesh K Thampi, Biju VS, Anand Shankar OT, C Radhakrishna Pillai	33-37
8	33	Design considerations for selecting GNSS antenna mounting location in launch vehicles	Anand Shankar O T, Aneesh K Thampi, Biju V S, Vinoj VS, Radhakrishna Pillai C	38-42
9	35	Design Methodology of Solid State C-Band Transponder for Radar Calibration	Indu Gopan, Muhammed Suhail S, Sherly Joy, Mukundan KK	43-48
10	38	WaterHCI Part 1: Open Water Monitoring with Realtime Augmented Reality	Steve Mann, Faraz Sadrzadeh-Afsharazar, Samir Khaki, Zhao Lu, Christina Mann and Jaden Bhimani	49-54
11	40	Aquila Optimizer based Deep Neural Network for Automatic Diabetic Retinopathy detection and classification	V. Desika Vinayaki, R. Kalaiselvi	55-60

12	46	A set of novel stress tests for high dynamic NavIC/GPS receiver software with RF signal input, observations and mitigation strategies	Biju V S, Anand Shankar O T, Aneesh K Thampi, Vinoj VS, Radhakrishna Pillai C	61-65
13	47	Development of a New Portable Test Station for Remote testing of Inertial Navigation Systems for Launch Vehicles	Anwar K Backer, Deepa Sara John, Aneesh K Thampi, Renjis Mathew	66-71
14	48	A Heuristic Approximation Algorithm to Design Power and Area Efficient FIR Filters in the Canonic Signed Digit Space	Sreegul G, Hareesh V, Bindiya T. S	72-76
15	49	SPV Panel Hotspot Thermal Profile Modeling and Characterization with Active Cooling Employing CAD Simulation	Polaka Divya Reddy, Pranavi Kakani, Ketan Ramaneti, Surya Prakash	77-80
16	50	Supervised Fan Beam Computed Tomography Image Synthesis using 3D CycleGAN	Jiffy Joseph, Pournami P. N., Jayaraj P. B.	81-86
17	52	Open-Circuit Switch Fault-Tolerant Half-Bridge LLC Resonant Converters for Satellite Applications	Abraham Mathews, Jagadanand G	87-91
18	53	Graph Based Document Model and its Application in Keyphrase Extraction	Sincy V. Thambi, P. C. ReghuRaj	92-98
19	54	Design of Computationally Efficient IFIR based Filter Structure for Digital Channelizer*	Rinu C Varghese, Amir A	99-104
20	56	Design and Performance Analysis of Various 32-bit Hybrid Adders using Verilog	Renjith R, Ancy Joy, Benson Biju, Vaishnavi Ganeshan, Sivasankar R	105-112
21	57	Comparison of Different Machine Learning Algorithms for Cardiac Auscultation	Indu T, Ashin Prakash, S Rishikesh Chandran, Nevin Babu, Soorya R	113-117
22	59	Cross Spectral Image Registration for Fever Detection	Joseph Mathew, Sudhish N. George	118-122
23	61	Performance Evaluation of DFT Based Channel Estimation for Spatial Modulated FBMC-COQAM systems on Multipath Fading Channels	Anetha Mary Soman, R. Nakkeeran, Shinu Mathew John	123-128

24	64	Comparison of GSEIM with Simulink with respect to simulation speed	Akhil Nandan, Mahesh B. Patil	129-134
25	65	Design of Band-Pass FIR Filter Using Modified Social Group Optimization Algorithm and Its Implementation On FPGA	Arijit Nag, Supriya Dhabal, Tania Paul Das, Palaniandavar Venkateswaran	135-140
26	66	Design of Quadrature Mirror Filter using Grasshopper Optimization Algorithm	Aritra Ghosh, Supriya Dhabal, Palaniandavar Venkateswaran	141-145
27	67	A Survey on Various Combination of Breast Cancer Biomarkers	Ms. Sheethal Aji Mani, T. K. Thivakaran	146-151
28	70	Performance Analysis of Path Tracking Controllers for Robotaxi Manoeuvres	Anurag R, V R Jisha	152-157
29	71	Passive Control of Annealing in Polymerase Chain Reaction Using Phase Changing Materials	B. Indulakshmi, Nikhil Prasad, Ranjith S. Kumar	158-161
30	73	Regenerative Braking of Switched Reluctance Motor for Electric Vehicle Application	Aaliya Farzana P. A, Bindu V. R.	162-167
31	74	Steering Angle Estimation for an Autonomous Car	Shalu George K, Abhiram A, Amal Jose, Ajay Soorya Madhav, Najiya N, S Aswin	168-173
32	81	A study of Change Impact Analysis Techniques based on Requirement Defects during the Software Development Process	Anjali C, Julia Punitha Malar Dhas, J. Amar Pratap Singh	174-179
33	82	Torque Ripple Reduction and Speed Control of PMSM Using Fuzzy Logic for Propulsion Application	Lekshmi P. Nair, Nisha G.K.	180-186
34	83	A Survey of Metadata Retrieval through Sentiment Analysis	M. Thanga Subha Devi, R. Suji Pramila	187-191
35	89	SnO <sub>2</sub> Thin Film Coated Fiber Optic VC Sensor based on Intensity Modulation Technique	A. Prasanth, Athira C, Kanzul T A, M. Velumani, S. Narasimman, Z. C. Alex	192-194
36	92	Implementation of Testing Accreditation Analytical Framework for Higher Education System	Sushitha S, Niveditha B	195-200
37	98	Design of an Optimized Controller for Docking System for Space Application	Navya S Warriar, Ann Elizabeth Babu, Shyju Susan Mathew, Aswin R B	201-206

