Shri Gajanan Shikshan Sanstha's
SHRI SANT GAJANAN MAHARAJ COLLEGE OF ENGINEERING
SHEGAON – 444203, DIST. BULDANA (MAHARASHTRA STATE), INDIA
"Recognized by A.I.C.T.E., New Delhi" Affiliated to Sant Gadge Baba Amravati University, Amravati
"Approved by the D.T.E., M.S. Mumbai"

Ph : +918669638081/82
Fax : 091-7265-252346
Email.principal@ssgmce.ac.in, registrar@ssgmce.ac.in
Website- www.ssgmce.ac.in

Academic Year 2021-22

Sr. No.	Name of the Teacher	Title of the book/chapters published	Title of the paper	Department	Evidences
1	Prof.C.M.Mankar	--	ML Hybrid Approach for IntrusionDetection in Networks	Computer Science and Engineering	Click Here
2	Prof. J. M. Patil	--	MLEDM: Hybrid Machine Learning Approach using Real Time Data Processing for Educational Data Mining	Computer Science and Engineering	
3	Prof. J. M. Patil	--	Literature Review :Educational Data Mining and Learning Analytics	Computer Science and Engineering	
4	Prof. P. V. Deshmukh	--	A Review on Data Hiding Mechanism for Enhancing Embedding Capacity	Computer Science and Engineering	
5	Prof. A. K. Shahade	--	systematic literature review on advancements and innovations done in Digital libraries through recent trending technologies	Computer Science and Engineering	
6	Prof. P. V. Deshmukh	--	ML Hybrid Approach for Intrusion Detection in Networks	Computer Science and Engineering	
7	A. U. Jawadekar G.M.Dhole S.R.Paraskar S.S.Jadhao	Novel Perspectives of Engineering Research Vol. 7, 14 February 2022 , Page 140-151	Assessment of Artificial Neural Network-based Induction Motor Fault Classifier Using Continuous Wavelet Transform	Electrical Engineering	Click Here
8	S.R.Paraskar	Novel Perspectives of Engineering Research Vol. 8, *2021 pp 11-23*	Study on Discrimination between Inrush and Fault in Transformer: ANN Approach	Electrical Engineering	
9	R.S Kankale, Dr. S.R Paraskar, Dr. S.S. Jadhao	--	Classification of power Quality Disturbances in emerging power system with distributed generation using space phasor model and normalized cross correlation	Electrical Engineering	

Shri Gajanan Shikshan Sanstha's
SHRI SANT GAJANAN MAHARAJ COLLEGE OF ENGINEERING
SHEGAON – 444203, DIST. BULDANA (MAHARASHTRA STATE), INDIA
"Recognized by A.I.C.T.E., New Delhi" Affiliated to Sant Gadge Baba Amravati University, Amravati
"Approved by the D.T.E., M.S. Mumbai"

Ph : +918669638081/82
Fax : 091-7265-252346
Email.principal@ssgmce.ac.in, registrar@ssgmce.ac.in
Website- www.ssgmce.ac.in

10	R.S Kankale, Dr. S.R Paraskar, Dr. S.S. Jadhao	--	Classification of Power Quality Disturbances in Emerging Power System Using Discrete Wavelet Transform and K-Nearest Neighbor	Electrical Engineering	Click Here
11	G.N.Bonde Dr. S.R Paraskar, Dr. S.S. Jadhao	--	Review on Detection and Classification of Underlying Causes of Power Quality Disturbances using Signal Processing and Soft Computing Technique	Electrical Engineering	
12	R.S.Kankale Dr. S.R Paraskar, Dr. S.S. Jadhao	--	Classification of power quality disturbances in emerging power system using S-transform and support vector machine	Electrical Engineering	
13	Pratik R,Dhabe	--	Solve Selective Harmonic Elimination Problem with a new Metaheuristic Optimization Algorithm	Electrical Engineering	
14	M.N.Tibdewal	--	Analysis of Psychophysiological Effects on Meditation through Electroencephalogram	Electronics and Telecommunication Engineering	Click Here
15	M.N.Tibdewal	--	Application of Modified Restricted Boltzmann Machine (mRBM) for denoising of motion-Artifacted MRI scans	Electronics and Telecommunication Engineering	
16	Swapnil P. Badar, Kamlesh Khanchandani	--	Implementation of Combinational Logic for Polar Decoder	Electronics and Telecommunication Engineering	
17	Amit S. Manekar	--	Interactive Smart Mirror using Raspberry Pi 4	Information Technology	Click Here
18	Amitkumar Manekar	--	A Review on Pose Estimation and its Recent Progress	Information Technology	
19	Prof. A. K. Shahade	--	A Review on Smart Attendance Monitoring System using Deep Learning Approach	Information Technology	
20	S. D. Padiya	Implementing Data Analytics and Architectures for Next Generation Wireless Communications	Chapter 10: Analysis of Bluetooth Versions (4.0, 4.2, 5, 5.1, and 5.2) for IoT Applications.	Information Technology	

Shri Gajanan Shikshan Sanstha's
SHRI SANT GAJANAN MAHARAJ COLLEGE OF ENGINEERING
SHEGAON – 444203, DIST. BULDANA (MAHARASHTRA STATE), INDIA
"Recognized by A.I.C.T.E., New Delhi" Affiliated to Sant Gadge Baba Amravati University, Amravati
"Approved by the D.T.E., M.S. Mumbai"

Ph : +918669638081/82
Fax : 091-7265-252346
Email.principal@ssgmce.ac.in, registrar@ssgmce.ac.in
Website- www.ssgmce.ac.in

21	S. D. Padiya	IoT with BLE Beacons: Research Opportunities, Planning and Strategy (English Edition)		Information Technology	Click Here
22	Prof M.B. Bhambere	--	Recent design of fins for heat transfer enhancement of thermal system- A review	Mechanical Engineering	Click Here
23	Prof M.B. Bhambere	--	Numerical analysis of heat transfer from perforated fins of an induction motor housing	Mechanical Engineering	
24	Prof.P.A.Dalke	--	Experimental Investigation of Hybrid Nanofluids Characteristics in Ti6Al4V Drilling Using Minimum Quantity Lubrication Technique	Mechanical Engineering	
25	Dr. H M Jha "Bidyarthi"	--	Assessing the Need of Personalizing Activities and Role to Drive Academic Innovation	Master of Business Administration	Click Here
27	Dr. H M Jha "Bidyarthi"	--	Millennial Trend in Disruptive Innovation	Master of Business Administration	
28	Dr. L B Deshmukh	--	Digital Marketing: An Innovative Approach Towards Traditional Marketing	Master of Business Administration	
31	Dr. L B Deshmukh	--	Innovative Marketing Strategies of Leading Shoe Manufactures – A Study	Master of Business Administration	
32	Dr. L B Deshmukh	--	Petroleum Swap: An Innovative Approach to Enhance Petroleum Customer Service Level (CSL)	Master of Business Administration	
35	Dr.P M Kuchar	--	Recipe for Inclusive Growth – Women Empowerment	Master of Business Administration	
36	Dr.P M Kuchar	--	Men and Women from Mars and Venus at Work	Master of Business Administration	
37	Dr.P M Kuchar	--	Revitalizing Non-profits – An Enquiry into Innovative Inputs by Vinoba Bhave and Baba Amte	Master of Business Administration	Click Here
39	Dr. M A Dande	--	Diffusing Family Business Innovations – A Case of Treasure Trove 'Khandelwal Jewellers'	Master of Business Administration	

Shri Gajanan Shikshan Sanstha's
SHRI SANT GAJANAN MAHARAJ COLLEGE OF ENGINEERING
SHEGAON – 444203, DIST. BULDANA (MAHARASHTRA STATE), INDIA
"Recognized by A.I.C.T.E., New Delhi" Affiliated to Sant Gadge Baba Amravati University, Amravati
"Approved by the D.T.E., M.S. Mumbai"

Ph : +918669638081/82
Fax : 091-7265-252346
Email.principal@ssgmce.ac.in, registrar@ssgmce.ac.in
Website- www.ssgmce.ac.in

40	Dr. M A Dande	--	Recipe for Inclusive Growth – Women Empowerment	Master of Business Administration	
41	Dr. M A Dande	---	Men and Women from Mars and Venus at Work	Master of Business Administration	
42	Dr. M A Dande	--	Revitalizing Non-profits – An Enquiry into Innovative Inputs by Vinoba Bhave and Baba Amte	Master of Business Administration	
44	Dr. S M Mishra	--	Recipe for Inclusive Growth – Women Empowerment	Master of Business Administration	
45	Dr. S M Mishra	--	Men and Women from Mars and Venus at Work	Master of Business Administration	
46	Dr. S M Mishra	--	Revitalizing Non-profits – An Enquiry into Innovative Inputs by Vinoba Bhave and Baba Amte	Master of Business Administration	
48	Prof. W Z Suliya	--	Life Management in India during Covid-19 Period – A Study	Master of Business Administration	
49	Prof. W Z Suliya	--	Vibrant Hands for Rural Development in India – A Study	Master of Business Administration	
50	Prof. W Z Suliya	--	Potential for Rural Economic Development Model in Tribal Pockets of Nimad Region, Madhya Pradesh – An Enquiry	Master of Business Administration	
51	Prof. W Z Suliya	--	Productive Mental Health: Need of Individuals and Organizations	Master of Business Administration	
53	Prof. V V Patil	--	Dynamically Continuous Innovations in Financial Services – A Case of AU Small Finance Bank (Badlaav Hamse Hai)	Master of Business Administration	
54	Prof. V V Patil	--	Men and Women from Mars and Venus at Work	Master of Business Administration	
55	Prof. V V Patil	--	Revitalizing Non-profits – An Enquiry into Innovative Inputs by Vinoba Bhave and Baba Amte	Master of Business Administration	Click Here
56	Dr. B T Husain	--	Identification and Assessment of Risks Involved in Construction Projects inWestern Vidarbha from the Perspective of Civil Contractors	Master of Business Administration	

Shri Sant Gajanan Maharaj College of Engineering SHEGAON 444 203

PRINCIPAL
Shri Sant Gajanan Maharaj
College of Engineering,Shegaon.


IEEE IAS Global Conference on Emerging Technologies
(GlobConET-2022)
IEEE
Advancing Technology for Humanity
(100 % Financial Sponsorship of IEEE Industry Applications Society USA)
IAS
IEEE INDUSTRY APPLICATIONS SOCIETY
Linking Research to Practice
May 20-22, 2022
Certificate of Participation
This is to certify that Prof. /Dr. /Mr. /Ms. SAKSHI RAVINDRA DESHMUKH of Computer Engineering,Shri Sant Gajanan Maharaj College of Engineering Shegaon Maharashtra has presented a paper titled ML Hybrid Approach for Intrusion Detection in Networks authored by SAKSHI RAVINDRA DESHMUKH; CHANDRASHEKHAR MANKAR in the IEEE IAS Global Conference on Emerging Technologies (GlobConET-2022) which was held online mode (WebEx) during May 20-22, 2022.
Certificate No. GlobConET/2022/242.
Technical Chair
Technical Chair


IC
CCC
3rd INTERNATIONAL CONFERENCE ON
CONTENT, COMPUTING AND COMMUNICATION
26th & 27th Feb 2022
Organized by
Matoshri College of Engineering & Research Centre, Nashik
SSRN
tomorrow's research today
Certificate
This is to certify that,
Jaikumar M Patil
Shri Sant Gajanan Maharaj College of Engineering, Shegaon
has presented a paper entitled,
"MLEDM: Hybrid Machine Learning Approach using Real Time Data Processing for Educational Data Mining"
In 3rd International Conference on Content, Computing and Communication-2022.

Shri Vile Parle Kelavani Mandal's

INSTITUTE OF TECHNOLOGY, DHULE

ICETIC

CERTIFICATE OF PRESENTATION

This is to certify that,

Mr. /Ms. **Jaikumar Patil** of **Shri Sant Gajanan Maharaj College of Engineering, Shegaon** has presented a paper entitled "Literature Review: Educational Data Mining and Learning Analytics" in "Virtual International Conference on EMERGING TRENDS IN INTELLIGENT COMPUTING (ICETIC'21)" jointly organized by Department of Computer Engineering and Information Technology, SVKM's Institute of Technology, Dhule, held on **23rd to 24th December 2021.**

Dr. Bhushan Chaudhari
Convener, ICETIC'21 and
Head, Dept. of Information Tech.

Dr. Makarand Shahade
Convener, ICETIC'21 and
Head, Dept. of Computer Engg.

Dr. Nilesh Salunke
Principal
SVKM's IOT, Dhule

Springer

2nd International Conference on Sustainable Expert Systems ICSES 2021

Certificate of Presentation

Ms. Priyanka V Deshmukh

has successfully presented a research paper entitled

A Review on Data Hiding Mechanism for Enhancing Embedding Capacity

at the 2nd International Conference on Sustainable Expert Systems (ICSES 2021) organized by Tribhuvan University, Nepal on 17 & 18, September 2021.

Session Chair

Dr. S Smys
Organizing Secretary

Prof. Dr. Subarna Shakya
Conference Chair

SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

Approved by AICTE | Affiliated to Anna University | Accredited by NBA
'A' Grade Accreditation by NAAC | ISO 9001:2015 Certified

SRM Nagar, Kattankulathur - 603 203

Department of Electronics and Communication Engineering

National Conference on Emerging Trends in Communication Engineering, Computing Systems and Applications (ETCECSA 2022)

Certificate of Participation

This is to certify that Prof. ANIKET SHAHADE of Shri Sant Gajanan Maharaj College of Engineering, Shegaon has presented the paper titled A systematic literature review on advancements and innovations done in Digital libraries through recent trending technologies in the National Conference on "Emerging Trends in Communication Engineering, Computing Systems and Applications" (ETCECSA 2022) on 27th April 2022.

Co-Conveners

Dr. N. Udha Bhanu, Professor,
Dr. S. Ramesh, Associate Professor,

Convener

Dr. Komala James,
Professor & Head

Organizing Chair

Dr. B. Chidhambararajan,
Principal

ML Hybrid Approach for Intrusion Detection in Networks

Sakshi Ravindra Deshmukh ; Chandrashekhar Mankar All Authors

Abstract: As in today's developing network environment there is threat of new type of attacks daily in the network. So, the network administration system is also needed to be updat... **View more**

Metadata

Abstract:

As in today's developing network environment there is threat of new type of attacks daily in the network. So, the network administration system is also needed to be updated regularly for upgradation of security level. One of the network packet monitoring system is Intrusion Detection Systems (IDS). The proposed model is designed using machine learning approach for detection of malicious activities of the network packets. For that NSL-KDD dataset is used. First of all, the dataset is normalized for reducing calculation complexity, further features are reduced using co-relation algorithm, Particle Swarm Optimization (PSO) and Genetic Algorithm (GA). In final step of proposed algorithm multilevel (ML) hybrid classifiers, based on support vector machine (SVM) and random forest (RF), are designed for classification of dataset into five attack categories i.e. DOS, U2R, R2L, Probe and Normal. As compared to some other multilevel classifier work the proposed algorithm proves its efficiency in terms of high accuracy and False Alarm Rate (FAR).

Published in: 2022 IEEE IAS Global Conference on Emerging Technologies (GlobConET)

Date of Conference: 20-22 May 2022

DOI: 10.1109/GlobConET53749.2022.9872392

Date Added to IEEE *Xplore*: 09 September 2022

Publisher: IEEE

ISBN Information:

Conference Location: Arad, Romania

Contents

Chapter 12
Print ISBN: 978-93-5547-513-8, eBook ISBN: 978-93-5547-514-5

Assessment of Artificial Neural Network-based Induction Motor Fault Classifier Using Continuous Wavelet Transform

A. U. Jawadekar [a*], G. M. Dhole [a], S. R. Paraskar [a] and S. S. Jadhao [a]

DOI: 10.9734/bpi/nper/v7/3473E

ABSTRACT

Induction motors are widely used in industrial, commercial, and residential applications due to their significant advantages over other types of electric motors. These motors are subjected to a variety of operating stresses that can result in faults. Bearing faults, stator interturn faults, and cracked rotor bars are the most common recurrent faults in induction motors. Early detection of induction motor faults is critical for reliable and cost-effective operation. Faults and failures of induction motor can lead to excessive downtimes and generate large losses in terms of maintenance and revenues. The purchasing and installation cost of equipment usually cost less than half of total expenditure over the life of machine for maintenance. Maintenance cost is 15% to 40% of the total cost and it can go up to 80% of the total cost. In many cases, the failure of a critically loaded machine can bring an entire industry process to a halt. The growing demand for high-quality and low-cost production has increased the need for automated manufacturing systems with effective monitoring and control capabilities.

Condition monitoring and fault diagnosis of an induction motor are critical in the manufacturing process. It can reduce maintenance costs and the risk of unexpected failures by allowing for the early detection of catastrophic failures. There are many condition monitoring methods, including vibration monitoring, thermal monitoring, chemical monitoring, acoustic emission monitoring, but all these methods require expensive sensors or specialized tools. Whereas the current monitoring does not require additional costly sensors as basic electrical quantities voltage and current are readily measured by voltage and current transformers that are always installed as a part of the protection system. As a result current monitoring is non-intrusive and may be implemented even if the motor is at the remote end from the motor control center. Thus MCSA proves to be a low cost online nondestructive fault diagnosis and detection system to provide accurate assessment of motor faults. This chapter presents experimental results for multiple fault detection in induction motors using signal processing and artificial neural network approaches. The continuous wavelet transform was used to analyse motor line currents recorded under various fault conditions. A feedforward neural network was used for fault characterization based on fault features extracted using continuous wavelet transform.