38	103	Design and Development of a Simulation Environment for IoT Devices	Srivatsan V, Vinod Pathari	207-211
39	108	Design and Numerical Analysis of a Compact Microstrip Antenna Sensor for Wireless Body Area Networks	Sreelekshmi.S, S.Perumal Sankar	212-216
40	109	Voltage Profile Improvement of a Multi Microgrid Interconnection Scheme using Synchronverters	Charivil Sojy Rajan, Mabel Ebenezer	217-222
41	110	A blockchain-based platform for smart contracts and intellectual property protection for the additive manufacturing industry	Abhiram Haridas, Adil Abdul Samad, Vysakh D, Deepak Lawrence K, Vinod Pathari	223-230
42	113	Social media monitoring using ELK Stack	Perumal Sankar, Deepa Elizabeth George, Aparna Sankar N S	231-235
43	118	Measurement of chaos and quantum decoherence in H&E stained images of oral epithelium for early detection Oral Submucous Fibrosis	Aparajita Karmakar, Reetoja Nag, Mousumi Pal, Ranjan Rashmi Paul, Jyotirmoy Chatterjee, Raunak Kumar Das	236-242
44	125	Parametric Analysis on Charge Scheduling and Pricing of Electric Vehicles	Lakshmi M Nair, Mary Synthia Regis Prabha D M	243-248
45	126	An Efficient Analysis of E-Commerce Site using Big Data Assisted Modified Learning Strategy based on Novel Customer Recommendations	HO CHI MINH PERUMAL, BALA SUBRAMANIAN CHOKKALINGAM	249-256
46	127	Performance Assessment of a Hybrid Islanding Detection Scheme for PV Based Distributed Generators Combining Total Harmonic Distortion and Bidirectional Reactive Power Injection	Praveen Raj R S, Sreejaya	257-262
47	129	A cellular IoT based sensor system for atmospheric studies using UAVs	Rajesh K, Laxma Reddy Ch, Varaprasad G, Muralikrishnan S	263-267
48	130	IPMSM Drive with Interleaved Bidirectional Converter for Electric Vehicle Application	Chandni Asok, Deepa M. U.	268-273
49	132	Analysis of Mental Task Ability in Students based on Electroencephalography Signals	T. Ananda Babu, Sridevi Gadde, S. Ravi, K. V. Venkateswara Rao, Y. Mamillu, D. Krishna	274-278

50	134	Smart Bridges Based on Bridge Information Modelling	Saju S	279-284
51	136	A Comparative Analysis of Localization Techniques in Wireless Sensor Network	Akshay A, Arlene Davidson	285-289
52	137	Investigation of Choice of State Space for Reinforcement Learning Based Battery Scheduling in Microgrid	Imthias Ahamed T P, Rahul Roy, Sajin Siyad, Sarin Santhosh, Vaishak Rajeev	290-295
53	139	LSTM based Synthesis of 12-lead ECG Signal from a Reduced Lead Set	Ato Kapfo, Sumit Datta, Samarendra Dandapat, Prabin Kumar Bora	296-301
54	140	Decentralized Crowdfunding Platform using Smart Contracts	Sujaritha M, Arun Bharath S, Inderajith K, Shunmugapriya S, Hariharan S	302-307
55	141	An efficient approach for spammer detection on Twitter and their behavior analysis	Anaswara K, Saleema A, Indu V	308-313
56	142	Star identification in night sky images using mobile phone camera	Harsh Gupta, Dhruv Balkrishna Salvadi, Anu Shaju Areeckal, Sujay Udupa	314-319
57	144	Modelling of Power Flow Dynamics for Congestion Control	Chakravarthi Kotakonda, Pratyasa Bhui	320-325
58	147	A Comparative Study of State-of-the-art Image Splicing Localization Methods Using Fully Convolutional Networks	Vidya K.R., Shajimon K. John, M Wilscy, Remya Revi K., Rahul Antony	326-332
59	150	Emotion Classification using Physiological Signals: A Recent Survey	Amita Dessai, Hassanali Virani	333-338
60	167	High Power Microwave Rectifier for Lower Variation to Input Power and Phase	Vivek Kumar, Amit Kumar Baghel, Shashank S. Kulkarni, Niraja Pravin Sanghai, Sisir Kumar Nayak	339-342
61	168	New Mixed Model Order Reduction Approach for Linear System	Kishan Mushar, Yogesh V. Hote, G. N. Pillai	343-348
62	169	Fractional Order Modelling and Controller Design for Non-ideal DC-DC Buck Converter	Deeksha Mittal, Yogesh V. Hote	349-354
63	173	Exhibiting the Effect of Time Delays on Load Frequency Control of Multi Area Interconnected Hybrid Power System	P V N S Harideep, P V S Gowtham, P. Sri Harsha, P. Mahesh Babu, V. Pavan Sai Reddy, CH.Naga Sai Kalyan	355-360

64	181	Shallow SegNet with bilinear interpolation and weighted cross-entropy loss for Semantic segmentation of brain tissue	Pranav Goyal	361-365
65	183	Cost Analysis of a Smart Home Energy Management System-A Case Study	Reshmi K M, Divya N A	366-371
66	188	Revocable and Scalable Access to Personal Health Records in a Cloud Computing Environment	F. Sammy, S. Maria Celestin Vigila	371-377
67	190	WaterHCI Part 2: Open water sensing, meta-sensing, and observing with drones and augmented reality	Steve Mann, Zhao Lu, Faraz Sadrzadeh-Afsharazar, Christina Mann, Samir Khaki, Jaden Bhimani	378-383
68	192	A holistic approach towards detection, tracking, and recognition of face	Kuldeep Singh Yadav, Naseem Ahmad, Anish Monsley K, Saharul Alom Barlaskar, Naragoni Saidulu, Rabul Hussain Laskar	384-388
69	194	Automated Alert Generation Ensuring Women Safety Using Heartbeat Detection	Anindya Kumar Patro, Anusha Jhampri, S. Metilda Florence	389-394
70	201	Review of Battery Charging Methods for Electric Vehicle	Sandhya.P, Nisha.G.K	395-400
71	203	Alzheimer's Disease Classification from Cross-sectional Brain MRI using Deep Learning	Sreelakshmi S, Malu G , Elizabeth Sherly	401-405
72	207	Fraud Detection and Analysis for Insurance Claim using Machine Learning	Abhijeet Urunkar, Amruta Khot, Rashmi Bhat, Nandinee Mudegol	406-411
73	208	Sensor-less Vector Control of Surface PM Synchronous Motor Using Reduced -Order Cubature Kalman Filter Based Estimator	Arabindo Chandra, Soumyajit Datta, Aritro Dey, Sumana Chowdhuri	412-417
74	211	FEM analysis and experiments of a Double-sided Axial Flux Switched Reluctance Motor for two alternative phase winding terminal connections	Sabarni Pal, Mainak Sengupta	418-424
75	218	An Overview on Handling Anti Forensic Issues in Android Devices Using Forensic Automator Tool	H. Hemanth Bharath Bhushan, S Metilda Florance	425-430
76	219	On some issues in Kalman filter based trilateration algorithms for indoor localization problem	Hena Kausar, Suwendu Chattaraj	431-435

77	223	Gain Scheduled LQR Control of a Two Wheeled Mobile Robot with Heavy Payloads	Anu Gopinath, V. R. Jisha	436-441
78	224	Decentralized Control of a Slow Moving Mobile Manipulator	Shyju Susan Mathew, V.R. Jisha	442-447
79	225	Patch-based All Convolutional Neural Network Model for Classification of Benign and Malignant Mammograms	Gurpreet Kaur, Annie Julie Joseph, Pournami P N	448-455
80	227	A solution to power balancing in high renewable penetration power system: Use of Abandoned Generating Units	Athul Jose P, Arun V Jose, Deepak M, Sunitha R	456-462
81	229	Achieving Market Segmentation from B2B Insurance Client Data Using RFM & K-Means Algorithm	Srijith J Kumar, Abin Oommen Philip	463-469
82	231	Radial force reduction of Switched Reluctance Motor for EV application	Rani S, Jayapragash R	470-475
83	235	A Single-Phase Hybrid Seventeen Level Multilevel Inverter Topology	Sahana B K, Rupesh K C	476-480
84	239	Maximizing Strategy in Customer Segmentation Using Different Clustering Techniques	Pavithra M, Ayushman Prashar, Abirami	481-485
85	240	Performance Comparison of Classifiers of MR Brain Tumor Images on Various Datasets	Divya Mohan, V. Ulagamuthalvi, Nisha Joseph	486-490
86	242	A Disturbance Observer Based Control for Quadrotor Aircraft Subject to Wind Gusts	Sini S, T Ananthan	491-496
87	243	Design, Fabrication, Analysis and Testing of a Planar Inductor on a High Frequency Buck Converter using SiC Device	Arnab Dey, Kousik Ghosh, Abhishek Kar, Mainak Sengupta	497-502
88	245	Virtual Smart Canteen System	Tanay Bagayatkar, Shivam Pawar, Vishal Salvi, Kiran Gawande	503-508
89	247	A Secured Key Management Scheme for Mobile Ad Hoc Networks with Modified Montgomery Modular Arithmetic	Janani.V. S, M S K Manikandan	509-512

90	248	Space syntax analysis of Total connectivity through the evolution of Bag Bazar Street, Kolkata (1746-2020)	Shilpi Chakraborty, Shiva Ji	513-518
91	249	Techno-Economic Feasibility Analysis of LVDC System to Retrofit an Existing AC System: Case Study	R. P. Nishitha, Akhil Sabu, Lijo Joseph O, Rani Chacko, Jaimol Thomas, Victor Jose	519-524
92	251	Detailed FEM-based Analysis of Vibration in a 3-phase Switched Reluctance Motor and its Experimental Validation	Samrat Das, Devraj Roy, Mainak Sengupta	525-530
93	252	Investigations on Performance Parameters of Hybrid Perovskite Solar Cells	Kiran Susan Pavu, Sreelekshmi P. S, Jobymol Jacob	531-535
94	253	Analyzing Tone of the Annual Report - An Indian Context	Prakash K. Aithal, Dinesh Acharya U., Geetha M.	536-542
95	257	Gate Matching Algorithm for Early False Path Detection in Statistical Static Timing Analysis	Sachin K Bhat Agni, R. Jayagowri	543-548
96	259	Hot Carrier Effect on Base Resistance of SiGe Heterojunction Bipolar Transistors	Ann Mary Alex, Jobymol Jacob	549-552
97	261	Performance Analysis of Code Hopping Multiple Access using Orthogonal Complementary Codes under Rician Fading Channels	D. Judson, K. A. Aswathy	553-558
98	262	Transfer learning for Speech Based Emotion Recognition	Meenu S Nair, Deepa P Gopinath	559-564
99	263	A Novel State Space Model of an Interleaved Boost Converter operating over a wide range of duty ratio	Frieda Mohan, Nikhil Sasidharan	565-570
100	268	Parameter Independent Backstepping Controller for Bidirectional Buck-Boost Converter in DC Grid Battery Interface with CPL	Renuka V. S, Nikhil Sasidharan, Abraham T. Mathew	571-576
101	269	A Real-Time IoT and Cloud System for Carbon Dioxide Monitoring in Dhaka City's Buildings with Rooftop Garden and without Rooftop Garden	Md. Hasan Imam Bijoy, Aysha Siddika, Md. Mahbubur Rahman, Md Rabin Mia, Fizar Ahmed, Fahad Faisal	577-583

102	276	Effective Software Effort Estimation using Heterogeneous Stacked Ensemble	Somya Goyal	584-588
103	278	Dual Stepped Line Impedance Antenna for 8 GHz Communication	Ankita Bagri, Mukesh Yadav	589-594
104	279	Residual Network based Single Object Tracking	Shiv Kumar, Sandeep Kumar Singh	595-600

# Design of High-Pass FIR Filter using Arithmetic Optimization Algorithm and its FPGA Implementation

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**Abstract**—This paper presents an efficient implementation of high-pass filter using the Arithmetic Optimization Algorithm. The result of this algorithm was found to be better in terms of pass-band ripple and stop-band attenuation in comparison to the Park-McClellan (PM) algorithm. Further, the hardware implementation of the proposed design in the FPGA platform have been discussed in this proposed work.

**Keywords**—FIR Filter, High-Pass Filter, AOA, meta heuristic optimization algorithm, genetic optimization algorithm, simulated annealing algorithm, Sine Cosine algorithm, whale optimization algorithm, forced switching mechanism, FPGA.