Keywords: Artificial neural networks; continuous wavelet transform; induction motor; multiple fault detection.

1. INTRODUCTION

As induction motors are a critical component in the majority of industrial processes, any failure in the machine has a negative impact on the industries. Early detection of motor faults is highly desirable to reduce downtime and also for safety considerations, which necessitates condition-based monitoring of the induction motor. Bearing faults, stator winding faults, and rotor faults are the most common induction motor faults. Bearing failures account for roughly one-fifth of all faults. One-third of reported

[a] *Department of Electrical Engineering, S. S. G. M. College of Engineering Shegaon, (M.S.), India.*
**Corresponding author: E-mail: anjali.jawadekar@gmail.com;*

Biography of author(s)

A. U. Jawadekar
Department of Electrical Engineering, S. S. G. M. College of Engineering Shegaon, (M.S.), India.

She is working as Associate Professor in the department of Electrical Engineering in SSGM College of Engineering Shegaon Maharashtra India. She has 20 years of experience in teaching and research. She received B.E., ME. Degree in Electrical Power System, and Ph.D. degree in Electrical Engineering from Sant Gadge Baba Amravati University, India. She is IEEE, ISTE, ISRD and IAENG member. She has published more than 80 research papers in different International and National Journals and Conference Proceedings. Her main research interest includes condition monitoring of Electrical Equipment, Power Electronics and Embedded Systems, Application of intelligent methods, and signal processing to power system.

G. M. Dhole
Department of Electrical Engineering, S. S. G. M. College of Engineering Shegaon, (M.S.), India.

He is working as an industry consultant and providing customized solutions and products for industries. He received B.E., MTech., Degree from Visvesvaraya National Institute of Technology, Nagpur, India, and Ph.D. degree in Electrical Engineering from Amravati University, India. He is IEEE, IACSIT, IE and ISTE member. He has published more than 100 research papers in different International and National Journals and Conference Proceedings. His main research interest includes power system planning, operation and control, power quality solutions, intelligent methods and its applications in power system and embedded product designs.

S. R. Paraskar
Department of Electrical Engineering, S. S. G. M. College of Engineering Shegaon, (M.S.), India.

He is working as a Professor in the department of Electrical Engineering in SSGM College of Engineering Shegaon Maharashtra India. He has 25 years of experience in teaching and research. He received B.E., ME. Degree in Electrical Power System, and Ph.D. degree in Electrical Engineering from Sant Gadge Baba Amravati University, India. He is IEEE, ISTE, ISRD and IAENG member. He has published more than 80 research papers in different International and National Journals and Conference Proceedings and 1 patent. His main research interest includes condition monitoring of Electrical Equipment, Power Quality FACTS and Application of intelligent methods, and signal processing to power system.

Chapter 2
Print ISBN: 978-93-5547-380-6, eBook ISBN: 978-93-5547-391-2

Study on Discrimination between Inrush and Fault in Transformer: ANN Approach

S. R. Paraskar [a#*]

DOI: 10.9734/bpi/rtcams/v8/2606C

ABSTRACT

Transformer protection is a critical issue in power systems because it involves accurately and quickly distinguishing magnetising inrush current from internal fault current. An artificial neural network has been proposed and demonstrated its ability to solve the transformer monitoring and fault detection problem using a low-cost, dependable, and noninvasive procedure. This paper presents an algorithm in which statistical parameters of detailed d1 level wavelet coefficients of signal are used as an input to the artificial neural network (ANN), which develops into a novel approach for online detection method to discriminate the magnetising inrush current and inter-turn fault, as well as the location of fault, i.e. whether the interturn fault lies in primary or secondary winding, using discrete wavelet transform and artificial neural network (ANNs). In the laboratory, information from controlled experiments was collected using a custom-built single-phase transformer. Following feature extraction with the discrete wavelet transform (DWT), a neural network model MLP was designed and rigorously trained. It is also discussed the proposed on-line detection scheme.

Keywords: Neural networks; transformer; fault detection; discrete wavelet transform (DWT); inrush current.

1. INTRODUCTION

Power transformers are critical components of any power system. As a result, it is critical to avoid any malfunctioning of the necessary protective system. Differential protection has been used as the primary protection of power systems for many years. It houses the differential relay, which operates for all internal power transformer fault types and blocks caused by inrush current. The main disadvantage of differential protection relays is the possibility of misoperation caused by the transient inrush current that flows when the transformer is energised. The inrush current contains a large second harmonic component. Most of the methods for digital differential protection of transformers are based on harmonic content of differential current. These methods are based on this fact that the ratio of the second harmonics to the fundamental component of differential current in inrush current condition is greater than the ratio in the fault condition.

However, the second harmonic may also be generated during faults on the transformers. It might be due to saturation of CTs, parallel capacitances or disconnected transformers. The second harmonic in these situations might be greater than the second harmonic in inrush currents. Thus, the commonly employed conventional differential protection based on second harmonic restraint will face difficulty in distinguishing inrush current and internal faults. Thus, an improved technique of protection is required to discriminate between inrush current and internal faults [1].

To overcome this difficulty and prevent the mal-function of differential relay, many methods have been presented to analyze and recognize inrush current and internal fault currents. As both inrush current

#Professor & Head

[a] Department of Electrical Engineering, S.S.G.M.College of Engineering , Shegaon.(M.S.),44203, India.
**Corresponding author: E-mail: srparaskar@gmail.com;*

7. Moravej Z, Vishwakarma DN, Singh SP. ANN based protection scheme for power transformer. Electric Machines and Power Systems. 2000;28(9):875-884.
8. Mao PL, Aggarwal RK. A novel approach to the classification of the transient phenomena in power transformers using combined wavelet transform and neural network. IEEE Transaction on Power Delivery. 2001;16:654–660,.
9. Moravej Z, Vishwakarma DN, Singh SP. Radial basis function (RBF) neural network for protection of a power transformer. Electric Power Components and Systems. 2001;29:307-320.
10. Shin MC, Park CW, Kim JH. Fuzzy logic-based for large power transformer protection. IEEE Transaction on Power Delivery. July 2003;18(3):718-724.
11. Moravej Z. Power transformer protection using support vector machine network. PES, U.S.A. 2008; 29-33.
12. Jazebi S, Vahidi B, Hosseinian SH. A new stochastic method based on hidden Markov models to transformer differential protection. IEEE Proceeding OPTIM'08. 2008;1:179–184.
13. Xu, Fu and Li. Application of artificial neural network to the detection of the transformer winding deformation', paper presented at International Symposium on High Voltage Engineering. London; 1999.
14. Goda MA. Discrimination between inrush and fault currents of transformers using Artificial Neural Network Tools. The Egyptian International Journal of Engineering Sciences and Technology. 2022 Mar 1;37(2):34-8.
15. Suliman MY, Al-Khayyat MT. Discrimination Between Inrush and Internal Fault Currents in Protection Based Power Transformer using DWT. International Journal on Electrical Engineering and Informatics. 2021 Mar 1;13(1):1-20.

ICSCC
2021

IEEE

CERTIFICATE

This is to certify that

Ravishankar Shaligram Kankale, Dr. Sudhir Paraskar, Dr. Saurabh Jadhao

have presented a paper titled

Classification of Power Quality Disturbances in Emerging Power System with Distributed Generation Using Space Phasor Model and Normalized Cross Correlation

in the 8th International Conference on Smart Computing and Communications (ICSCC 2021) organized by Muthoot Institute of Technology and Science, Kochi during 1-3 July, 2021.

DR ABHILASH ANTONY
ORGANIZING CHAIR

DR NEELAKANTAN P. C.
PROGRAM CHAIR

CO-SPONSORED BY
IEEE Kerala Section

HOSTED BY
Muthoot Institute of Technology & Science

POWERED BY
claysys Synthite IBM

KNOWLEDGE PARTNER
MathWorks

Scopus
Indexed Publication

BENTHAM SCIENCE PUBLISHERS LTD.

ICTACADEMY

3rd International Conference on
Smart Innovations for Society
"ICSIS 2021"

Springer

Clarivate Analytics
WEB OF SCIENCE

August 20-21, 2021

in conjunction with

"The Smart City"
Convergence 2021
Role of Engineers in Innovation and Technological Advancement

Certificate of Presentation

Organized by
DEPARTMENT OF APPLIED SCIENCE

POORNIMA
INSTITUTE OF ENGINEERING & TECHNOLOGY
Affiliated to Rajasthan Technical University, Kota & Approved by AICTE, New Delhi

Mr. Ravishankar Shaligram Kankale, Assistant Professor
Presented the paper entitled
Classification of Power Quality Disturbances in Emerging Power System Using Discrete Wavelet Transform and K-Nearest Neighbor
at "International Conference on Smart Innovations for Society (ICSIS) 2021" held online during **August 20-21, 2021** at Poornima Institute of Engineering & Technology, Jaipur, Rajasthan.

Dr. Sama Jain
HOD I Year, PIET, Jaipur
Program Chair (ICSIS-2021)

Dr. Gautam Singh
Registrar, PIET, Jaipur
Conferance Chair (ICSIS-2021)

Dr. Dinesh Goyal
Director, PIET, Jaipur
Patron(ICSIS-2021)

Scopus
Indexed Publication

BENTHAM SCIENCE PUBLISHERS LTD.

ICTACADEMY

3rd International Conference on Smart Innovations for Society "ICSIS 2021"

Springer

Clarivate Analytics
WEB OF SCIENCE™

August 20-21, 2021

in conjunction with

"The Smart City"
Convergence 2021
Role of Engineers in Innovation and Technological Advancement

Organized by
DEPARTMENT OF APPLIED SCIENCE

POORNIMA
INSTITUTE OF ENGINEERING & TECHNOLOGY
Affiliated to Rajasthan Technical University, Kota & Approved by AICTE, New Delhi

Certificate of Presentation

Dr. Sudhir Ramdas Paraskar, Professor
Presented the paper entitled
Classification of Power Quality Disturbances in Emerging Power System Using Discrete Wavelet Transform and K-Nearest Neighbor
at "International Conference on Smart Innovations for Society **(ICSIS)** 2021" held online during **August 20-21, 2021** at Poornima Institute of Engineering & Technology, Jaipur, Rajasthan.

Dr. Sama Jain
HOD I Year, PIET, Jaipur
Program Chair (ICSIS-2021)

Dr. Gautam Singh
Registrar, PIET, Jaipur
Conferance Chair (ICSIS-2021)

Dr. Dinesh Goyal
Director, PIET, Jaipur
Patron(ICSIS-2021)

Scopus
Indexed Publication

BENTHAM SCIENCE PUBLISHERS LTD.

ICTACADEMY

3rd International Conference on Smart Innovations for Society "ICSIS 2021"

Springer

Clarivate Analytics
WEB OF SCIENCE™

August 20-21, 2021

in conjunction with

"The Smart City"
Convergence 2021
Role of Engineers in Innovation and Technological Advancement

Organized by
DEPARTMENT OF APPLIED SCIENCE

POORNIMA
INSTITUTE OF ENGINEERING & TECHNOLOGY
Affiliated to Rajasthan Technical University, Kota & Approved by AICTE, New Delhi

Certificate of Presentation

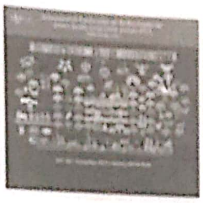
Dr. Suarabh Sureshrao Jadhao, Assistant Professor
Presented the paper entitled
Classification of Power Quality Disturbances in Emerging Power System Using Discrete Wavelet Transform and K-Nearest Neighbor
at "International Conference on Smart Innovations for Society (ICSIS) 2021" held online during **August 20-21, 2021** at Poornima Institute of Engineering & Technology, Jaipur, Rajasthan.

Dr. Sama Jain
HOD I Year, PIET, Jaipur
Program Chair (ICSIS-2021)

Dr. Gautam Singh
Registrar, PIET, Jaipur
Conferance Chair (ICSIS-2021)

Dr. Dinesh Goyal
Director, PIET, Jaipur
Patron(ICSIS-2021)

CLASSIFICATION OF POWER QUALITY DISTURBANCES IN EMERGING POWER SYSTEM USING DISC WAVELET TRANSFORM AND K-NEAREST NEIGHBOR



(https://spast.org/techrep/issue/view/6)

Published Sep 15, 2021

Ravishankar Kankale
:1:{s:5:"en_US";s:2:"Dr";}

Abstract

Power quality becomes a highly important issue in the power system operation due to the increasing use of power electronic devices. Waveform distortions are frequent by the power quality disturbances such as sag, swell, interruption, harmonics, flicker, transients, and notch. These disturbances cause malfunctions, instabilities, and fail user equipment's [1].

It is important to select appropriate features for the classification of PQDs. In order to extract features from the captured signal, signal processing techniques are used. T features are further fed to the classifier. The feature extraction is done in two steps. To begin, the time domain voltage signal is processed using signal processing techni Second, extraction of appropriate feature is done using the processed signal. A well selected feature vector reduces the classifiers load [2]. Features can be directly extra the original time domain signals, and from the transformed frequency domain signals. To convert the time domain signal into a frequency domain signal, signal processi techniques such as Fourier transform (FT), short-time Fourier transform (STFT), wavelet transform (WT), and S-transform (ST) are utilized.

The frequency contents in the signal were extracted using FT. The frequency content of the signal can be used to identify some PQDs. However, FT is ineffective for trans signals. This is due to the fact that FT only tells you if a frequency component exists, but not when it appears [2]. In order to get this information, the time-frequency loca techniques are used. This enables you to obtain time-evolved signal components in different frequency ranges. This problem can be solved by using STFT, but it has a fix size. The STFT approach is found to be insufficient for evaluating non-stationary signals. Hence there is a requirement of efficient and powerful techniques for analysing stationary signals [3-6]. Many researchers have recommended Wavelet transform for the analysis of PQDs to overcome the fixed window width problem of STFT [7]. This automatically adapts to give correct time and frequency resolutions. High-frequency signal components have a higher time resolution, whereas the low-frequency signal components have higher frequency resolution with this technique. These characteristics make the WT ideal for analysing power system transients induced by a variety o

In Wavelet transform wavelet is used as the basis function, and it scales according to the frequency under consideration. The WT delivers superior results than the FT an because the basis function is a wavelet rather than an exponential function. The WT divides the signal into several frequency levels and displays them as wavelet coefficie ntinuous wavelet transform (CWT) and discrete wavelet transform (DWT) are used based upon type of signal under study. CWT-based decomposition is used for contir signals, while DWT-based decomposition is used for discrete time signals [8].

This paper proposes a discrete wavelet transform and KNN based approach for the classification of PQDs. The PQDs such as sag, swell and interruption are created by si the emerging power system using MATLAB Simulink. These disturbances are further analyse using wavelet transform for feature extraction. The features extracted from further used for training and testing the KNN classifier.

How to Cite

Kankale, R. (2021). Classification of Power Quality Disturbances in Emerging Power System Using Discrete Wavelet Transform and K-Nearest Neighbor . *SPAST Abstracts*, *1*
Retrieved from https://spast.org/techrep/article/view/550

Keywords

References

International Conference on Artificial Intelligence & Energy Systems (AIES-2021)

December 08 & 09, 2021 –Virtual mode

Lead Guest Editor

Dr. Basil Kuriachen

Additional Guest Editors

Dr. Lintu Rajan

Dr. V.P. Devassia

Dr. Lijo Paul

Dr. Jilse Sebastian

Prof. Tomson Devis

BONFRING®
Intellectual Integrity

The International Conference on Artificial Intelligence & Energy Systems (AIES-2021)

Year of publication 2021

ISBN 978-93-92537-13-4

Bonfring

309, 2nd Floor, 5th Street Extension
Gandhipuram, Coimbatore-641 012.
Tamilnadu, India.
E-mail: conference.@bonfring.org, Website: www.bonfring.org

AIES 2021
Review on Detection and Classification of Underlying Causes of Power Quality Disturbances using Signal Processing and Soft Computing Technique

*Ganesh N. Bonde[a], Dr. S. R. Paraskar[b], Dr. S. S. Jadhao[c]

[a]*Shri Sant Gajanan Maharaj College of Engineering, Shegaon – 444203, India. ganeshbonde2009@gmail.com
[b]Shri Sant Gajanan Maharaj College of Engineering, Shegaon – 444203, India. srparaskar@gmail.com
[c]Shri Sant Gajanan Maharaj College of Engineering, Shegaon – 444203, India. ssjadhao@gmail.com

Abstract— The new age power system is highly subjected to PQ disturbances that require proper attention and address. The research in this field is mainly categorized into different parts such as mathematical modelling, basic PQ principles, standards, impact and solutions, sources, and analysis. There are several underlying causes behind the occurrence of the PQ disturbance. Therefore, it is important to address the exact underlying cause for proper mitigation of the PQ disturbance. There are several methods available in the literature, which concentrated on to detection and classification of power quality events rather than root cause of the PQ events. So an effective method for root cause identification of PQ events is the need of the day. This article covers a broad review of signal processing and soft computing techniques used for the detection & recognition of the underlying cause of it. This will help the researcher, engineers, designers working in the field of detection, recognition, and monitoring of power quality. The comparative study of existing methods used in the literature is tabulated. The major concerns and obstacles in categorizing the recognition of power quality disturbances are thoroughly examined and discussed. The potential for new researchers in the field of power quality disturbance detection and recognition of underlying causes is further explored in this review.