## I. INTRODUCTION

Filters can be broadly classified as analog and digital. Digital filter is an important part of digital signal processing. A digital filter is actually used to serve the purposes like signal separation and restoration. Since a digital filter takes a digital input and gives a digital output, with various digital components mixed up, so signal separation separates the noise and signal restoration restores the signal in its actual form. Digital filters are again classified as Finite Impulse Response (FIR) filter and Infinite Impulse Response (IIR) filter [1]. The output of FIR filters fades away due to impulse input within a limited amount of time and they are non-recursive. Due to greater stability and having a linear phase[2] and finite impulse response, FIR filters are preferred over IIR filters in many applications.

The design of a digital FIR filter in an optimum way requires a set of coefficients so that the magnitude response has a maximum stop-band attenuation and minimum pass-band ripple. Conventionally, various well-known methods have been implemented for the design of digital FIR filters like the window method, frequency sampling method, etc. The window method consists of window functions such as Butterworth, Chebyshev, Kaiser, etc. It consists of truncating an infinite filter impulse response by a window function that will be suitable for the respective filter. The windowing method for the digital filter design is fast, robust, convenient but usually suboptimal. For the design of optimal digital

filters, the main objective function involves specific control of various parameters of the frequency spectrum which is highly non-uniform, non-linear, non-differentiable, and multimodal. So optimization of the above objective function cannot be done using the above techniques and convergence to the global minimum solution is also quite difficult. So, various optimization techniques or algorithms [1-3] are used to get rid of these problems.

The most important purpose of these evolutionary or meta-heuristic optimization algorithms for the digital filter is to optimize the cost function by reducing or minimizing the error between the desired response and the actual response as much as possible. Due to this the requirement of conventional gradient-based design processes like continuous and differentiable cost function has been eliminated. Again the problem of “Local Optima Entrapment” that is the chance of getting trapped in local minima is very much less for this algorithm. Algorithms like simulated annealing, genetic algorithm, particle swarm optimization algorithm [4], whale optimization algorithm [5], cuckoo search algorithm [6], etc. are significant optimization problems.

According to the theoretical studies it has been published that a single algorithm cannot solve all optimization problems and this theorem is known as the “No Lunch Free Theorem”. Based on this theorem, the researchers are motivated to design new problems and get better results. In 2020, Laith Abualigah developed Arithmetic Optimization Algorithm (AOA) [7-9]. This algorithm mainly depends on the properties of arithmetic operators which are multiplication, division, subtraction, and addition, which helps in exploring and exploiting the minima within the search region. According to our literature survey this algorithm is applied in various design problems like pressure vessel design, 3-bar truss design problems, etc [8]. Again an improved version of this algorithm is integrated with forced switching mechanism [6], a chaotic mapping strategy introduced in AOA to boost its convergence speed and accuracy[8], etc. Based on this algorithm, various other algorithms hybridized with AOA have been developed. Few examples are advanced AOA for solving mechanical engineering design algorithms hybridizing Sine Cosine Algorithm (SCA) with AOA and fuzzy SCA-AOA in information security, AOA in multi-level thresholding

# Wideband Design of A Circularly Polarized Fabry-Perot Cavity Antenna

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**Abstract**—A novel design of Fabry-Perot cavity antenna (FPCA) is proposed to achieve circularly polarized (CP) radiation over a wide axial ratio (AR) bandwidth. Degenerate orthogonal modes of a square-shaped slotted patch are excited by using the dual-offset feeding technique and the patch has been used as a primary radiator of the proposed CP-FPCA. An approximate gain improvement of 7–11 dB is achieved just by using a specially engineered superstrate which consists of strategic square patches. The boresight gain of the antenna varies between 11.5–16.2 dBi over its 25% matching as well as AR-bandwidth. The AR value remains below 1 dB over the operating bandwidth and has a 25° AR-beamwidth. Estimated values of boresight cross-pol and sidelobe levels are below -27dB and -8dB, respectively.

**Keywords**—Fabry-Perot cavity antenna (FPCA), circular polarization (CP); resonant cavity antenna (RCA); patch antenna; superstrate; high gain

## I. INTRODUCTION

Fabry-Perot cavity antennas (FPCAs) are known for their high gain properties and they are often used as substitutions for a bulky horn or array antenna [1, 2]. The directivity is further enhanced by placing a superstrate above the array underneath and utilizing the constructive interference between [3]. Linearly polarized FPCAs were realized by using various superstrate and primary radiators configurations [3]. However, to-date, very few of the FPCA designs reported in the literature provide circular polarization (CP), for which there is a high demand in both mobile and space applications [4]. But most of these designs were limited due to their poor gain and bandwidth performances. Maintaining higher gain over a wide axial ratio (AR) bandwidth is very difficult to achieve according to the earlier reports.

In this paper, a wideband CP-FPCA is designed by us using a novel feed and superstrate configuration. Two orthogonal resonating modes of a slotted microstrip patch are excited by using two dual-offset microstrip feed lines for CP radiation [5]. The superstrate configuration is strategically designed by using the square patch elements. A metallic cavity wall is used to enhance the gain at the higher frequencies [6]. All antenna dimensions are optimized by using a commercial EM-solver [7]. The broadside gain of the optimized antenna is maintained between 11.5–16.2 dBi, both over its 25% impedance matching as well as AR-bandwidths. An approximate gain improvement

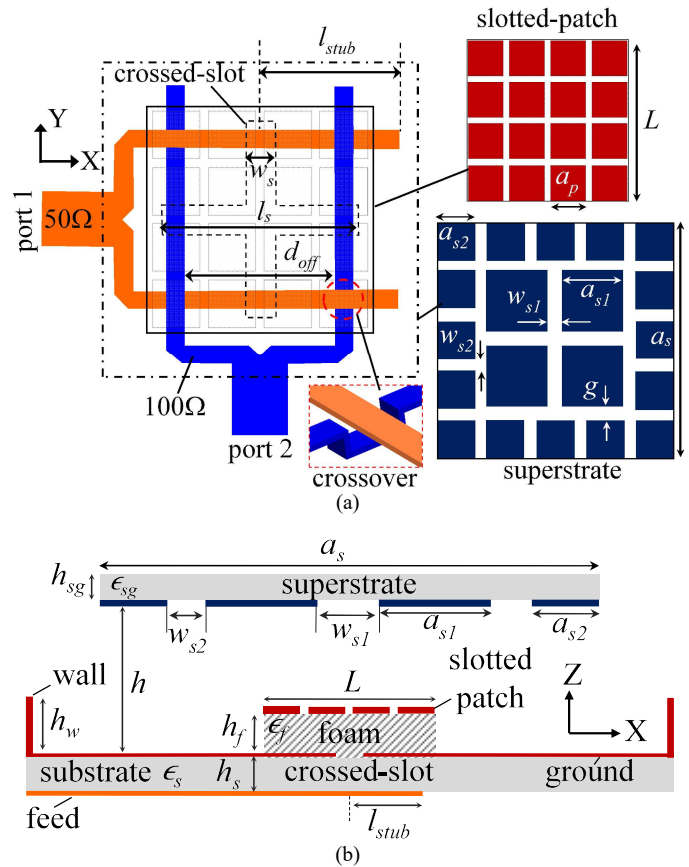


Fig. 1. Schematic view of the proposed CP-FPCA. (a) Top view, (b) side view. Parameters:  $a_s=71$ ,  $a_{sl}=20$ ,  $a_{s2}=10$ ,  $w_{s1}=3$ ,  $w_{s2}=5.25$ ,  $g=4$ ,  $h_{sg}=0.254$ ,  $\epsilon_s=2.2$ ,  $\epsilon_{sg}=2.55$ ,  $\epsilon_f \approx 1.07$ ,  $L=16$ ,  $a_p=3.85$ ,  $h_f=3.27$ ,  $h_s=0.508$ ,  $h_w=9$ ,  $h=15.2$ ,  $l_s=14$ ,  $w_s=1.5$ ,  $d_{off}=5.3$ ,  $l_{stub}=12$ , ground plane  $\rightarrow 90 \times 90$ . All other parameters as in Fig. 2. (all dimensions in mm).

of 7–11 dB is achieved just by using a specially engineered superstrate which consists of strategic square patches. The proposed antenna is simulated and a few representative results are included. Experimental of the simulation results are currently in progress.

## II. THE ANTENNA CONFIGURATION

The side and top views of the proposed antenna are shown in Figs. 1(a) and (b), respectively. The substrate and superstrate

# 2021 IEEE International Symposium on Antennas and Propagation and North American Radio Science Meeting

## PROCEEDINGS

4–10 December 2021  
Singapore

Sponsored by

The Institute of Electrical and Electronics Engineers  
IEEE Antennas and Propagation Society

IEEE Catalog Number: CFP21APS-ART  
ISBN: 978-1-7281-4670-6



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IEEE Catalog Number: CFP21APS-ART  
ISBN: 978-1-7281-4670-6

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# TABLE OF CONTENTS

## MO-A1.1A: ANTENNA THEORY I

### MO-A1.1A.1: ANTENNA DESIGN FOR IMPROVED NON-LINEAR RADAR .....1 PERFORMANCE

*Alex Bouvy, Nader Behdad, University of Wisconsin-Madison, United States; Gregory Mazzaro, The Citadel, United States; Kelly Sherbondy, Kyle Gallagher, Army Research Lab, United States*

### MO-A1.1A.2: A CONCEPT OF TRANSPARENT ANTENNA ARRAY ON TOUCH SCREEN .....3 PANEL FOR SUB-6 GHZ CELLULAR DEVICES

*Kosuke Fujita, Masaharu Takahashi, University of Chiba, Japan*

### MO-A1.1A.3: ACCURATE CLOSED-FORM EXPRESSIONS FOR MAXIMUM RADIATED .....5 POWER AND SURFACE WAVE LOSS OF PRINTED ANTENNAS ON A THICK SUBSTRATE

*Andrey Kobayakov, Corning Inc., United States*

### MO-A1.1A.4: SPARSE CYLINDRICAL ARRAYS WITH LOW DISCREPANCY ELEMENT .....7 SPACING BASED ON VAN DER CORPUT SEQUENCE

*Travis Torres, Payam Nayeri, Randy Haupt, Colorado School of Mines, United States; Paolo Rocca, University of Trento, Italy*

### MO-A1.1A.5: A METHOD TO WIDEN THE RANGE OF DIRECTION FINDING BY TIME .....9 MODULATED ARRAY

*Yue Ma, Chen Miao, Yue Li, Wen Wu, Nanjing University of Science and Technology, China*

### MO-A1.1A.6: SEVERAL EFFECTIVE METHODS ON REDUCING CROSS-POLARIZATION .....11 OF A PATCH ANTENNA

*Jing-Yi Zhang, Jin-Dong Zhang, Wen Wu, Da-Gang Fang, Nanjing University of Science and Technology, China*

### MO-A1.1A.7: RADIATION CHARACTERISTICS OF 2-D FABRY-PEROT CAVITY .....13 ANTENNAS WITH UNIFORM SUPERSTRATE

*Yanlin Hei, Min Wang, Jia-Yan Xu, Wen Wu, Nanjing University of Science and Technology, China*

### MO-A1.1A.9: LONG RANGE DIPOLE WITH OMNIDIRECTIONAL PATTERN BASED ON .....15 SPOOF SURFACE PLASMON POLARITONS STRUCTURE

*Jing Zhang, Junping Geng, Kun Wang, Chaofan Ren, Jingzheng Lu, Silei Yang, Yangzhou Zhang, Da Su, Xianling Liang, Ronghong Jin, Shanghai Jiao Tong University, China*

### MO-A1.1A.10: OPTIMUM GAIN CONDITIONS FOR 1-D UNIDIRECTIONAL .....17 LEAKY-WAVE ANTENNAS

*Walter Fuscaldo, National Research Council of Canada, Italy; Alessandro Galli, Sapienza University of Rome, Italy; David R. Jackson, University of Houston, United States*

## MO-A5.1A: WIRELESS POWER TRANSMISSION I

### MO-A5.1A.2: WIRELESS POWER CHARGING OF SMARTPHONE UP TO 6 FEET FROM .....19 TRANSMITTER ANTENNA AT 2.4 GHZ

*Pawan Gaire, Dieff Vital, MD Rayhan Khan, Shubhendu Bhardwaj, Florida International University, United States; Cherif Chibane, WiGL inc., United States*