Keywords— *Underlying Cause of Power Quality Disturbances, Signal Processing Methods, Soft Computing Techniques*

978-93-92537-13-4

AIES 2021

The International Conference *on* Artificial Intelligence & Energy Systems

(Virtual Mode)

December 08 & 09, 2021

aies.sjcetpalai.ac.in

CERTIFICATE *of* PARTICIPATION

This is to certify that

Mr. Ganesh N Bonde

has presented a paper entitled

Review on Detection and Classification of Underlying Causes of Power Quality Disturbances using Signal Processing and Soft Computing Technique

in the international conference on ***Artificial Intelligence & Energy Systems (AIES 2021)***
organized by the Department of Mechanical Engineering & Department of Electronics and Communication Engineering of St. Joseph's College of Engineering and Technology, Palai on 8th and 9th December 2021.

DR. LIJO PAUL
Organizing Chair

PROF. TOMSON DEVIS
Organizing Chair

DR. J. DAVID
Principal

अखिल भारतीय तकनीकी शिक्षा परिषद्
All India Council for Technical Education

ENTUPLE TECHNOLOGIES

Scopus®
materialstoday: PROCEEDINGS

ELSEVIER

ST. JOSEPH'S
COLLEGE OF ENGINEERING AND TECHNOLOGY,
- PALAI -
CHOONDACHERRY P.O., KERALA, INDIA 686579

AIES 2021

The International Conference *on* Artificial Intelligence & Energy Systems

(Virtual Mode)

December 08 & 09, 2021

aies.sjcetpalai.ac.in

CERTIFICATE *of* APPRECIATION

This is to certify that

Dr. Sudhir Paraskar

is a co-author for the paper entitled

Review on Detection and Classification of Underlying Causes of Power Quality Disturbances using Signal Processing and Soft Computing Technique

in the international conference on ***Artificial Intelligence & Energy Systems (AIES 2021)***
organized by the Department of Mechanical Engineering & Department of Electronics and Communication Engineering of St. Joseph's College of Engineering and Technology, Palai on 8th and 9th December 2021.

DR. LIJO PAUL
Organizing Chair

PROF. TOMSON DEVIS
Organizing Chair

DR. J. DAVID
Principal

अखिल भारतीय तकनीकी शिक्षा परिषद्
All India Council for Technical Education

ENTUPLE TECHNOLOGIES

Scopus®
materialstoday: PROCEEDINGS

ELSEVIER

ST. JOSEPH'S COLLEGE OF ENGINEERING AND TECHNOLOGY, PALAI
CHOONDACHERRY P.O., KERALA, INDIA 686579

AIES 2021

The International Conference *on* Artificial Intelligence & Energy Systems

(Virtual Mode)

December 08 & 09, 2021

aies.sjcetpalai.ac.in

CERTIFICATE *of* APPRECIATION

This is to certify that

Dr. Saurabh Jadhao

is a co-author for the paper entitled

Review on Detection and Classification of Underlying Causes of Power Quality Disturbances using Signal Processing and Soft Computing Technique

in the international conference on ***Artificial Intelligence & Energy Systems (AIES 2021)***
organized by the Department of Mechanical Engineering & Department of Electronics and Communication Engineering of St. Joseph's College of Engineering and Technology, Palai on 8th and 9th December 2021.

DR. LIJO PAUL
Organizing Chair

PROF. TOMSON DEVIS
Organizing Chair

DR. J. DAVID
Principal

अखिल भारतीय तकनीकी शिक्षा परिषद्
All India Council for Technical Education

ENTUPLE TECHNOLOGIES

Scopus®
materialstoday: PROCEEDINGS

ELSEVIER

ST. JOSEPH'S
COLLEGE OF ENGINEERING AND TECHNOLOGY,
- PALAI -
CHOONDACHERRY P.O., KERALA, INDIA 686579

IEEE BOMBAY SECTION

IEEE MP Section

Certificate of Participation

2nd IEEE International Conference

on

ELECTRICAL POWER & ENERGY SYSTEMS

(ICEPES-2021)

December 10-11, 2021

This is to certify that Mr./Ms./Mrs./Dr. ***Ravishankar Shaligram Kankale*** *from* ***Shri Sant Gajanan Maharaj College of Engineering, Shegaon*** *has presented research paper entitled"* ***Classification of Power Quality Disturbances in Emerging Power System using S-transform and Support Vector Machine****" in* ***2nd IEEE International Conference on Electrical Power & Energy Systems*** *jointly organized by* ***Department of Electrical Engineering, MANIT Bhopal,*** *and* ***Department of Electrical & Instrumentation, SLIET Longowal.***

Dr. Ashwani Agrawal
Organizing Secretary
SLIET Longowal

Dr. Sanjay Marwaha
Organizing Secretary
SLIET Longowal

Dr. Priyanka Paliwal
Organizing Secretary
MANIT Bhopal

Dr. Savita Nema
Organizing Secretary
MANIT Bhopal

IEEE BOMBAY SECTION

IEEE MP Section

Certificate of Participation

2nd IEEE International Conference

on

ELECTRICAL POWER & ENERGY SYSTEMS

(ICEPES-2021)

December 10-11, 2021

This is to certify that Mr./Ms./Mrs./Dr. ***Dr. Sudhir Ramdas Paraskar*** *from* ***Shri Sant Gajanan Maharaj College of Engineering, Shegaon*** *has presented research paper entitled "****Classification of Power Quality Disturbances in Emerging Power System using S-transform and Support Vector Machine****" in* ***2nd IEEE International Conference on Electrical Power & Energy Systems*** *jointly organized by* ***Department of Electrical Engineering, MANIT Bhopal,*** *and* ***Department of Electrical & Instrumentation, SLIET Longowal.***

Dr. Ashwani Agrawal	**Dr. Sanjay Marwaha**	**Dr. Priyanka Paliwal**	**Dr. Savita Nema**
Organizing Secretary	Organizing Secretary	Organizing Secretary	Organizing Secretary
SLIET Longowal	SLIET Longowal	MANIT Bhopal	MANIT Bhopal

IEEE BOMBAY SECTION

IEEE MP Section

Certificate of Participation

2nd IEEE International Conference

on

ELECTRICAL POWER & ENERGY SYSTEMS

(ICEPES-2021)

December 10-11, 2021

This is to certify that Mr./Ms./Mrs./Dr. **Dr. Saurabh Sureshrao Jadhao** *from* **Shri Sant Gajanan Maharaj College of Engineering, Shegaon** *has presented research paper entitled "***Classification of Power Quality Disturbances in Emerging Power System using S-transform and Support Vector Machine***" in 2nd IEEE International Conference on Electrical Power & Energy Systems jointly organized by Department of Electrical Engineering, MANIT Bhopal, and Department of Electrical & Instrumentation, SLIET Longowal.*

Dr. Ashwani Agrawal
Organizing Secretary
SLIET Longowal

Dr. Sanjay Marwaha
Organizing Secretary
SLIET Longowal

Dr. Priyanka Paliwal
Organizing Secretary
MANIT Bhopal

Dr. Savita Nema
Organizing Secretary
MANIT Bhopal

2021 IEEE 2nd International Conference on Electrical Power and Energy Systems (ICEPES 2021)
MANIT, Bhopal, India. Dec 10-11, 2021

Classification of Power Quality Disturbances in Emerging Power System using S-transform and Support Vector Machine

Ravishankar Kankale
Department of Electrical Engineering
SSGMCE, Shegaon
Shegaon, India
ravi_kankale@rediffmail.com

Dr. Sudhir Paraskar
Department of Electrical Engineering
SSGMCE, Shegaon
Shegaon, India
srparaskar@gmail.com

Dr. Saurabh Jadhao
Department of Electrical Engineering
SSGMCE, Shegaon
Shegaon, India
ssjadhao@gmail.com

***Abstract*— Classification of Power Quality Disturbances (PQDs) becomes a key issue for end-users in order to enhance the Power Quality (PQ). S-transform (ST) based Support Vector Machine (SVM) classifier is presented in this paper for classification of PQDs in emerging power systems. S-transform is a new and powerful signal processing technique used for feature extraction in the PQDs classification algorithms. In this article, an energy threshold-based algorithm for the classification of PQDs is also presented. In this research work three PQDs namely voltage sag, swell, and interruption are considered under study. The data required for the analysis of PQDs is generated by simulating the emerging power system with these PQDs in a MATLAB Simulink environment. By using S-transform, the non-stationary voltage signal was transformed to extract the appropriate features needed for the classification of PQDs. For automatic classification of PQDs, the features extracted using S-transform are used for training and testing the SVM classifier. The proposed approach uses less features hence the classifier requires less memory and learning time. The simulation results reveal that S-Transform in combination with SVM is an effective way of classifying different PQDs in emerging power system.**

Keywords*— *Power quality disturbances, S-transform, Support Vector Machine, Signal processing techniques.

I. INTRODUCTION

It has always been a top priority for electric utilities around the world to reduce PQDs because they can have adverse effect on the reliability and security of electrical power system. Faults in power system, increasing use of power electronic devices, switching operation, penetration of inverter-based renewable energy sources, operation of distributed generation, and improper grounding are the most common causes of PQDs [1]. If the disturbances were caused by the operating conditions of the emerging power system, the power utility needs to immediately rectify these issues to prevent a recurrence of the problem. The information about the type of PQD and its cause is very important. This information will help to make decisions and take corrective actions for the improvement of power quality. Therefore, power utilities must take some practical steps in order to identify the types of PQDs that could arise from the emerging power system [2].

PQDs have different characteristics, and we can classify them on the basis of their characteristics. Voltage variation, frequency deviation, transients, and presence of notches are some of the common characteristics used to classify PQDs [4].

A variety of signal processing techniques have been proposed by many researchers for the classification of PQDs.

It is important to note that the PQDs are non-stationary by nature. Fourier Transform (FT), Short Time Fourier Transform (STFT), Wavelet Transform (WT), and Filter Bank Method have been proposed for the analysis of signals from various fields [5]. There is a large amount of work being done on PQ that makes use of WT for analyzing power signals. Nonstationary signals are decomposed into time-scale distributions using the WT. WT is the widely used signal processing technique for the detection and classification of PQ disturbances, but it has the limitation that it is unable to estimate the Fourier frequencies and has a local phase reference [6]. The S-transform is a powerful time-frequency analysis tool. The S-transform is widely used in PQ studies as well as many other domains because it has the ability to estimate the time localized Fourier frequency spectrum and has a global phase reference. It also has the capability to accurately detect the PQDs in a noisy environment. This capability attracts many researchers to use S-transform for the detection and classification of PQDs. When using the S-transform instead of WT, you don't have to test various mother wavelets to find the best one for a better classification result, which is another benefit. The S-transform is similar to the WT but with some phase correction. In the case of PQDs with noise, the S-transform produces patterns that closely match the disturbance type and hence requires a simple classification method. By visualizing the contour of the S-transform one can classify the type of PQDs which is another advantage of the S-transform over WT. Because of all these superior features, S-transform is now significantly used in the classification of PQDs [7].

A variety of soft computing techniques are available in the literature for the classification of PQDs. As far as classification problems are concerned, SVM is the most widely used supervisory algorithm available [8]. In this paper, PQDs are classified using the unique combination of S-transform and SVM. To classify PQDs in emerging power systems, the features from the S-transform are directly applied to SVM.

II. S-TRANSFORM

In the field of signal processing, the S-transform is regarded as one of the most recent developments. A time-domain signal is converted to a time-frequency representation. Currently, it is used as a tool to monitor power quality. S-Transform is able to accurately detect disturbances in noisy environments, whereas Wavelet

978-1-6654-0236-1/21/$31.00 ©2021 IEEE

PQDs. The classification algorithm developed based on threshold values of Parseval's energy gives accurate results for all cases of PQDs. A dataset is generated from the feature vector by computing the Parseval's energy for different cases of PQDs for training and testing the SVM classifier. The classification results show that the SVM classifier accurately classifies the type of PQDs with 100% training and testing accuracy. The proposed approach was validated using simulation waveforms. The simulation results reported in this research paper effectively demonstrate the ability of the proposed algorithm to correctly classify the PQDs. We can conclude from the analysis that the suggested methodology outperforms existing methods. The proposed approach was found to be much faster and simpler than other WT-based approaches. The use of this technique on a broad scale could improve the power quality monitoring system and finally the quality of the power.

REFERENCES

[1] P. Gao and W. Wu, "Power Quality Disturbances Classification using Wavelet and Support Vector Machines," Sixth International Conference on Intelligent Systems Design and Applications, 2006, pp. 201-206, doi: 10.1109/ISDA.2006.217.

[2] S. Mishra, C. N. Bhende, and B. K. Panigrahi, "Detection and Classification of Power Quality Disturbances Using S-Transform and Probabilistic Neural Network," IEEE Trans. Power Delivery, Vol.23, pp. 280-28 7, Jan. 2008.

[3] Bhende, C.N., S. Mishra and B.K. Panigrahi, 2008. Detection and classification of power quality disturbances using S-transform and modular neural network. Electr. Power Syst. Res., 78: 122-128.

[4] S. Kaewarsa, "Classification of power quality disturbances using S-transform based artificial neural networks," 2009 IEEE International Conference on Intelligent Computing and Intelligent Systems, 2009, pp. 566-570, doi: 10.1109/ICICISYS.2009.5357780.

[5] M. Uyar, S. Yildirim and M. T. Gencoglu, "An expert system based on S-transform and neural network for automatic classification of power quality disturbances," Expert Systems with Applications, vol. 36, no. 3, Part 2, pp. 5962-5975, April 2009.

[6] G. Găşpăresc, "Automatic classification of power quality events using S-Transform," 2011 10th International Conference on Environment and Electrical Engineering, 2011, pp. 1-4, doi: 10.1109/EEEIC.2011.5874747.

[7] Milan Biswal, P.K. Dash, "Detection and characterization of multiple power quality disturbances with a fast S-transform and decision tree-based classifier", Digital Signal Processing, Volume 23, Issue 4, 2013, Pages 1071-1083

[8] Khoa, Ngo Minh, Dinh Thanh Viet, and Nguyen Huu Hieu. "Classification of power quality disturbances using wavelet transform and K-nearest neighbor classifier" , 2013 IEEE International Symposium on Industrial Electronics, 2013

[9] R. Kumar, B. Singh, D. T. Shahani, A. Chandra and K. Al-Haddad, "Recognition of Power-Quality Disturbances Using S-Transform-Based ANN Classifier and Rule-Based Decision Tree," in IEEE Transactions on Industry Applications, vol. 51, no. 2, pp. 1249-1258, March-April 2015, doi: 10.1109/TIA.2014.2356639.

[10] P. K. A. Kumar, V. J. Vijayalakshmi, J. Karpagam and C. K. Hemapriya, "Classification of power quality events using support vector machine and S-Transform," 2016 2nd International Conference on Contemporary Computing and Informatics (IC3I), 2016, pp. 279-284, doi: 10.1109/IC3I.2016.7917975.

[11] Puliyadi Kubendran, Arun Kumar and Loganathan, Ashok Kumar, "Detection and classification of complex power quality disturbances using S-transform amplitude matrix-based decision tree for different noise levels", International Transactions on Electrical Energy Systems, John Wiley & Sons, DOI: 10.1002/etep.2286, (2016)

[12] Swati R. Satao, Ravishankar S. Kankale. "A new approach for classification of power quality events using S-Transform", 2016 International Conference on Computing Communication Control and automation (ICCUBEA), 2016

[13] M. Venkateswara Reddy and R. Sodhi, "A Modified S-Transform and Random Forests-Based Power Quality Assessment Framework," in IEEE Transactions on Instrumentation and Measurement, vol. 67, no. 1, pp. 78-89, Jan. 2018.

[14] P. Hariramakrishnan and S. Sendilkumar, "Classification of Power Quality Disturbances using Hyperbolic S-Transform," in International Journal of Engineering Research & Technology (IJERT), Special Issue-2018.

[15] Ravishankar Kankale, Sudhir Paraskar, Saurabh Jadhao. "Classification of Power Quality Disturbances in Emerging Power System with Distributed Generation Using Space Phasor Model and Normalized Cross Correlation", 2021 8th International Conference on Smart Computing and Communications (ICSCC), 2021

Nagar Yuvak Shikshan Sanstha's

Yeshwantrao Chavan College of Engineering

(NAAC 'A' Graded Autonomous Institution Affiliated to Nagpur University)

Hingna Road, Wanadongri, NAGPUR-441 110

Certificate of Best Paper Presentation

is awarded to Sarika D. Patil, Akshay D Kadu & Pratik Dhabe,

for Best Paper in the Track- 16 (MODELING, SIMULATION & OPTIMIZATION) with the manuscript entitled

"Solve Selective Harmonic Elimination problem with a new Metaheuristic Optimization Algorithm"

with manuscript ID: 492, in

The International Conference on

"Recent Advances in Materials, Manufacturing and Machine Learning (RAMMML-2022)"

organized by

Department of Mechanical Engineering, Yeshwantrao Chavan College of Engineering, Nagpur,

in association with

The Institution of Engineers (Maharashtra State Centre and Nagpur Local Centre)

held on 26th - 27th April 2022.

Dr. Jayant Giri
Conference Chair
HOD Mechanical

Dr. R. B. Chadge
Conference Chair

Dr. U. P. Waghe
Patron
Principal,YCCE

Shri Gajanan Shikshan Sanstha's
SHRI SANT GAJANAN MAHARAJ COLLEGE OF ENGINEERING
SHEGAON – 444203, DIST. BULDANA (MAHARASHTRA STATE), INDIA
"Recognized by A.I.C.T.E., New Delhi" Affiliated to Sant Gadge Baba Amravati University, Amravati
"Approved by the D.T.E., M.S. Mumbai"

Ph : +918669638081/82
Fax : 091-7265-252346
Email: principal@ssgmce.ac.in, registrar@ssgmce.ac.in
Website- www.ssgmce.ac.in

3.3.3: Number of books and chapters in edited volumes/books published and papers published in national/ international conference proceedings per teacher during year

Year: 2021-22

Sr. No.	Name of the teacher	Title of the paper	Name of the conference
1	M.N.Tibdewal	Analysis of Psychophysiological Effects on Meditation through Electroencephalogram	International Conference on Medical Imaging Science and Technology (MIST 2021)
2	M.N.Tibdewal	Application of Modified Restricted Boltzmann Machine (mRBM) for denoising of motion-Artifacted MRI scans	10th International Conference on Emerging Trends in Engineering and Technology - Signal and Information Processing (ICETET-SIP-22)
3	Swapnil P. Badar, Kamlesh Khanchandani	Implementation of Combinational Logic for Polar Decoder	2nd IEEE International Conference on Range Technology (ICORT-2021)

Mrs. K. S. Vyas / Mr. V. S. Ingole
Prepared By

9/9/23
Dr. M. N. Tibdewal
HoD, EXTC

S.S.G.M.C.E. SHEGAON-444203 (M.S.) INDIA
Department of Electronics & Telecomm.

2021 International Conference on Medical Imaging Science and Technology

December 1-3, 2021 (GMT+8, Beijing Time)

Online Conference via Microsoft Teams

Conference Program

MIST 2021

Bosen

BEB
Conference on Biomedical Engineering and Biotechnology

MIST 2021

CONFERENCE PROGRAM

December 1st-3rd, 2021

China Standard Time (GMT+8:00)

ONLINE-Microsoft Teams Meeting

For MIST 2021 Academic Exchange Only
Not for Distribution to the Public

Session 3_ Computerized Medical Imaging and Graphics

Time: 08:30-12:35, December 3, 2021 (GMT+8)

Session Room Link: http://www.academicconf.com/teamslink?confname=MIST2021

08:30-08:45	MIST1048	Facial Expression Annotation: from Sign Language to Pain Analysis *Dr. Emely Puj ́ali da Silva, University of Campinas, Brazil*
08:45-09:05	MIST1057	Long-tone-burst Ultrasound Enhanced Microbubble Thrombolysis *Prof. Xianghui Chen, First Affiliated Hospital of Jinan University, China*
09:05-09:25	MIST1058	Generative Adversarial Network for Medical Image Synthesis: A Case Study in Realistic Knee Image Generation *Dr. Hong-Seng Gan, Universiti Malaysia Kelantan, Malaysia*
09:25-09:40	MIST1038	Imaging and Computer Vision for Biomedical Robotics *Asst. Prof. Liangjing Yang, Zhejiang University, China*
09:40-10:00	MIST1051	Brain Tumor Segmentation in MRI Images using Di-Phase Midway Convolution and Deconvolution Network *Prof. PL. Chithra, University of Madras, India*
10:00-10:25	MIST1029	A Bi-splitting Radial Curve Method for Region based Segmentation of Tumour Detection *Mr. Radhamadhab Dalai, Birla Institute of Technology Mesra, India*
10:25-10:35		**BREAK**
10:35-10:50	MIST1031	Imaging Noise Models, Poisson Noise Reasons and its Effect on X-Ray Images *Asst. Sajid Ullah Khan, University of Lakki Marwat, Pakistan*
10:50-11:20	MIST1052	Analysis of Psychophysiological Effects of Meditation Through Electroencephalogram *Dr. Manish N. Tibdewal, Shri Sant Gajanan Maharaj College of Engineering, India*
11:20-11:30	MIST1018	Robotic Device for MRgFUS Applications in Veterinary Medicine *Ms. Anastasia Antoniou, Cyprus University of Technology, Cyprus*
11:30-11:50	MIST1003	Digital Passports: Biometric & Vaccine Information *Prof. Khaled A. Nagaty, British University in Egypt, Egypt*
11:50-12:05	MIST1037	Application of Wavelet Theory in Medical Imaging (Knee : Patella) *Dr. Belarbi Mansour, Mascara University, Algeria*
12:05-12:20	MIST1042	Fractional Brownian Motion Model for Bone X-ray Images Characterization *Dr. Khaled Harrar, University M'Hamed Bougara of Boumerdes, Algeria*
12:20-12:35	MIST1021	Deterministic Global Optimization Methods for the Study of Inverse Problems *Dr. Dmitri E. Kvasov, University of Calabria, Italy*

MIST1052: Analysis of Psychophysiological effects of Meditation through Electroencephalogram

Manish N. Tibdewal*, Dhanashri N. Nagbhide
Department of Electronics and Telecommunication Engineering, Shri Sant Gajanan Maharaj College of Engineering, Shegaon, 444203, Maharashtra, India

Abstract. Meditation has a metaphysical influence on the physical as well as mental health of humans. It promotes relaxation to the human being which is required for alleviating stress. This experiment investigates the psychophysiological effects of meditation using an electroencephalogram (EEG). In this research work, the analysis of EEG signals is done for cognitive effects on the human brain for before and after meditation intervention of 25 subjects. The aim of this study is to analyze brain functioning after a month of meditation intervention using statistical and spectral analysis. The statistical and spectral analysis was performed through Sample entropy and Power spectral density respectively. The statistical analysis shows that the Sample Entropy decreased after meditation. The spectral analysis stated that theta power has increased 88 % of subjects whereas the alpha power is increased for the entire subjects after meditation. These features index the meditation improves relaxation, cognitive functions. In future, the work shall be extended by increasing more subjects with a sustained period of meditation to present the more benefits of meditation.

Keywords: EEG; Meditation; Sample Entropy; Power Spectral Density

MIST1018: Robotic Device for Mrgfus Applications in Veterinary Medicine

Marinos Giannakou, Nikolas Evripidou, Anastasia Antoniou, Christakis Damianou*
Department of Electrical Engineering, Computer Engineering and Informatics, Cyprus University of Technology, Cyprus

Abstract. Magnetic Resonance guided Focused Ultrasound (MRgFUS) constitutes an emerging non-invasive therapeutic modality in modern oncology. Since application of this technology in veterinary medicine contributes to optimizing therapeutic protocols and more rapidly translating research into clinical practice, a robotic device intended for veterinary MRgFUS has been developed. The device comprises a positioning mechanism dedicated to navigating a single element spherically focused transducer operating between 1-3 MHz in four PC-controlled axes. All the motion stages are actuated by piezoelectric motors, whereas two optical encoder setups are arranged on each stage, thus providing precise position estimates. Sufficient accuracy and repeatability of motion were demonstrated through caliper-based and Magnetic Resonance Imaging (MRI) techniques, with an estimated mean positioning error smaller than 0.1 mm. Highly accurate motion was also confirmed through visual examination by performing multiple ablations on a plastic film. For MR compatibility assessment, quantitative evaluation was performed by calculating the signal-to-noise ratio during device activation in a 1.5 T scanner using an in-house phantom, as well as through a more comprehensive approach of quality assurance and a series of specialized tests. The system was proven safe for operation inside the scanner without significantly affecting the overall image quality. Due to its compact and simple design, it is easily transportable, ergonomic, and suitable for integration into the bore of up to 7T MRI scanners. Upon veterinary validation, the developed system could be easily translated into clinical medicine for treating abdominal cancer in humans with minimal design modification.

Keywords: MRgFUS; Robotic Device; Veterinary Medicine

2021 International Conference on Medical Imaging Science and Technology (MIST 2021)

December 1-3, 2021 ONLINE via MS Teams

CERTIFICATE OF ORAL PRESENTATION

This certificate is awarded to

Dr. Manish N. Tibdewal

in recognition of your presentation titled

Analysis of Psychophysiological Effects of Meditation Through Electroencephalogram

MIST 2021
Organizing Committee

Conference Chair

Analysis of Psychophysiological effects of Meditation through Electroencephalogram

Manish N. Tibdewal
Department of Electronics and Telecommunication Engineering
Shri Sant Gajanan Maharaj College of Engineering, SHEGAON, 444203,
MAHARASHTRA, INDIA
mntibdewal@ssgmce.ac.in

Dhanashri N. Nagbhide
Department of Electronics and Telecommunication Engineering
Shri Sant Gajanan Maharaj College of Engineering, SHEGAON, 444203,
MAHARASHTRA, INDIA
dhanashri4nagbhide@gmail.com

***Abstract* — Meditation has a metaphysical influence on the physical as well as mental health of humans. It promotes relaxation to the human being which is required for alleviating stress. This experiment investigates the psychophysiological effects of meditation using an electroencephalogram (EEG). In this research work, the analysis of EEG signals is done for cognitive effects on the human brain for before and after meditation intervention of 25 subjects. The aim of this study is to analyze brain functioning after a month of meditation intervention using statistical and spectral analysis. The statistical and spectral analysis was performed through Sample entropy and Power spectral density respectively. The statistical analysis shows that the Sample Entropy decreased after meditation. The spectral analysis stated that theta power has increased 88 % of subjects whereas the alpha power is increased for the entire subjects after meditation. These features index the meditation improves relaxation, cognitive functions. In future, the work shall be extended by increasing more subjects with a sustained period of meditation to present the more benefits of meditation.**

Keywords—EEG, meditation, Sample entropy, Power spectral density.

I. INTRODUCTION

Meditation has been used to address the various health related problems for ages. Basically, meditation is an activity that supports to enhance the understanding of self realization. Nowadays, the psychological stress arises from decrescent work load, tends to insomnia, negativity, depression and many other symptoms that turns into long term heath related issues.

Meditation is an effective solution to reduce the stress which can remarkably affect on physical as well as mental health as studied in previous [1], [2]. The EEG is a temporal technique that record and monitor the electrical activity of human brain cerebrum. The rootlet of EEG activity is the electric potential within the neurons of the human brain. The EEG activity produces oscillations at different types of frequencies [3]. This technique used to analyze the effects of meditation.

The EEG signal analysis is frequently grouped in frequency bands: delta, theta, alpha, beta, and gamma. Delta band (0.5–4 Hz), the slowest and strongest brain wave which is mainly involved with deep sleep or dreamless sleep is also found during deep meditation. Theta band (4–8 Hz) is linked with drowsiness, light sleep, concentration, deep relaxation, or meditation. Alpha band (8–12 Hz) is related to relaxation, calmness, or peaceful state. Beta band (12–30 Hz) is associated with normal awaking consciousness, high alert, active thinking, angry, anxiety, or focus. Normally, a person functions in frequency band during daytime. Gamma band (30–100 Hz) is the fastest brain wave associated with hyperactivity or the processing of information from different brain areas.

EEG studies have been used with different signal processing techniques to mention the brainwave changes that arise during meditating [4]. Dillbeck et al. found that significant changes in frontal alpha coherence in TM practice [5]. Incagli et al. conducted the meditation program to examine the cognitive process [6]. Ahmed et al. studied the effect of mental behavior through DWT [7]. Ahani et al. proposed methods to analyze the changes of EEG and respiration signals for meditation and control state [8]. Mingqian et al. carried the experiment to investigate the insight of mindfulness meditation [9]. Fulpatil et al. examined the EEG signal during meditation using a wavelet function [10].

Andrew et al. investigated the utilization of EEG screening for personalized approach in the meditation [11]. Sobolewski et al. explored the effect meditation impact on emotional regulation [12]. Sharma et al. implied that regular meditation practice can affect the positive impact on brain areas especially, on frontal and parietal areas [13]. Frederick Travis narrated the importance of narrow frequency bands that reflects the different cognitive process [14]. Kora et al. elaborated the different meditation styles on Brain waves concerning physical and mental health [15].

Meditation produces changes in certain frequency bands. It is essential to process EEG signals because of non-stationary, highly non-linear, and stochastic behavior. Hence in order to investigate the meditation impact on human brain, this study examines EEG signals for before meditation and after a month

of meditation intervention. The analysis performed through statistical and spectral features for 25 subjects using the features: Sample entropy and power spectral density.

II. METHODS AND MATERIAL

In this work, the 'Medicaid Neuro-Compact 2400' system is used to acquire EEG signals from different subjects using Ag-Cl types of electrodes for analyzing the impact of meditation. There are total 21 electrodes for data acquisitions with 10-20 international system. The sampling frequency (Fs) is observed as 114 Hz. Here, the experiment conducted on 25 novice healthy subjects between the age group of 16–50 year including male and female genders.

The EEG signal recording is done before meditation and after a month of meditation intervention for the same 25 subjects. Before meditation, the EEG data recorded when the subjects are in a calm and relaxed state with their mind stable for 10 min. The same subjects have performed meditation continuously for a minimum 15-30 minutes daily for a month. After a month of meditation, the EEG of meditators was recorded for 5-7 min.

The prefrontal cortex is majorly responsible for the cognitive process [9]. Thus, for analysis of the cognitive effects of meditation the frontal lobe electrodes (F3, F4, F7, F8, FP1, FP2, Fz) are used. Each epoch has a total of 912 samples. The EEG signals are sampled at 114 Hz over 8 second time duration. All the datasets are processed by designing every step. The implementation is done through the MATLAB (R2015a) 8.5.0.197613 platform. The ethical clearance is acquired from the Government Medical College Akola, Maharashtra, India.

The feature extraction carried by utilizing finite impulse response (FIR) filter for the separation of EEG bands as per frequency bands. FIR band pass filter process by assigning the '0.001' value as band attenuation, '1' value as the pass band ripple and '20' as the density factor.

All features are evaluated at the frontal electrodes for various bands, including delta, theta, alpha, and beta. The delta is excluded in the study because of its hyperactivity in nature. The statistical and spectral analyses are performed by extracting Sample Entropy and Power spectral density. These features are extracted band wise for both control and meditators group with frontal lobe channels of EEG time series. The student t-test is performed to examine the discrimination of control and meditators group. The p-values estimated from the t-test show how better these data discriminate between both cases. The equations for computation of each of the features are demonstrated as below:

Sample Entropy (SampEn)

The Sample Entropy measures the randomness of a time series. A high random brain indicates creativity or anxiety. It is useful to obtain the nonlinear interrelations and complexity of brain areas. The sample Entropy is one of the types of different entropies.

It is a measure of information as the measure probability distribution. The SampEn is less affected by the presence of noise. So as to evaluate the SampEn, two parameters are required, which is length of compared window m and tolerance r. The SampEn [16] value is calculated for the time series with N samples, as discussed below:

$$sampEn(m, r, N) = -\ln[\frac{A^m(r)}{B^m(r)}] \quad (1)$$

Where, $B^m(r)$ = Probability that two vectors will match for 'm' samples and $A^m(r)$= Probability that two vectors will match for $m + 1$ samples.

Power spectral density (PSD)

The spectral analysis will illustrate the activity of brain over different regions and different states, which reflect the general arousal levels of brain. Power spectral density represents the power distribution of EEG series per unit frequency. PSD is evaluated using Fast Fourier Transform (FFT) quantifies the amount of activity in a different frequency band of EEG signal that reveals the strength of variation as the function of frequency.

Let $x[n]$ = EEG data

$$Power = \frac{1}{N}\sum_{k=0}^{N-1}|X[k]|^2 \quad (2)$$

where, N = Length of EEG signals, $X[k]$ = DFT of $x[n]$.

PSD estimation is a non-parametric method utilized to calculate the power spectrum of EEG time series as a function of frequency while maintaining the balance between smoothing in time and frequency resolution. The analysis is performed through all four bands after averaging frontal electrodes for before and after meditation intervention. All 25 subjects' EEG signals processed using band pass filter. After feature extraction each band is separated and hence delta, theta, alpha and beta power is calculated as shown in fig.1.

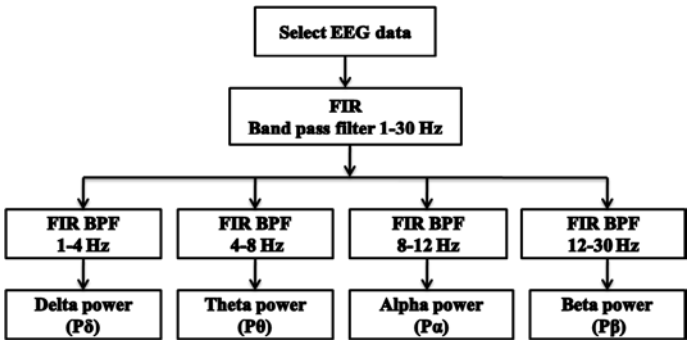


Fig .1. Flow chart of PSD estimation

III. RESULTS AND DISCUSSION

Statistical Analysis

According to the methodology the analysis of each subjects' EEG signals is done for before and after meditation. The study estimates the statistical and spectral analysis after

averaging the seven frontal channels of EEG data. Here it is demonstrated the features such as Sample Entropy and Power Spectral Density. Table 1, shows the differences in statistical and spectral features of all 25 subjects for pre and post meditation.