<b>MO-A5.1A.3: OPTIMAL EMBROIDERED WEARABLE WPT SYSTEMS WITH LIQUID METAL NANOPARTICLES</b>	<b>21</b>
<i>Juan Barreto, Abdul-Sattar Kaddour, Stavros Georgakopoulos, Florida International University, United States; Hyeon Seok An, Robert Sheperd, Cornell University, United States</i>	
<b>MO-A5.1A.4: METASURFACE LENS DESIGN FOR HIGH-GAIN WPT SYSTEM</b>	<b>23</b>
<i>Scott Clemens, Magdy Iskander, Zhengqing Yun, University of Hawaii at Manoa, United States; Hooman Kazemi, Raytheon Company, United States</i>	
<b>MO-A5.1A.5: A SIMPLE AND RELIABLE APPROACH TO STABILIZING OUTPUT VOLTAGE OF A WIRELESS POWER TRANSFER SYSTEM FOR ACTIVE IMPLANTABLE MEDICAL DEVICES</b>	<b>25</b>
<i>Cheng Peng, Jinyan Li, Zhongwei Zhao, University of Electronic Science and Technology of China, China; Zhizhang Chen, Dalhousie University, Canada</i>	
<b>MO-A5.1A.6: TIME REVERSAL BASED MULTI-POINT FOCUSING WIRELESS POWER TRANSFER</b>	<b>27</b>
<i>Zhouming Yang, Jinlong Bao, Deshuang Zhao, University of Electronic Science and Technology of China, China</i>	
<b>MO-A5.1A.7: WIRELESS POWER TRANSFER ON HUMAN ARM FOR FUTURE BODY AREA NETWORK</b>	<b>29</b>
<i>Yiying Wang, Yuanzheng Xu, Bo Wang, Jinjun Mo, Guilin University Of Electronic Technology, China; Safieddin Safavi-Naeini, University of Waterloo, Canada</i>	
<b>MO-A5.1A.8: ON THE EVALUATION OF WIRELESS POWER TRANSFER EFFICIENCY BETWEEN TWO ANTENNA APERTURES IN THE FRESNEL REGION OVER WIDE BANDWIDTH</b>	<b>31</b>
<i>Daniele Inserra, Guangjun Wen, University of Electronic Science and Technology of China, China</i>	
<b>MO-A5.1A.9: AN ADAPTIVE MULTI BRANCH DUAL BAND RECTIFIER FOR RF ENERGY HARVESTING EFFICIENCY IMPROVEMENT</b>	<b>33</b>
<i>M. Arif Hussain Ansari, Salahuddin Raju, Agency for Science, Technology and Research (A*STAR), Singapore</i>	
<b>MO-A5.1A.10: BASIC STUDY ON TWO-DIMENSIONAL BEAM PROPAGATION CHARACTERISTICS IN PARALLEL PLATE WAVEGUIDE</b>	<b>35</b>
<i>Kazuki Yukawa, Takayuki Matsumuro, Toshio Ishizaki, Ryukoku University, Japan; Yohei Ishikawa, Kyoto University, Japan</i>	
<b>MO-SP.1A: HIGH SENSITIVITY PHASED ARRAY RECEIVERS FOR LOCATION SERVICES, 5G, RADIO ASTRONOMY, AND SATELLITE COMMUNICATIONS</b>	
<b>MO-SP.1A.3: FLEXIBLE AND SCALABLE ADDITIVELY MANUFACTURED ANTENNA ARRAY TILES FOR SATELLITE AND 5G APPLICATIONS USING A NOVEL RUGGED MICROSTRIP-TO-MICROSTRIP TRANSITION</b>	<b>37</b>
<i>Kexin Hu, Xuanke He, Manos Tentzeris, Georgia Institute of Technology, United States</i>	
<b>MO-SP.1A.4: WIDEBAND RFI CANCELLATION USING TRUE TIME DELAYS AND A HADAMARD PROJECTION OPERATOR</b>	<b>39</b>
<i>Jakob Kunzler, Karl Warnick, Brigham Young University, United States; Mohammad Chahardori, Deukhyoun Heo, Washington State University, United States</i>	
<b>MO-SP.1A.5: THE BLUERING ARRAY RECEIVER SYSTEM</b>	<b>41</b>
<i>Grant Hampson, Wan Cheng, David Humphrey, John Bunton, Paul Roberts, Keith Bengston, Ron Beresford, Yuqing Chen, Raji Chekkala, Giles Babich, CSIRO, Australia</i>	
<b>MO-SP.1A.6: SPECTRAL SMOOTHNESS OF EMBEDDED ELEMENT PATTERNS IN THE SKA-LOW PROTOTYPE STATION AAVS2: PRELIMINARY RESULTS</b>	<b>43</b>
<i>David Davidson, Daniel Ung, Curtin University, Australia</i>	



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The Institute of Electrical and Electronics Engineers  
IEEE Antennas and Propagation Society

IEEE Catalog Number: CFP21APS-ART  
ISBN: 978-1-7281-4670-6



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## MO-A5.1A: WIRELESS POWER TRANSMISSION I

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*Pawan Gaire, Dieff Vital, MD Rayhan Khan, Shubhendu Bhardwaj, Florida International University, United States; Cherif Chibane, WiGL inc., United States*