It is inferred that the average sample entropy value for average of theta and alpha band is decreased in meditators whereas in delta and beta bands it is increased after a month of meditation intervention. The theta and alpha bands' sample entropy is low for meditators as compared to the control group. The sample entropy of delta band is 0.23 and 0.24, theta band is 0.48 and 0.45, alpha band is 0.49 and 0.48, beta band is 0.68 and 0.69 for the control and meditators group respectively. A high random brain indicates creativity or anxiety. Hence, decreased sample entropy indicates decrease in randomness and increase in non-linearity of EEG signals. As the non-linearity increases, brain cognitive functions perform better.

The *p*-value is evaluated from student t-test for different bands with < 0.05 as a significant level. Table 2 shows the p-values for both features between control group and meditators group.

Table 1: Sample entropy and Power features for before (control group) and after a month of meditation intervention (meditators group)

Subjects/ Gender/Age	Features	EEG bands: Control Group				EEG bands: Meditators Group			
		Delta	**Theta**	**Alpha**	**Beta**	**Delta**	**Theta**	**Alpha**	**Beta**
S1/M/19	**Sample entropy**	0.23	0.45	0.5	0.6	0.25	0.48	0.46	0.65
	Power	180.52	23.85	0.25	4.97	153.58	27.14	7.1	1.58
S2/F/19	**Sample entropy**	0.32	0.48	0.46	0.61	0.28	0.46	0.49	0.6
	Power	282.22	20.95	0.23	3.17	139.45	35.19	4.75	1.69
S3/F/19	**Sample entropy**	0.26	0.52	0.51	0.62	0.29	0.49	0.47	0.75
	Power	120.39	27.9	0.4	15.64	128	41.7	19.34	3.79
S4/F/22	**Sample entropy**	0.22	0.51	0.41	0.63	0.29	0.36	0.54	0.62
	Power	109.38	17	0.19	4.35	34.29	31.73	11.27	3.42
S5/F/18	**Sample entropy**	0.24	0.42	0.47	0.7	0.21	0.49	0.47	0.64
	Power	137.19	38.33	0.27	3.53	531.35	85.4	50.79	1.26
S6/M/32	**Sample entropy**	0.26	0.49	0.54	0.64	0.22	0.45	0.49	0.71
	Power	463.74	19.69	0.17	7.67	101.35	53.47	11.62	1.58
S7/M/29	**Sample entropy**	0.28	0.47	0.51	0.57	0.24	0.5	0.48	0.93
	Power	100.43	14.35	0.51	7.69	71.25	71.86	5.25	2.12
S8/F/22	**Sample entropy**	0.2	0.48	0.47	0.88	0.25	0.44	0.54	0.78
	Power	624.08	14.01	0.2	1.92	71.25	14.35	18.86	2.12
S9/F/23	**Sample entropy**	0.18	0.48	0.52	0.87	0.26	0.52	0.51	0.76
	Power	748.78	19.33	0.24	4.04	132.34	22.51	4.79	2.34
S10/F/21	**Sample entropy**	0.28	0.47	0.42	0.69	0.27	0.48	0.48	0.68
	Power	132.85	65.16	0.69	5.46	90.11	62.76	9.62	4.5
S11/F/50	**Sample entropy**	0.21	0.48	0.47	0.64	0.3	0.42	0.52	0.61
	Power	254.43	96.89	0.53	12.63	76.07	32.94	8.26	4.9
S12/M/24	**Sample entropy**	0.22	0.43	0.5	0.69	0.23	0.52	0.52	0.67
	Power	132.71	34.34	0.15	2.81	428.47	65.8	20.74	4.13
S13/F/18	**Sample entropy**	0.38	0.48	0.5	0.71	0.26	0.41	0.48	0.72
	Power	107.25	140.3	1.68	131.53	342.05	162.69	84.1	151.11
S14/F/18	**Sample entropy**	0.21	0.5	0.53	0.74	0.25	0.38	0.46	0.7
	Power	1302.16	73.07	0.22	1.91	444.75	141.51	15.73	3.73
S15/F/23	**Sample entropy**	0.19	0.44	0.51	0.67	0.23	0.49	0.51	0.77
	Power	324.08	17.46	0.15	5.73	154.49	19.64	12.58	1.27
S16/M/24	**Sample entropy**	0.22	0.49	0.49	0.67	0.28	0.45	0.42	0.6
	Power	273.4	16.4	0.21	1.33	138.3	28.85	13.02	6.07

S17/F/19	**Sample entropy**	0.21	0.49	0.48	0.57	0.22	0.45	0.49	0.59
	Power	253.62	20.01	0.51	3.63	159.16	71.85	8.23	7.73
S18/F/16	**Sample entropy**	0.19	0.54	0.5	0.65	0.25	0.48	0.46	0.65
	Power	104.09	17.35	0.14	2.4	153.58	27.14	7.1	1.58
S19/F/18	**Sample entropy**	0.19	0.45	0.55	0.71	0.21	0.38	0.55	0.7
	Power	337.26	24.22	0.09	3.62	127.95	60.78	17.95	1.52
S20/F/18	**Sample entropy**	0.22	0.45	0.54	0.76	0.19	0.51	0.52	0.79
	Power	117.49	63.73	0.68	18.62	418.91	57.56	23.37	24.78
S21/M/28	**Sample entropy**	0.2	0.51	0.49	0.72	0.23	0.51	0.41	0.78
	Power	397.05	10.98	0.41	3.22	154.16	55.61	10.57	2.86
S22/F/18	**Sample entropy**	0.23	0.51	0.52	0.71	0.21	0.49	0.48	0.68
	Power	716.44	49.71	0.28	6.31	208.08	82.41	16.42	1.26
S23/F/48	**Sample entropy**	0.24	0.48	0.49	0.56	0.25	0.49	0.48	0.56
	Power	159.17	28.34	1.02	18.99	1157.57	57.81	63.49	10.88
S24/M/30	**Sample entropy**	0.2	0.49	0.51	0.71	0.19	0.52	0.44	0.76
	Power	476.73	16.97	0.26	1.45	164.58	24.05	15.31	2.38
S25/F/18	**Sample entropy**	0.25	0.52	0.49	0.69	0.21	0.43	0.41	0.62
	Power	470.55	38.13	34.97	3.22	309.47	43.4	0.86	5.27

Table 2: *p*–Values of different EEG rhythms for Sample Entropy and Power

features	**p-value (EEG Band)**			
	Delta	**Theta**	**Alpha**	**Beta**
Sample Entropy	1.01E-01	1.01E-01	1.06E-01	2.50E-01
Power	1.01E-01	8.70E-04	7.71E-08	2.35E-01

Power Spectral analysis: The aim of this work is to investigate the effects on human being brain after the meditation. This is done by examining the different brain rhythms. The Spectral analysis gives information regarding to the existence of different frequency bands of EEG that reflects the general arousal levels of the brain [18]. Here the spectral analysis calculated by using FFT shows the power distribution over the brain regions. The FFT method is utilized to convert a signal from the time domain to frequency domain.

The maximum power value is extracted from the maximum amplitudes of the EEG signals shown in Table 1. It is observed that there is an overall increase in power after a month of meditation, in theta and alpha bands compared with the control group. While delta and beta band power decreases. Increased power in the alpha band implies high activity while doing easy tasks and theta band indicates subject alert to the external environment [9]. Whereas the delta band and beta band power are decreased in the corresponding subject.

From the analysis, theta and alpha bands are stronger with respect to band power in meditators than the control group which implies that theta and alpha changes appear from meditation practice. The increases in alpha and theta band power and decrease in frequency correlates with the lower level of anxiety and a higher level of calmness [1]. As the subject get calm it said that emotionally stable state and thus, subjects can increase concentration level. The alpha and th band shows that $p \ll 0.05$ while delta and beta bands indicate $p > 0.05$. From the observation of p-value, it is implied that the theta band has a lower *p*-value while alpha band has higher discriminating data set between the control group and the meditators group as shown in table 2.

Through the power spectral analysis, it is perceived that power in theta and alpha bands increases significantly which supports and signifies the previous studies conducted on meditation. It is stated that, after meditation, there is a considerable increase in theta power for 88 % subjects' and an increase in alpha power for all the subjects. Whereas the delta and beta bands power are decreased. Theta band is associated with alertness, attention, working memory, concentration, and increased awareness of surrounding. Hence, the psycho-physiological effects are obtained by statistical and spectral features as the evidence by alpha and theta bands.

IV. CONCLUSION

The purpose of this innovative work is to analyse the psycho-physiological effects of meditation. The spectral analysis stated that theta power has increased 88 % of subjects whereas the alpha power is increased for all the meditators after meditation. From the quantitative analysis, it is stated that meditation improves psychological parameters in terms of relaxation, stress relief whereas, physiological parameters in terms of cognitive abilities. In future, the work shall be extended by increasing more subjects with sustained period of meditation to enact the more benefits of meditation.

ACKNOWLEDGMENT

Authors wish to thank Dr. Monika Malokar, MD, DM (Neurology), Neuro physician, Malokar Hospital; Akola, Maharashtra, India for providing all types of data base whenever required.

REFERNCES

[1] Shih-Feng Wang, Yu-HaoLee, Yung-Jong Shiah, Ming-Shing Young, Time-Frequency Analysis of EEGs Recorded during Meditation, Robot, Vision and Signal Processing (RVSP), 2011 First International Conference on, Nov. 2011, pp.73-76, DOI 10.1109/RVSP.2011.91.

[2] Meditation Practices for Health: State of the Research Evidence Report/Technology Assessment, *No.* 155, University of Alberta Evidence-based Practice Center Edmonton, Alberta, Canada, June 2007, AHRQ Publication No. 07-E010.

[3] S. R. Benbadis, A. M. Husain, P. W. Kaplan, and W. O. Tatum, William Tatum, Selim Benbadis, Aatif Husain, and Peter Kaplan. Handbook of EEG interpretation, Demos Medical Publishing, 2007.

[4] F. R. On, R. Jailani, H. Norhazman and N. Mohamad Zaini, Binaural beat effect on brainwaves based on EEG, IEEE 9th International Colloquium on Signal Processing and its Applications, Kuala Lumpur, Malaysia, March. 2013, pp.339-343, https://doi.org/10.1109/CSPA.2013.6530068.

[5] Michael C. Dillbeck And Edward C. Bronson Short-term longitudinal effects of the transcendental meditation technique on eeg power and coherence, Intern. J. Neuroscience,1981, 14(3-4), pp. 147-151, https://doi.org/10.3109/00207458108985827.

[6] Incagli, Francesca, Vincenza Tarantino, Cristiano Crescentini, and Antonino Vallesi, The effects of 8-week mindfulness-based stress reduction program on cognitive control: an EEG study, *Mindfulness* 11, no. 3 (2020): 756-770.

[7] Ahmed, T. Islam, M. Yusuf, M.S.U. Ahmad, M., Wavelet based analysis of EEG signal for evaluating mental behavior, International Conference on Informatics, Electronics & Vision (ICIEV), 2013 May, pp.1-6,https://doi.org/ 10.1109/ ICIEV. 2013.6572706.

[8] AsiehAhani, Helane Wahbeh, Meghan Miller , Nezamfar H, Erdogmus D and Oken B, Change in physiological signals during mindfulness meditation, 6th Annual International IEEE EMBS Conference on Neural Engineering, San Diego, California, 2013 November, pp. 1738-1381, https://doi.org/10.1109/ NER. 2013. 6696199.

[9] Mingqian Liu and Nugraha Priya Utama, Meditation Effect on Human Brain Compared with Psychological Questionnaire, International Journal of Information and Education Technology, June 2014, Vol. 4(3). pp. 264-269.

[10] Prajakta Fulpatil, Yugandhara Meshram, Review on Analysis of EEG Signals with the Effect of Meditation, Int. Journal of Engineering Research and Applications, Vol. 4, Issue 6(Version 6), June 2014, pp.51-53.

[11] Andrew A. Fingelkurts, Alexander A. Fingelkurts, Tarja Kallio-Tamminen, EEG-Guided Meditation: A Personalized Approach, Journal of Physiology-Paris, Dec 2015,109(4-6),pp. 180-190.https://doi.org/10.1016/j.jphysparis.2015.03.001.

[12] Sobolewski, Aleksander, Ewa Holt, Ewa Kublik, and Andrzej Wróbel., Impact of meditation on emotional processing—a visual ERP study,Neuroscience research 71, no. 1 (2011): 44-48.

[13] Kanishka Sharma, Sushil Chandra, Ashok Kumar Dubey, Exploration of lower frequency EEG dynamics and cortical alpha asymmetry in long-term rajyoga meditators, International Journal of Yoga, Jan 2018,11(1), pp. 1-6.

[14] Travis, Frederick, Temporal and spatial characteristics of meditation EEG, Psychological Trauma: Theory, Research, Practice, and Policy 12, no. 2 (2020): 111 https://psycnet.apa.org/doi/10.1037/tra0000488.

[15] Kora, Padmavathi, K. Meenakshi, K. Swaraja, A. Rajani, and Mantena Satyanarayana Raju, EEG based Interpretation of Human Brain activity during Yoga and Meditation using Machine Learning: A systematic review, Complementary Therapies in Clinical Practice (2021): 101329.https://doi.org/10.1016/j.ctcp.2021.101329

[16] Keshmiri, Soheil, Entropy and the Brain: An Overview, Entropy 22, no. 9 (2020): 917.https://doi.org/10.3390/e22090917

[17] Manish N. Tibdewal, Himanshu R. Dey, Mahadevappa Manjunatha, Ajoy Kumar Ray, Monika Malokar, Multiple entropies performance measure for detection and localization of multi-channel epileptic EEG, Biomedical Signal Processing and Control,2007, 38, pp.158–167, https://doi.org/10.1016 /j.bspc. 2017.05.002.

[18] Narayanan Srinivasan, Cognitive neuroscience of creativity: EEG based approaches, May 2007, 42(1), pp.109-16.

Application of Modified Restricted Boltzmann Machine (mRBM) for denoising of motion-artifacted MRI scans

Vijay R. Tripathi
Department of Electronics and Telecommunication
G. H. Raisoni University
Amaravati, India, 444701
vijayrtripathi@rediffmail.com

Manish Tibdewal
Department of Electronics and Telecommunication Engineering
Shri Sant Gajanan Maharaj College of Engineering
Shegaon, India, 444203
mntibdewal@ssgmce.ac.in

Ravi Mishra
Department of Electronics and Telecommunication
G. H. Raisoni Institute of Engineering and Technology
Nagpur, India, 440028
ravi.mishra@raisoni.net

***Abstract*—One of the key difficulties that might impact the diagnosis is motion artifact in MR imaging. A Restricted Boltzmann Machine (RBM) may train itself using a probability distribution over a set of inputs. As a result, RBM may be used to create MRI scans that are devoid of artifacts. The suggested approach for denoising motion artifact-induced MRI data uses a feedback network to modify the existing restricted Boltzmann machine (RBM). Because to RBM, the number of weights and biases that must be calibrated is limited to visible and hidden layers, considerably speeding up the training process. Once trained, RBM output for a 256 x 256-pixel image takes roughly 2 seconds. mRBM has a root mean squared error (RMSE) of 0.00343. Because mRBM does not require repeat MRI, the speed and accuracy of diagnosis can be increased.**

***Index Terms*—MRI, mRBM, motion artifact**

I. Introduction

Human movements are unavoidable and may lead to motion artifacts during magnetic resonance imaging [1], [2]. The motion artifact-induced MRI is generally degraded in its image quality [3]. Because of the low SNR, such MRIs are not very useful in diagnosis. Low SNR due to the gradient echos cause blurring in the MRI images [4].

Restricted Boltzmann Machine (RBM) is used to extract features from an image [5]. Typically hidden layers are trained in an RBM using feature activation of its visible layer [6], [7]. RBM has two biases which are distinctive features in comparison to other methods reported in the literature [8], [9]. The hidden bias allows activation in the forward path.Visible layer bias helps in the reconstruction of the RBM in the backward direction. RBMs are shallow networks consisting of only two layers - the visible layer and the hidden layer. Nodes are interconnected across the layers but no two nodes of the same layer are linked. RBMs are called restricted Boltzmann machines because there is no intralayer communication.

Figure 1 shows the proposed methodology of the modified RBM. As shown in Fig. 1 (a) MRI scans are pre-processed to remove the name and other printed information. The name-removed output is then transformed into a 1-D array, with the region of interest (ROI) moved in the center. Each pixel in the visible layer gets its multiplying weight.When all of the pixels of a 2-D image are processed through the visible and hidden layers, a difference image is formed. This image is then compared to the ground truth, yielding a different image. The learning rate and the values in the difference image are used to alter all of the weights and biases. In Fig. 1 (b), a blinded sample with trained mRBM is used for real-time motion artifact correction testing. The RMSE was calculated using the ground truth and the generated output image. With the available dataset, the minimal RMSE value can be as low as 0.008.

II. Literature Review

Lyu *et al.* [10] employed a recurrent neural network to reduce heart motion artifacts. They claim that their approach produces superior image quality than any of the cardiac images published in the literature. Lyu employed a recurrent neural network to reduce heart motion artifacts in MRI images. They integrated bidirectional convolutional long short-term memory with multiscale convolution. They also recommended using the same approach to rebuild missing frames in order to improve temporal resolution. Zhao *et al.* [11] has presented deep learning-based MRI artifact reduction (DMAR). They were successful in lowering the RMSE to 0.068. They were able to obtain a maximum PSNR of 23.38 dB. Oh *et al.* [12] corrected motion artifacts in MRI pictures using unsupervised deep learning algorithms. The photos were 320 × 320 pixels in size. Their recorded PSNR was 24.47, which was higher than the value given by pix2pix. They obtained a PSNR of

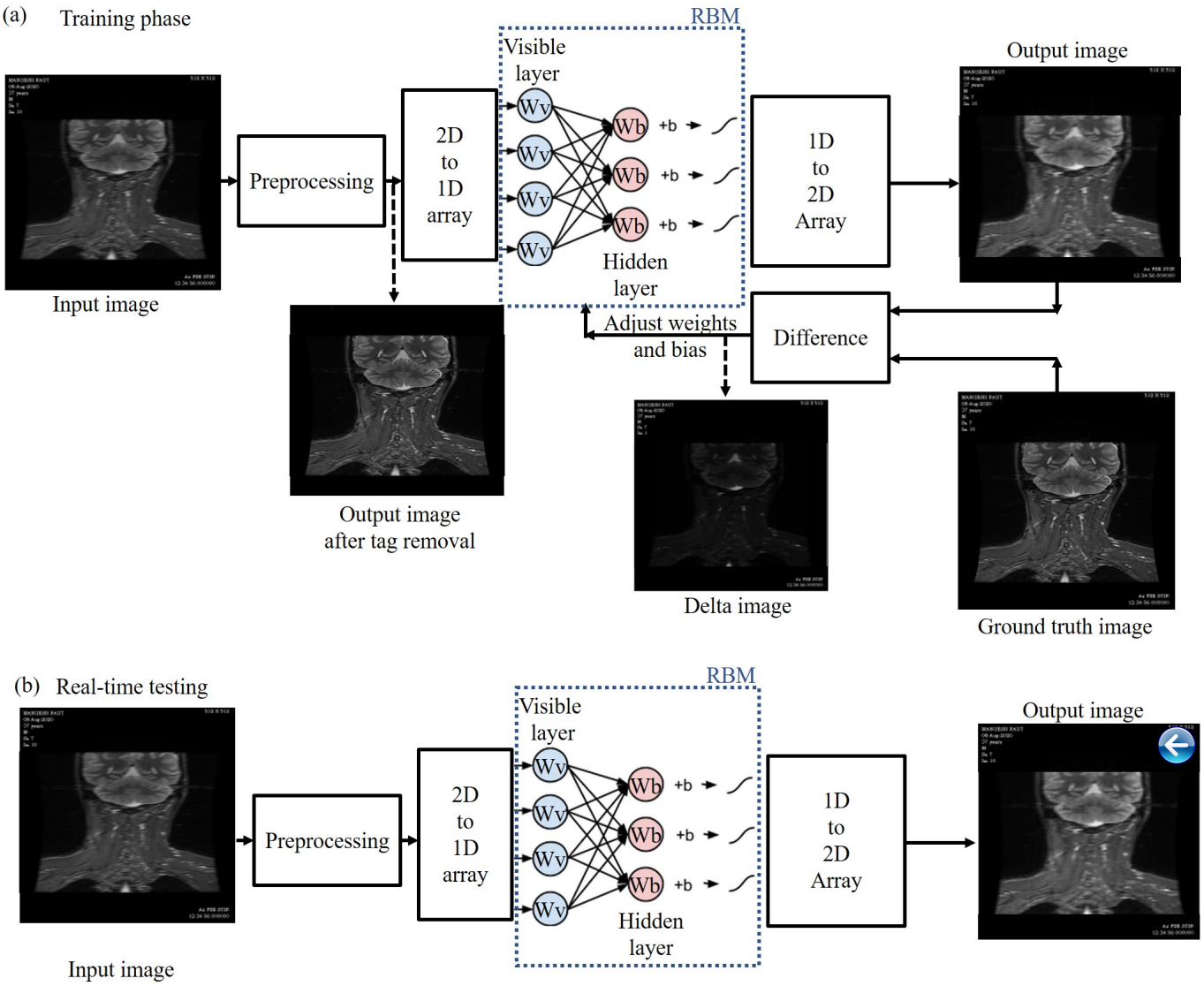


Fig. 1. Concept diagram for the proposed methodology. (a) The proposed system architecture uses a blurry MRI scan and its corresponding ground-truth version that was recaptured, as inputs. The name and other printed information are removed from the MRI images during preprocessing, and the data is converted to a 1D array. The 1D array is then sent into the RBM, where each pixel on the visible layer gets its multiplying weight. After that, all of the pixels are passed through the hidden layers, the weight of each hidden layer is multiplied, and the bias is added. To generate a difference image, the 1D output image is transformed to a 2D image before being compared to the ground truth image. (b) The proposed method is tested in real-time on a blinded sample using trained mRBM, with the resulting output image being used for RMSE estimates. We discovered that RMSE can be as low as 0.008.

34.13. Armanious *et al.* [13] proposed using cycle GAN to fix motion artifacts. They received an MSE of 375.01 for the 256 × 256 image size. Cycle-MedGAN and Cycle-MedGAN V2.0 were also created. Ciric *et al.* [14] improved MRI scans by 100 times using motion estimation and mathematical expressions. In addition, motion artifacts could be corrected in as little as 40 minutes to 4 hours.

Pipe *et al.* [15] employed Propeller MRI techniques to fix spatial discrepancies by sampling K-Space data. Their approach identifies and rejects data that has motion artifacts. Diffusion-weighted imaging (DW) was employed by Liau *et al.* [16]. They discovered that signal dropout occurs during heart scanning and is proportional to the b value. To eliminate motion artifacts in MRI, Smith *et al.* [17] employed a pulse sequence, better scanning, and a specific pulse design. To reduce motion artifacts, Goto *et al.* [18] employed regional displacement interaction (RDI) and scrubbing. Wang *et al.* [19] employed a convolutional constrained Boltzmann machine to predict breast cancer pathological response. The feature map is extracted using the CRBM, which is subsequently used for classification. In both the visible and hidden layers of their convolutional RBM model, they used a 2D block. They utilized a standard PCR as a comparison. They were able to obtain a maximum accuracy of 80 %.

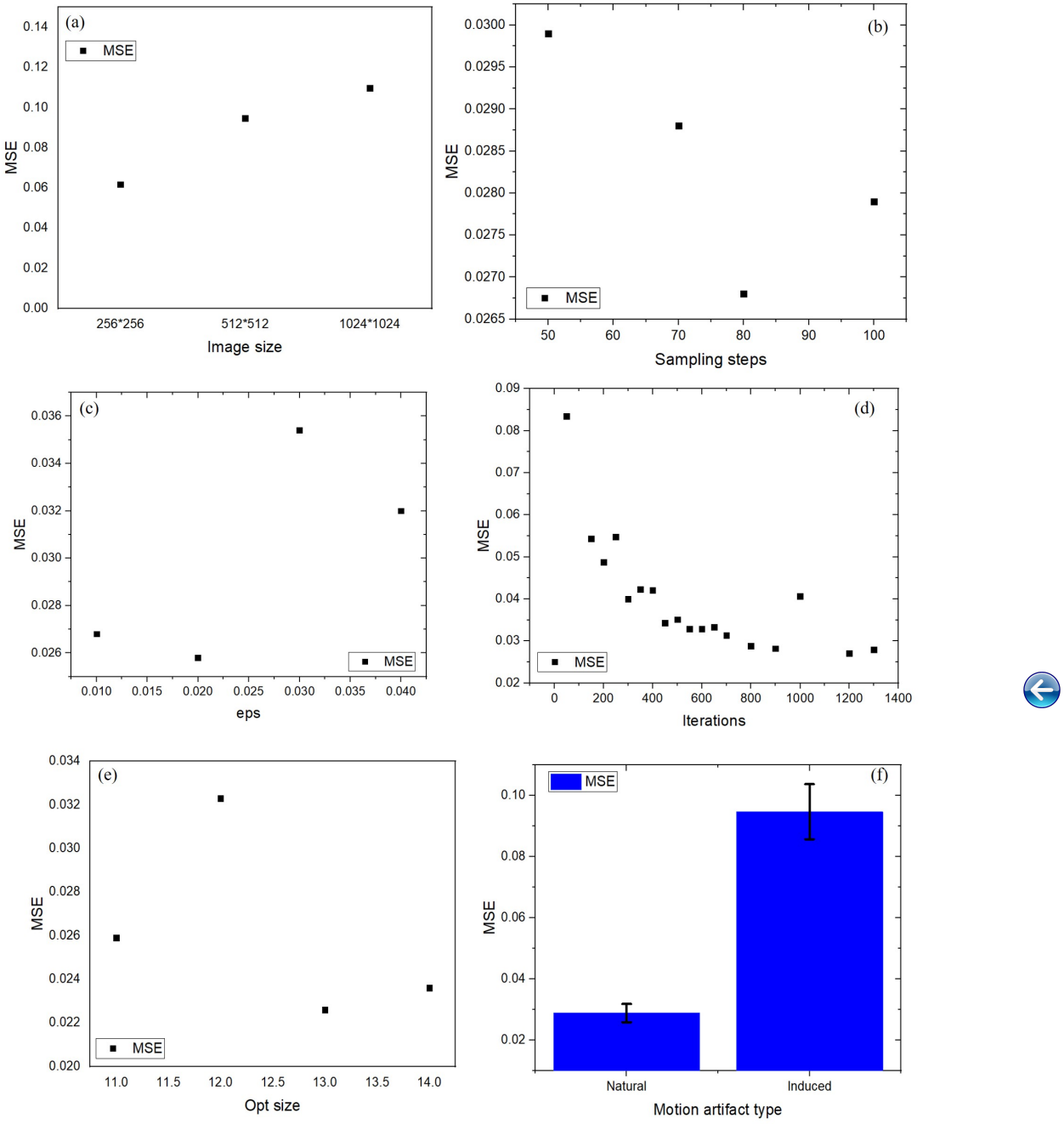


Fig. 2. Optimizing learning parameters with respect to Mean Square Error (MSE). (a) Plot of variation of input image size vs MSE. 256 X 256 pixels yields the lowest RMSE. (b) Plot of variation of sampling steps vs MSE. 80 sampling steps was the most optimal value. (c) Plot of variation of learning rate vs MSE. MSE was lowest at the learning rate of 0.02. (d) Plot of variation of the maximum number of iterations vs MSE. The lowest RMSE was produced in 900 iterations. (e) Plot of variation of the mini-batch size vs MSE. A mini-batch size of 13 yields the lowest RMSE value. (f) Comparison of RMSE for natural and artificially-induced motion artifacts in MRI scans. The average RMSE for natural motion artifacted MRI scans was lower than the average RMSE value of artificial motion artifacted MRI scans. Hence the proposed mRBM system should be preferred in cases of natural motion artifacts occurring in MRI scans.

III. Methodology

All of the image files that needed to be trained were housed in a single folder. The training inputs were set to a size of 256 × 256 pixels for the length and breadth of the images. We also tried 512 X 512 pixels and 1024 X 1024 pixels as size variations. If there were any colored images, they were transformed to grayscale, and all of the photos were changed from their standard uint-8 format to double format for mathematical computation.

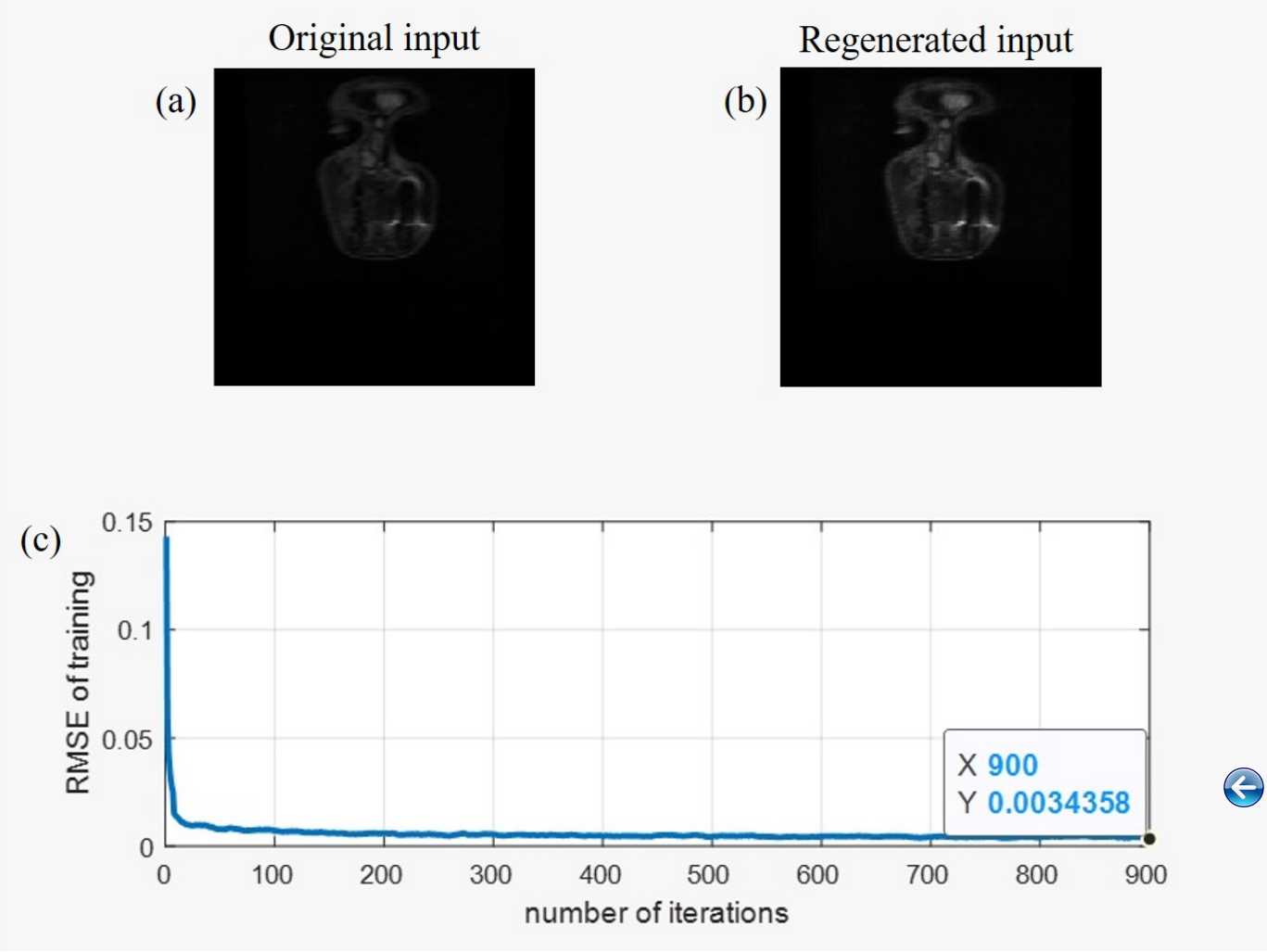


Fig. 3. Testing the proposed mRBM algorithm. (a) A motion blurred MRI scan is provided as input to the system. (b) Corresponding output generated by mRBM. (c) Plot of iterations vs Root Mean Square Error (RMSE). For this particular pair of input and output images, the lowest RMSE was 0.00343 obtained after 900 iterations.

We employed a conventional restricted Boltzmann machine (RBM method) and adjusted its parameters based on the difference between motion artifact corrected photos and their ground truths. The number of learning iterations that could be performed was limited to 900. We performed the algorithm from 50 to 1300 iterations with a configurable step size of 50, 100, and 200 to get the optimal number of iterations for the desired accuracy. The number of neurons in the hidden layer was set to 256 and the size of the mini-batch data was set at 13 images. We experimented with changing the learning rate from 0.01 to 0.04 in 0.1 increments. We also attempted Gibbs sampling steps of 50, 60, 70, 80, 90, and 100. The RMSE was minimized in all of these versions.

A. Details of training with mRBM

The entire input data was normalized between 0 to 1 using equation 1 and 2.

$$xn(i) = x(i) - min(x) \tag{1}$$

Where,
xn(i) is difference between the current value and the minimum value.
x(i) is the pixel value at ith location where i goes from 0 to (m X n).
min(x) is minimum value in image x.

$$xnormalized(i) = xn(i)/(max(x) - min(x)) \tag{2}$$

Where,
xnormalized is the normal value of x.
max(x) is maximum value in image x.

For both visible and hidden layers, all starting biases were set to 0. The seed point was chosen at random and mini-batch data was loaded following the seed point for training. Each neuron's initial weights were created at random. We began Gibbs sampling with the energy function. The hidden weights

were adjusted using sigmoid functions of the visible layer weights. Equation 3 gives the sigmoid function.

$$S(w) = 1/1 + e^{-w} \tag{3}$$

Where,
S(w) is the sigmoid function at w.
w is the weight value of the other layer.