<b>MO-A5.1A.3: OPTIMAL EMBROIDERED WEARABLE WPT SYSTEMS WITH LIQUID METAL NANOPARTICLES</b>	<b>21</b>
<i>Juan Barreto, Abdul-Sattar Kaddour, Stavros Georgakopoulos, Florida International University, United States; Hyeon Seok An, Robert Sheperd, Cornell University, United States</i>	
<b>MO-A5.1A.4: METASURFACE LENS DESIGN FOR HIGH-GAIN WPT SYSTEM</b>	<b>23</b>
<i>Scott Clemens, Magdy Iskander, Zhengqing Yun, University of Hawaii at Manoa, United States; Hooman Kazemi, Raytheon Company, United States</i>	
<b>MO-A5.1A.5: A SIMPLE AND RELIABLE APPROACH TO STABILIZING OUTPUT VOLTAGE OF A WIRELESS POWER TRANSFER SYSTEM FOR ACTIVE IMPLANTABLE MEDICAL DEVICES</b>	<b>25</b>
<i>Cheng Peng, Jinyan Li, Zhongwei Zhao, University of Electronic Science and Technology of China, China; Zhizhang Chen, Dalhousie University, Canada</i>	
<b>MO-A5.1A.6: TIME REVERSAL BASED MULTI-POINT FOCUSING WIRELESS POWER TRANSFER</b>	<b>27</b>
<i>Zhouming Yang, Jinlong Bao, Deshuang Zhao, University of Electronic Science and Technology of China, China</i>	
<b>MO-A5.1A.7: WIRELESS POWER TRANSFER ON HUMAN ARM FOR FUTURE BODY AREA NETWORK</b>	<b>29</b>
<i>Yiying Wang, Yuanzheng Xu, Bo Wang, Jinjun Mo, Guilin University Of Electronic Technology, China; Safieddin Safavi-Naeini, University of Waterloo, Canada</i>	
<b>MO-A5.1A.8: ON THE EVALUATION OF WIRELESS POWER TRANSFER EFFICIENCY BETWEEN TWO ANTENNA APERTURES IN THE FRESNEL REGION OVER WIDE BANDWIDTH</b>	<b>31</b>
<i>Daniele Inserra, Guangjun Wen, University of Electronic Science and Technology of China, China</i>	
<b>MO-A5.1A.9: AN ADAPTIVE MULTI BRANCH DUAL BAND RECTIFIER FOR RF ENERGY HARVESTING EFFICIENCY IMPROVEMENT</b>	<b>33</b>
<i>M. Arif Hussain Ansari, Salahuddin Raju, Agency for Science, Technology and Research (A*STAR), Singapore</i>	
<b>MO-A5.1A.10: BASIC STUDY ON TWO-DIMENSIONAL BEAM PROPAGATION CHARACTERISTICS IN PARALLEL PLATE WAVEGUIDE</b>	<b>35</b>
<i>Kazuki Yukawa, Takayuki Matsumuro, Toshio Ishizaki, Ryukoku University, Japan; Yohei Ishikawa, Kyoto University, Japan</i>	
<b>MO-SP.1A: HIGH SENSITIVITY PHASED ARRAY RECEIVERS FOR LOCATION SERVICES, 5G, RADIO ASTRONOMY, AND SATELLITE COMMUNICATIONS</b>	
<b>MO-SP.1A.3: FLEXIBLE AND SCALABLE ADDITIVELY MANUFACTURED ANTENNA ARRAY TILES FOR SATELLITE AND 5G APPLICATIONS USING A NOVEL RUGGED MICROSTRIP-TO-MICROSTRIP TRANSITION</b>	<b>37</b>
<i>Kexin Hu, Xuanke He, Manos Tentzeris, Georgia Institute of Technology, United States</i>	
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<b>MO-SP.1A.5: THE BLUERING ARRAY RECEIVER SYSTEM</b>	<b>41</b>
<i>Grant Hampson, Wan Cheng, David Humphrey, John Bunton, Paul Roberts, Keith Bengston, Ron Beresford, Yuqing Chen, Raji Chekkala, Giles Babich, CSIRO, Australia</i>	
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## 2

### Electro-Optic Switches

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(Presently associated with CNES/ONERA project)

#### 2.1 Introduction

Superfast transmission of large data sets is now needed to cope with the increasing demand for high-quality audio and video signals in mobile phones, smart TV etc. [1]. Currently, the advanced fiber-optic communication networks serve as the building blocks of the information superhighway. Reliable routing, fast switching, and errorless detection are the three essential goals that need to be fulfilled to accommodate the huge demands within the purview of fiber-optic communication technology. One of the indispensable components of fiber-optic communication is optical switches and, for the current scenario, they need to be reliable, robust, yet inexpensive. A good-quality optical switch can increase the capacity of optical fiber and reliably distribute optical signals and subsequently reduces the overall cost. Moreover, optical switches can convert or redirect light without any electronic to optical conversions and vice versa. In the electro-optic effect, the refractive index (RI) of non-centrosymmetric crystals can be changed upon application of an electric field due to the rearrangement of the position and/or density of the charge carriers and by inducing slight deformations in the crystal lattice. There are two categories of electro-optic effect, namely the linear (Pockels) effect (RI varies in proportion to the field) and the quadratic (Kerr) effect (RI varies in proportion to the square of the field). Electro-optic modulation has distinct advantages over the other mechanisms that can be used for 1.31–1.55  $\mu\text{m}$  fiber-optic communications and optical networks. Moreover, light can be restrained within a tiny area by using guided-wave-type electro-optic modulators, which are much superior to their conventional bulk counterparts in terms of switching speed, power consumption, and compatibility with optical fiber [2]. Thus, an electro-optic modulator-based efficient optical communication system is evidently required for telecommunication, remote detection systems [3], military applications, etc. In this article, a review of current optical switches in terms of operating principle, fabrication material, and device structure is presented. The performance issues and subsequent challenges are also briefly discussed.

**Optical Switching**

# Optical Switching

Device Technology and Applications in Networks

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This edition first published 2022  
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*Library of Congress Cataloging-in-Publication Data*

Names: Nandi, Dalia, editor. | Nandi, Sandip, editor. | Sarkar, Angsuman, editor. | Sarkar, Chandan Kumar, editor. | John Wiley & Sons, publisher.  
Title: Optical switching : device technology and applications in networks / edited by Dalia Nandi, Sandip Nandi, Angsuman Sarkar, Chandan Kumar Sarkar.  
Description: Hoboken, NJ : Wiley, 2022. | Includes bibliographical references and index.  
Identifiers: LCCN 2022010920 (print) | LCCN 2022010921 (ebook) | ISBN 9781119819233 (cloth) | ISBN 9781119819240 (adobe pdf) | ISBN 9781119819257 (epub)  
Subjects: LCSH: Optical communications—Equipment and supplies. | Optical fiber communication. | Signal processing.  
Classification: LCC TK5103.592.F52 O76 2022 (print) | LCC TK5103.592.F52 (ebook) | DDC 621.38275—dc23/eng/20220412  
LC record available at <https://lcn.loc.gov/2022010920>  
LC ebook record available at <https://lcn.loc.gov/2022010921>