The weights of visible layers were adjusted as a sigmoid function of the weights of newly discovered hidden layers. In terms of ground truth, positive divergence (pd) and negative divergence (nd) were calculated. As indicated in equation 4, the network weights were changed according to the learning rate specified and constructive divergence.

$$w(itr) = w(itr-1) + \epsilon\ X\ (pd - nd) \tag{4}$$

Where,
w(itr) is the weight value of the current iteration.
w(itr-1) is the weight value of the previous iteration.
ϵ is the learning rate.
pd is the positive divergence.
nd is the negative divergence.

The overall difference between the visible layer and the ground truth image from the mini-batch with which we started was used to update the bias of visible layers.

$$b(itr) = b(itr-1) + \epsilon\ X\ (O(itr) - GT) \tag{5}$$

Where,
b(itr) is the bias value of the visible layer in the current iteration.
b(itr-1) is the bias value of the visible layer in the previous iteration.
O(itr) is the output of the current iteration.
GT is the ground truth

$$hb(itr) = hb(itr-1) + \epsilon\ X\ (O(0) - O(itr)) \tag{6}$$

Where,
hb(itr) is the bias value of the hidden layer in the current iteration.
hb(itr-1) is the bias value of the hidden layer in the previous iteration.
O(0) is the output of the first iteration.
O(itr) is the output of the n^{th} iteration at which the node is activated.

$$RMSE = \sqrt{\frac{1}{m\ X\ n}\sum(O(i) - GT(i))^2} \tag{7}$$

Where,
RMSE is the root mean sqaure error.
m X n is the total number of locations
O(i) is the output of the i^{th} location.
GT(i) is the ground truth of the i^{th} location.

The visible layer's revised biases are presented in equation 5. Similarly, the hidden layer's biases were adjusted using the learning rate and the difference between the initial output and the output of the last iteration, where the output image is identical to the ground truth (as shown in equation 6). The RMSE of a mini-batch image is calculated by comparing the output of the last visible layer to the ground truth for that image. The existing trained mRBM network is used to import all of the training parameters, such as weights and biases. Visible layer biases and hidden layer biases are examples of these biases. The input is denoised using this trained network after the accuracy is within the specified range. By comparing the output of the last visible layer to the ground truth for that particular mini-batch image, the RMSE is calculated (as shown in equation 7).

B. Experimental Procedure

A group of local hospitals in Mumbai and Akola provided us with 160 motion artifact-induced MRI images. The photographs were in the 32-bit Digital Imaging and Communications in Medicine format (DICOM). Before sending the dataset, the hospital erased the identities of all patients for data privacy reasons. All of the photos were saved in two different datasets, one with 50 % training data and the other with 50 % testing data. The original graphics were 512 by 512 pixels in size. The images were downscaled to a size of 256 × 256 pixels for analysis and speed optimization. Between the labeling of the two images, there is a perfect correlation. The images were upscaled to a resolution of 1024 by 1024 pixels to better comprehend the influence of size fluctuation. We treated an entire range of 50 samples to 100 samples with a configurable step size to optimize the amount of Gibbs samples to be considered. The number of Gibbs samples and the image size were both optimized. The mRBM's mini-batch size ranged from 11 to 14 images in 1 image increments. We also attempted to create a motion artifact image and fix it for better analysis. Finally, the mRBM's mini-batch size ranged from 11 to 14 images in steps of 1.We employed a rotation and translation procedure to create the intentionally created motion artifact images. The image was rotated by a 10-degree angle and translated to a 10-pixel motion, and the final image was created by averaging the original image with the rotated and translated image. We utilized a motion blur filter with fspecial for averaging, and the final image was created with the imfilter function. For the required image and the generated image from the modified restricted Boltzmann machine, the RMSE was calculated.

IV. Results

The image sizes were modified from 256 x 256 pixels to 1024 × 1024 pixels, as shown in Fig. 2 (a). The RMSE increases from 0.6 to 0.11 as the image size increases. The sample steps were varied between 50 and 100, as shown in

TABLE I
COMPARISON OF THE PROPOSED MRBM WITH METHODS REPORTED IN THE LITERATURE

Method	RMSE	Iterations	Execution time (Sec.)	Number of images	PSNR
Tamada *et al.* [3]	0.01	80	–	40	–
Zhao *et al.* [11]	0.068	–	–	375	23.38
Armanious *et al.* [13]	0.805	–	–	–	26.03
Oh *et al.* [12]	0.9078	–	3.2	150	34.13
Rotman *et al.* [20]	0.013	120	159	7474	–
Proposed algorithm mRBM	0.00343	900	1.926	160	34.0875

Fig. 2 (b). As a consequence, 80 sample steps and a 256x256 pixel image size were determined to be ideal.

When the learning rate (eps i.e. ϵ) is altered between 0.01 and 0.04, the RMSE ranges from 0.0255 to 0.036. The effect of iterations variation on the least RMSE is shown in Figure 2 (c). With a learning rate ranging from 50 to 1300 in stages of 50, 100, and 200, the minimum RMSE occurs at 900 iterations as shown in Fig. 2 (d).

Because of the small size of the data set, the RMSE of a minibatch of motion artifact photos ranges from 0.022 to 0.034. The effect of changing the size of the mini-batch from 11 to 14 images is seen in Fig. 2 (e). As illustrated in Fig. 2 (f), we compared 160 naturally induced motion-artifact images to programmatically induced motion-augmented images. Artificially generated motion artifact images have an RMSE roughly three times that of naturally occurring motion artifact images. Artificially produced motion artifact images have an error bar of 0.098, whereas naturally, caused-motion artifact images have an error bar of 0.028. Both sorts of images have the same error bar. As a result, the suggested method outperforms the artificially induced method in the situation of naturally induced motion artifact images.

A sample motion blurred MRI scan and it's corresponding mRBM regenerated output is shown in Fig. 3. The RMSE of a trained mRBM can be as low as 0.00343 after 900 iterations, as shown in Fig. 3. Because the error decreases exponentially after the first 50 iterations, it is expected that at least 100 iterations will be necessary to fix any image with motion artifacts.

A. Discussions

The suggested mRBM technique is compared to existing methods reported in the literature in Table 1. The best approach for RMSE is mRBM, which has a value of 0.00343. Tamada *et al.* [3] and Rotman *et al.* [20] both have good RMSE in the 0.01 area. Other methods have reported only 80 [3] to 120 [20] iterations, however, the suggested technique takes the maximum number of iterations, ensuring greater quality. We also discovered that after the first 50 rounds, our algorithm works well, and we recommend at least 100 iterations for good accuracy. After training, the suggested approach has the best execution time of around 2 seconds, although others have reported 3 seconds [12] and 159 seconds [20]. The proposed approach has the second-best PSNR with 34.08, and Oh *et al.* [12] has the maximal PSNR of 34.13. Rotman *et al.* [20] utilized 7474 images, which was the maximum number of images used in the reported literature. Others, including the suggested technique, have samples ranging from a few hundred to a few thousand (it is difficult to get motion artifact data since most of the time rescan is immediately performed and such data is then discarded to save memory).

We needed a ground truth as well as motion artifact-induced images for this particular mRBM technique. To obtain rapid results, we employed an eight-core processor with 16 GB RAM and 6 GB of GPU. Because the entire network size is dependent on the size of the image, tuning a network like RBM is extremely challenging. Our network's accuracy is determined by the ground truth and their edge-to-edge matching with previous scans. Because the photographs were not aligned in the specific domain, we had to delete around 60 % of the images received. Only when the edge is not blurred can we align a ground truth image with the motion artifact-induced image using an extra pre-processing step based on the Canny edge detector.

V. CONCLUSIONS

Rescanning the MRI is the standard method for eradicating motion-induced artifacts. It is now possible to fix motion artifact photographs using advances in machine learning. The proposed method takes a limited Boltzmann machine and turns it into a closed-loop system that repeats until the error is within acceptable bounds. This mRBM (modified RBM) allows us to fix motion artifacts in less than 2 seconds with an RMSE of 0.00343. PSNR of 34.08 was attained with the proposed approach. The suggested approach required 900 iterations, and we anticipate that in the future, researchers will be able to employ this mRBM algorithm to fix motion artifacts in less time.

DECLARATIONS

Funding information

No funding was involved in the present work.

Conflicts of interest

Authors V. R. Tripathi, M. N. Tibdewal and R. Mishra declare that there has been no conflict of interest.

Code availability

Not applicable.

Authors' contributions

Conceptualization was done by V. R. Tripathi (VT), M. N. Tibdewal(MT), and R. Mishra (RM). All the literature reading and data gathering were performed by VT. All the experiments and coding was performed by VT. The formal analysis was performed by VT and RM. Manuscript writing- original draft preparation was done by VT. Review and editing was done by MT and RM. Visualization work was carried out by VT, MT and RM.

Ethics approval

All authors consciously assure that the manuscript fulfills the following statements: 1) This material is the authors' own original work, which has not been previously published elsewhere. 2) The paper is not currently being considered for publication elsewhere. 3) The paper reflects the authors'own research and analysis in a truthful and complete manner. 4) The paper properly credits the meaningful contributions of co-authors and co-researchers. 5) The results are appropriately placed in the context of prior and existing research.

Consent to participate

This article does not contain any studies with animals or humans performed by any of the authors. Informed consent was not required as there were no human participants. All the necessary permissions were obtained from Institute Ethical committee and concerned authorities.

Consent for publication

Authors have taken all the necessary consents for publication from participants wherever required.

REFERENCES

[1] S. Warach, J. Gaa, B. Siewert, P. Wielopolski, and R. R. Edelman, "Acute human stroke studied by whole brain echo planar diffusion-weighted magnetic resonance imaging," *Annals of Neurology: Official Journal of the American Neurological Association and the Child Neurology Society*, vol. 37, no. 2, pp. 231–241, 1995.

[2] D. Atkinson, D. L. Hill, P. N. Stoyle, P. E. Summers, and S. F. Keevil, "Automatic correction of motion artifacts in magnetic resonance images using an entropy focus criterion," *IEEE Transactions on Medical imaging*, vol. 16, no. 6, pp. 903–910, 1997.

[3] D. Tamada, M.-L. Kromrey, S. Ichikawa, H. Onishi, and U. Motosugi, "Motion artifact reduction using a convolutional neural network for dynamic contrast enhanced mr imaging of the liver," *Magnetic Resonance in Medical Sciences*, vol. 19, no. 1, p. 64, 2020.

[4] S. Park, S. Torrisi, J. D. Townsend, A. Beckett, and D. A. Feinberg, "Highly accelerated submillimeter resolution 3d grase with controlled blurring in-weighted functional mri at 7 tesla: A feasibility study," *Magnetic Resonance in Medicine*, vol. 85, no. 5, pp. 2490–2506, 2021.

[5] M. Midhun, S. R. Nair, V. N. Prabhakar, and S. S. Kumar, "Deep model for classification of hyperspectral image using restricted boltzmann machine," in *Proceedings of the 2014 international conference on interdisciplinary advances in applied computing*, 2014, pp. 1–7.

[6] J. Yu and X. Yan, "Whole process monitoring based on unstable neuron output information in hidden layers of deep belief network," *IEEE transactions on cybernetics*, vol. 50, no. 9, pp. 3998–4007, 2019.

[7] A. Almalaq and G. Edwards, "A review of deep learning methods applied on load forecasting," in *2017 16th IEEE international conference on machine learning and applications (ICMLA)*. IEEE, 2017, pp. 511–516.

[8] A.-r. Mohamed, G. Dahl, G. Hinton *et al.*, "Deep belief networks for phone recognition," in *Nips workshop on deep learning for speech recognition and related applications*, vol. 1, no. 9. Vancouver, Canada, 2009, p. 39.

[9] U. Schmidt and S. Roth, "Learning rotation-aware features: From invariant priors to equivariant descriptors," in *2012 IEEE Conference on Computer Vision and Pattern Recognition*. IEEE, 2012, pp. 2050–2057.

[10] Q. Lyu, H. Shan, Y. Xie, A. C. Kwan, Y. Otaki, K. Kuronuma, D. Li, and G. Wang, "Cine cardiac mri motion artifact reduction using a recurrent neural network," *IEEE Transactions on Medical Imaging*, 2021.

[11] Y. Zhao, J. Ossowski, X. Wang, S. Li, O. Devinsky, S. P. Martin, and H. R. Pardoe, "Localized motion artifact reduction on brain mri using deep learning with effective data augmentation techniques," *arXiv preprint arXiv:2007.05149*, 2020.

[12] G. Oh, J. E. Lee, and J. C. Ye, "Unsupervised mr motion artifact deep learning using outlier-rejecting bootstrap aggregation," *arXiv preprint arXiv:2011.06337*, 2020.

[13] K. Armanious, A. Tanwar, S. Abdulatif, T. Küstner, S. Gatidis, and B. Yang, "Unsupervised adversarial correction of rigid mr motion artifacts," in *2020 IEEE 17th International Symposium on Biomedical Imaging (ISBI)*. IEEE, 2020, pp. 1494–1498.

[14] R. Ciric, A. F. Rosen, G. Erus, M. Cieslak, A. Adebimpe, P. A. Cook, D. S. Bassett, C. Davatzikos, D. H. Wolf, and T. D. Satterthwaite, "Mitigating head motion artifact in functional connectivity mri," *Nature protocols*, vol. 13, no. 12, pp. 2801–2826, 2018.

[15] J. G. Pipe, "Motion correction with propeller mri: application to head motion and free-breathing cardiac imaging," *Magnetic Resonance in Medicine: An Official Journal of the International Society for Magnetic Resonance in Medicine*, vol. 42, no. 5, pp. 963–969, 1999.

[16] J. Liau, J. Lee, M. E. Schroeder, C. B. Sirlin, and M. Bydder, "Cardiac motion in diffusion-weighted mri of the liver: artifact and a method of correction," *Journal of Magnetic Resonance Imaging*, vol. 35, no. 2, pp. 318–327, 2012.

[17] T. B. Smith, "Mri artifacts and correction strategies," *Imaging in Medicine*, vol. 2, no. 4, p. 445, 2010.

[18] M. Goto, O. Abe, T. Miyati, H. Yamasue, T. Gomi, and T. Takeda, "Head motion and correction methods in resting-state functional mri," *Magnetic Resonance in Medical Sciences*, pp. rev–2015, 2015.

[19] L. Wang, L. Wang, Q. Chen, C. Sun, X. Cheng, and Y. Zhu, "Convolutional restricted boltzmann machine based-radiomics for prediction of pathological complete response to neoadjuvant chemotherapy in breast cancer," *arXiv preprint arXiv:1905.13312*, 2019.

[20] M. Rotman, R. Brada, I. Beniaminy, S. Ahn, C. J. Hardy, and L. Wolf, "Correcting motion artifacts in mri scans using a deep neural network with automatic motion timing detection," in *Medical Imaging 2021: Physics of Medical Imaging*, vol. 11595. International Society for Optics and Photonics, 2021, p. 1159514.

Application of Modified Restricted Boltzmann Machine (mRBM) for denoising of motion-artifacted MRI scans

Publisher: IEEE

Vijay Tripathi ; Manish Tibdewal ; Ravi Mishra **All Authors**

Abstract: One of the key difficulties that might impact the diagnosis is motion artifact in MR imaging. A Restricted Boltzmann Machine (RBM) may train itself using a probability di... **View more**

Metadata

Abstract:
One of the key difficulties that might impact the diagnosis is motion artifact in MR imaging. A Restricted Boltzmann Machine (RBM) may train itself using a probability distribution over a set of inputs. As a result, RBM may be used to create MRI scans that are devoid of artifacts. The suggested approach for denoising motion artifact-induced MRI data uses a feedback network to modify the existing restricted Boltzmann machine (RBM). Because of RBM, the number of weights and biases that must be calibrated is limited to visible and hidden layers, considerably speeding up the training process. Once trained, RBM output for a 256 x 256-pixel image takes roughly 2 seconds. mRBM has a root mean squared error (RMSE) of 0.00343. Because mRBM does not require repeat MRI, the speed and accuracy of diagnosis can be increased.

Published in: 2022 10th International Conference on Emerging Trends in Engineering and Technology - Signal and Information Processing (ICETET-SIP-22)

Date of Conference: 29-30 April 2022

INSPEC Accession Number: 21842902

Date Added to IEEE *Xplore*: 15 June 2022

DOI: 10.1109/ICETET-SIP-2254415.2022.9791510

ISBN Information:

Publisher: IEEE

ISSN Information:

Conference Location: Nagpur, India

Implementation of Combinational Logic for Polar Decoder

Swapnil P. Badar*, *Student Member, IEEE,* Kamalesh Khanchandani
Department of Electronics and Telecommunication Engineering,
Shri Sant Gajanan Maharaj College of Engineering
Shegaon, India
*Corresponding author: swapnilbadar@ssgmce.ac.in

Abstract— **Error free communication is possible due to channel coding. Polar code has been identified by control channel code for 5G wireless communication. In this paper we implement combinational logic for polar decoder. As compare to sequential circuits for polar decoder, the proposed combinational logic circuit has low complexity in design. The parallel architecture of proposed logic provides fastest logic for the designing of polar decoder. Polar decoder by using sequential bit decoding approach is also proposed here. The design implementation and its simulations are done on Xilinx platform using Verilog HDL. The analysis for complexity and delay is done here.**

Keywords—Polar decoder, Polar code, Combinational logic, Channel coding, 5G.