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Set in 9.5/12.5pt STIXTwoText by Straive, Pondicherry, India

## Contents

<b>Preface</b>	<i>xvi</i>
<b>About the Editors</b>	<i>xviii</i>
<b>List of Contributors</b>	<i>xix</i>

### **Part A Introduction 1**

#### **Introduction 3**

*Sandip Nandi and Dalia Nandi*

A.	Optical Communication Networks	3
A.1	Historical Perspective	3
A.2	Essential Background	6
A.2.1	Optical Networks	6
A.2.2	SONET/SDH	6
A.2.3	Multiplexing	7
A.2.4	All-Optical Networks	7
A.2.5	Optical Transport Network	8
B.	Optical Switching in Networks	8
B.1	Historical Perspective	8
B.2	Essential Background	9
B.2.1	Optical Switching in Networks	9
B.2.2	Optical Switching in Practice	9
B.2.3	Optical Switch Technology	10
C.	Organization of This Book	10
	Bibliography	11

### **Part B Switch Characterization 13**

#### **1 Optical Switches 15**

*Rajan Agrahari, Sambit Kumar Ghosh, and Somak Bhattacharyya*

1.1	Introduction	15
1.2	Electro-Optical Switching	16
1.2.1	Working Principle of Electro-Optical Switches	16

1.2.2	Realization of Electro-Optical Switches	17
1.3	Acoustic-Optical Switching	18
1.3.1	Types of Acoustic-Optical Switching	18
1.3.2	Acoustic-Optical Device Materials and Applications	19
1.4	Thermo-Optical Switching	19
1.4.1	Working Principle of Thermo-Optical Switches	20
1.4.2	Realization of Thermo-Optical Switches	20
1.4.3	Thermo-Optical Switch Materials and Applications	21
1.5	Liquid Crystal-Optical Switching	21
1.5.1	Types of Liquid Crystal-Optical Switches	21
1.5.2	Liquid Crystal-Optical Switch Applications	22
1.6	Photonic Crystal Optical Switching	22
1.7	Semiconductor Optical Amplifier (SOA) Optical Switching	23
1.8	Magneto-Optical (MO) Optical Switching	25
1.9	Micro Electro-Mechanical Systems (MEMS) Optical Switching	25
1.10	Metasurfaces Switches	26
1.11	Conclusion	26
	Bibliography	27
<b>2</b>	<b>Electro-Optic Switches</b>	<b>31</b>
	<i>Arpita Adhikari, Joydip Sengupta, and Arijit De</i>	
2.1	Introduction	31
2.2	Operating Principles	32
2.2.1	Operating Principles of the Single-Mode Switch	32
2.2.2	Operating Principles of the Multimode Switch	32
2.3	Materials for the Fabrication of Electro-Optic Switch	34
2.3.1	Ferroelectric Materials	34
2.3.2	Compound Semiconductors	35
2.3.3	Polymers	35
2.4	Device Structures of Electro-Optical Switches	36
2.4.1	1 × 1 Switch	36
2.4.2	1 × 2 Switch	37
2.4.3	2 × 2 Switch	39
2.4.4	2 × 3 Switch	40
2.4.5	3 × 2 Switch	41
2.4.6	3 × 3 Switch	42
2.4.7	1 × 4 Switch	42
2.4.8	2 × 4 Switch	43
2.5	Conclusions	43
	Bibliography	44
<b>3</b>	<b>Thermo-Optical Switches</b>	<b>47</b>
	<i>Fulong Yan, Xuwei Xue, and Chongjin Xie</i>	
3.1	History of Thermal Optical Switching	47
3.2	Principles of Thermo-Optic Switch	47
3.2.1	Thermo-Optic Effect	47
3.2.2	Trade-Off Between Switching Time and Power Consumption	48

3.2.3	Merits of Thermo-Optic Switch	49
3.3	Category	49
3.3.1	Material	49
3.3.2	Implementation Principle	51
3.3.3	Device Architecture	51
3.4	Scalability	52
3.4.1	Binary Tree	52
3.4.2	Modified Crossbar	53
3.4.3	Benes	54
3.5	Application Scenarios	54
	Bibliography	55
<b>4</b>	<b>Magneto-Optical Switches</b>	<b>57</b>
	<i>K. Sujatha</i>	
4.1	Introduction	57
4.1.1	Types of Optical Switch	57
4.1.2	How Does an Optical Switch Work?	59
4.1.3	Applications of Optical Switches	59
4.2	All-Optical Switch	60
4.2.1	Why is an All-Optical Switch Useful?	62
4.3	Magneto-Optical Switches	64
4.3.1	Magneto-Optical Switch Features	64
4.3.2	Principles of Magneto-Optical Switches	65
4.3.2.1	The Design Core of the Magneto-Optical Switch	65
4.3.3	Magneto-Optic Effect	66
4.4	Faraday Rotation	68
4.4.1	Phenomenological Model	68
4.4.2	Atomic Model	68
	Bibliography	70
	Further Reading	70
<b>5</b>	<b>Acousto-Optic Switches</b>	<b>73</b>
	<i>Sudipta Ghosh, Chandan Kumar Sarkar, and Manash Chanda</i>	
5.1	Introduction	73
5.2	Fundamentals of Acousto-Optic Effect	73
5.3	Acousto-Optic Diffraction	74
5.4	Raman–Nath Diffraction	76
5.5	Bragg Diffraction	77
5.6	Principle of Operation of AO Switches	78
5.7	Acousto-Optic Modulator	80
5.7.1	Acousto-Optic Q-Switching	81
5.7.2	Telecommunication Network	82
5.8	Recent Trends and Applications	83
5.8.1	Emerging Spatial Mode Conversion in Few-Mode Fibers	83
5.8.2	Lithium Niobate Thin Films	84
5.8.3	Optical Fiber Communication and Networking	85
	Bibliography	86