I. INTRODUCTION

Polar code is identified as channel code for 5G wireless communication (by 3GPP – third generation partnership project). The role of channel coding is to recover the noisy channel hence the reliable communication is possible. Such type of channel code is known as Error Correcting Code (ECC). According to Shannon's theorem [1] the receiver can receive correct information bit, if encoder and decoder designed properly. These information bits can be recovered at the receiver with coding rate $R = \frac{K}{N} < C$

$$C = \max_{p(x)} I(X;Y) \tag{1}$$

Where C is the channel capacity and $I(X;Y)$ is the mutual information between input and output and the maximization is over the all probability distribution $p(x)$ on the channel input.

Polar code was first time introduced by Arikan [2] in 2009, which provably achieved channel capacity with low complexity encoding and decoding algorithm. It achieved maximum channel capacity as compare to Turbo codes [3] and Low Density Parity Checked (LDPC) Codes [4][5][6]. Achieving maximum channel capacity for code is challenging. These three turbo codes, LDPC and polar codes are remarkable uses for wireless communication such as HSPA, Wi-Fi, WiMAX, and LTE etc.

LDPC codes can effectively supports multiple code rates, block length with better decoding latency and throughput than other codes; hence it was selected for the data channels of NR replacing the turbo code [7]. Whereas in 3GPP Meeting in 2016, it was discussed that polar codes can have best error correction capability at short length that are used for control information hence polar codes was selected for control channel coding replacing tail-biting convolution codes (TBCC) of LTE [8].

Polar code is low complexity channel coding method which can achieve Shannon's channel capacity for any binary input discrete memory less channel (B-DMC) W, based on the idea of channel polarization. The code create N synthetic channels from N independent uses of such channel, which turn out to be less or more noisy than the original channel. According to channel polarization, Bhattacharya parameter is used to quantify the reliability of channel W. The good bit channel has lowest Bhattacharya parameter, which is defined as

$$Z(W) = \sum_{y \in Y} \sqrt{W(y|0)W(y|1)} \tag{2}$$

Here Y is output alphabet and input alphabets are $\{0,1\}$ for a binary memoryless Symmetric (BMS) channel W. $\{W(y|x): x \in X, y \in Y\}$ is the transition probability.

In this we paper, we implement combinational logic to design polar decoder. The details of polar encoder and polar decoder are explained. The combination logic is the representation of equation used for decoding purpose. The equations of decoding can be formed from flow diagram of polar decoder. The f-function, g-function and partial sum function equation are used to implement combinational logic. We design SC polar code decoder by directly following the polar code *P (8, 5)* decoding graph as it is. Also here we present the design by structural way also, which constitute component code for 4-bit polar code. Here the 4-bit polar code is designed by combination logic. Polar decoder using sequential bit decoding approach is also designed here. The synthesis and simulation of SC polar decoder design has been done on Xilinx platform.

This paper is organized as follows: Section II has the details of polar code. The details about polar encoder are mentioned here, with the formulation of code using codeword. The representation of codeword is given in the form of tree as well as in encoder graph. The concept of polar decoder is given in section III. The decoding approach is well defined using different function (f and g) with their equivalent equations. Section IV has proposed work of combinational logic for polar decoder. The combinational logic is implemented for 4-bit polar code. This 4-bit polar code is treated as component code. By using component code we designed polar decoder. Polar decoder using sequential bit decoding approach is present in this section. The simulation and synthesis is done on Xilinx. The synthesis result of proposed design and comparison with present design is given in Section V.

II. POLAR CODE

Polar codes *P (N, K)* has (K) information bits and *(N – K)* called frozen bits. It allowed to divide the N - bit input vector u between reliable (message bits) and unreliable (frozen bits) bit channels as due to channel polarization effects. The predefined values of frozen bits are set to *0*. The

2021 2nd International Conference on Range Technology (ICORT) | 978-1-6654-4956-4/21/$31.00 ©2021 IEEE | DOI: 10.1109/ICORT52730.2021.9581844

reliability sequence (position of reliable and unreliable bits) will be known to encoder side and decoder side, which will make easy to decode the bits at decoder side with error correction.

A. Polar Encoder :

Polar encoder encodes the message bits (K) with frozen bits ($N-K$). A polar code is a linear block code of length $N=2^n$ and rate $\mathrm{R}=\frac{\mathrm{K}}{\mathrm{N}}$. The encoding process of polar code can be represented by modulo-2 matrix multiplication. The code word is

$$X = uG_N \tag{3}$$

Here u is the inputs bits of length N $(u_1, u_2, \ldots\ldots u_N)$ and X is the coded output bits of length $N\,(x_1, x_2, \ldots\ldots x_N)$, The key point for this code word is polar transform G_N, which is $N \times N$ generator matrix also known as n-th Kronecker product with a basic kernel of 2×2.

$$G_2 = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix}$$

As $N = 2^n$, hence G_N can be written as

$$G_N = G_{2^n} = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix}^{\otimes n} = G_2 \otimes G_{2^{(n-1)}} \otimes G_{2^{(n-2)}} \tag{4}$$

Code word for $N = 2$ is

$$X = uG_N$$

$$[x_1, x_2] = [u_1, u_2]\begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix}$$

$$x^{(2)} = [x_1, x_2] = [u_1 + u_2, u_2] \tag{5}$$

Here $+$ operator indicates modulo 2 operation that is bitwise xor ($\oplus$) operation. $X^{(2)}$ is the output decoded bits for *N=2.*

The polar transform for $N = 4$ is

$$G_4 = G_2 \otimes G_2 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 0 & 1 & 0 \\ 1 & 1 & 1 & 1 \end{bmatrix}$$

Hence the code ward for $N = 4$ can be found as follows

$$X = uG_N$$

$$[x_1, x_2, x_3, x_4] = [u_1, u_2, u_3, u_4]\begin{bmatrix} 1 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 0 & 1 & 0 \\ 1 & 1 & 1 & 1 \end{bmatrix}$$

$$X^{(4)} = [x_1, x_2, x_3, x_4] = [u_1, +u_2 + u_3 + u_4, u_2 + u_4, u_3 + u_2, u_2] \tag{6}$$

The code word tree representation of equation (6) for $N = 4$ is shown in Fig. 1. Here the dotted rectangular box represents the code word tree of $N = 2$ which follows the equation (5).

We can combine two component code (c_1 and c_2) of $N = 4$ to form the code ward $N = 8$. The code word tree for $N = 8$ is shown in Fig. 2 and its equivalent circuit graph is shown in Fig. 3. The polar encoder graph is having xor circuit elements, which follows equation (3). The rectangular box in Fig. 3 shows the component code of $N = 4$.

We may achieve the code word for highest values of N by combing $\mathrm{N}/2$ component codes.

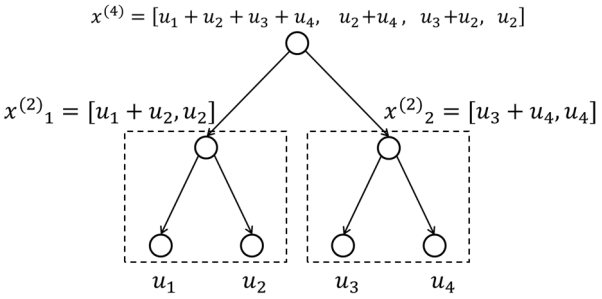


Fig. 1. Polar encoder codeword binary tree for $N = 4$

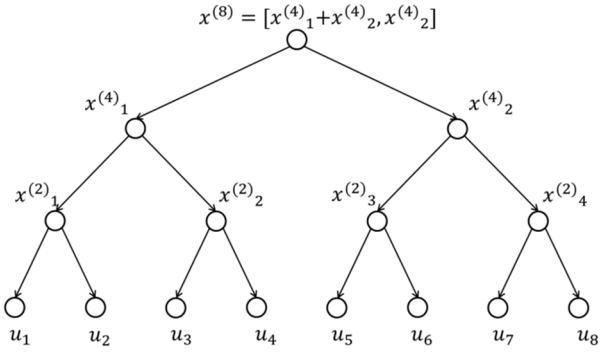


Fig. 2. Polar encoder codeword binary tree for $N = 8$

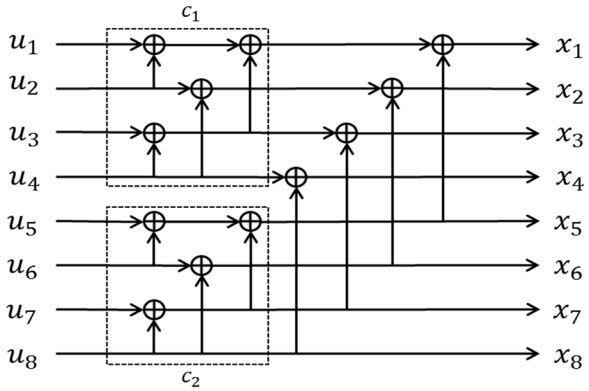


Fig. 3. Polar encoder graph for $N = 8$

III. Polar Decoder

To decode the original signal from noisy signal at receiver end, we need decoder. Polar code decoder uses a successive cancellation (SC) decoding approach introduced by Arikan in [2]. A code word is transmitted from transmitter; which receives at receiver end with the output vector $y \in Y^N$. The channel W has an input alphabet X {0, 1}, an output alphabet Y and transition probabilities$\{W(y|x): x \in X, y \in Y\}$. The receiver calculates the log-likelihood ratio (LLR) vector $\ell = (\ell_1, \ell_2, \ell_3, \ldots\ldots \ell_N)$ to decode the received message. These LLRs are the input for polar decoder. The LLR can be defined as

$$\ell_i = \ln\left(\frac{P(y_i|x_i=0)}{P(y_i|x_i=1)}\right) \tag{7}$$

Decoding binary tree of polar decoder is shown in Fig. 4. This tree is for polar code $P\,(8, 3)$ where $N = 8$ and $K = 3$

i.e. last three bits are message bits and 5 bits are frozen bits. The same bit information is known to polar encoder side with reliability sequence. At the decoder side, we have to decode the bits from received vector at receiver side. These received vectors have the LLR values received. The tree shows the root or vertex node at $t = 0$, which received all LLR values. At each stage t of tree, the soft LLR values $\alpha = \{\alpha_1, \alpha_2, \alpha_3, \dots\dots\dots, \alpha_{2^{(t-1)}}\}$ are passed from parent nodes to its child node and hard bit estimates $\beta = \{\beta_1, \beta_2, \beta_3, \dots\dots\dots, \beta_{2^{(t-1)}}\}$ are passed from child node to its parent node [9]. Here in Fig. 4, consider a v root node has α_v LLR values and β_v received hard bit estimation at v root node. Followed by next stage parent node having LLR values α^l and α^r for left and right side respectively, whereas β^l and β^r received hard bit estimations.

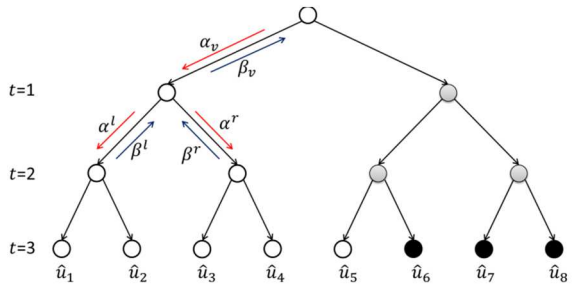


Fig. 4. SC polar decoder tree for Polar code $P(8,3)$

SC polar decoder tree can be depicted in its equivalent XOR circuit graphs shown in Fig. 5, which would be seen to be same as encoder side. The computations of the SC decode pertaining to XORs in the graph; here the XOR functionality will vary according to LLRs value at different steps in decoding process [10].

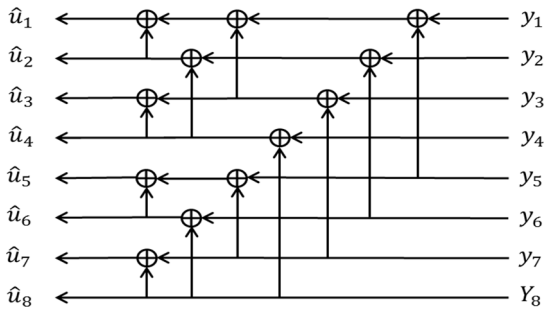


Fig. 5. Polar decoder graph for N=8

In the decoding process, the XOR operation is performed according to LLR of various received vector. It has identified by three operations which has $f-$ function, $g-$function and partial sum function, shown in Fig. 6. Fig. 6(a) is of $f-$function. Here we consider $\alpha_a$and α_b are two available LLRs value as inputs for XOR to compute LLR α_c according to function f [13].

$$\alpha_c = f(\alpha_a, \alpha_b)$$

$$\alpha_c = 2\tan^{-1}(\tanh(\alpha_a/2)\tanh(\alpha_b/2)) \quad (8)$$

or

$$\alpha_c \approx sign(\alpha_a)sign(\alpha_a)\min(|\alpha_a|, |\alpha_a|) \quad (9)$$

This equation (9) is min-sum approximation, where $sign(.)$ returns -1, if argument is negative and returns +1 in case if argument is positive.

According to the value of output LLR (α_c) of $f-$ function, we get the first decoded bit $\hat{\beta}_a$ (hard bit). $\hat{\beta}_a$ bit value is 0 for positive LLR value and 1 and for negative LLR. Using α_a and α_b and hard bit $\hat{\beta}_a$, can compute for LLR α_c according to g function in equation (10).

$$\alpha_d = g(\alpha_a, \alpha_b, \hat{\beta}_a) = (-1)^{\hat{\beta}_a}\alpha_a + \alpha_b \quad (10)$$

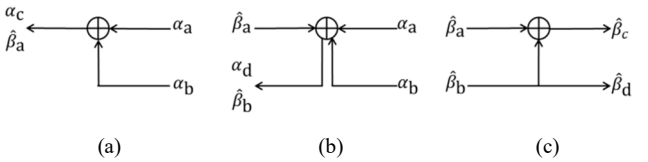


Fig. 6. Bits decoding approach with (a) f function (b) g function and (c) partial sum

Second hard bit detection can be achieved by $g-$ function shown in Fig. 6 (b); it depends on LLR value of α_d. From the decoded bits ($\hat{\beta}_a$, $\hat{\beta}_b$), we can go reverse back that is left side to right side for partial sum. By XOR function [13], we can find partial sum $\hat{\beta}_c$and $\hat{\beta}_d$ from equation (10) and (11), same is illustrated in Fig. 6(c).

$$\hat{\beta}_c = XOR\ (\hat{\beta}_a, \hat{\beta}_b) \quad (11)$$

$$\hat{\beta}_d = \hat{\beta}_b \quad (12)$$

The SC decoding process is begin with f function (8) or (9) by propagating LLRs from the right hand edge of the graph, to the top connection on the left-hand edge of the graph, allowing the first bit to be recovered as shown in Fig.5. decoding graph of SC decoder. f function continuously calculates LLR using min-sum approximation method till not reaching to first decoded bit. Once first bit is decoded, it may go with g function of (10) to decode second bit for a particular XOR to switch from bit propagation to LLR propagation. Before using the f function to propagate LLRs to the next connection on the left-hand edge of the graph, allowing the corresponding bit to be recovered. Each successive bit from top to bottom is recovered by using the partial sum computations of (11) and (12) to propagate bits from left to right. This process is continuously on till not reaching to last bit. Binary tree of SC decoder of $P(8,3)$ shown in Fig.4 also depicted the same thing. The left child node $\alpha^l = \{\alpha_0^l, \alpha_0^l, \dots\dots, \alpha_{T-1}^l\}$ can be computed by f function (8) or (9), whereas the right child node $\alpha^r = \{\alpha_0^r, \alpha_0^r, \dots\dots, \alpha_{T-1}^r\}$ can be computed using g function (10). Here we assume the LLRs values of respective value of node will be stored in internal LLR memory. The bit will be decoded according to LLR value, when node traverse and reach to leaf node.

The bit estimation in the SC decoder is based on the previous bit values. To complete this decoding process, the decoder takes $(2N-2)$ steps. To store LLR values, it required channel LLR memory, internal LLR memory and hard estimated bit storage memory to store the decoding bits.

IV. Combinational Logic for Polaer Decoder

In this paper, we designed polar decoder for 8-bit using combination logic of 4-bit polar decoder. The combinational logic is developed from f and g function of equation (9) and (10) respectively. Another implementation of polar decoder

is done, which follows the polar decoder graph shown in Fig. 5.

A. Combinational Logic :

Combinational logic is made by using f-function combinational circuit and g-function combinational circuit with some additive gate for overall design of polar decoder [12]

1. f-function circuit: The f-function circuit is implemented based on equation (8) (min-sum) as discussed in previous section. To implement this, we use a comparator circuit which will compare two LLR values; multiplexer which provide us the minimum values of LLT depends on control signal generated from comparator; another XOR gate is used for sign generation. All the combination of comparator, multiplexer and XOR gate shown in Fig. 7 follows the min-sum equation (8).

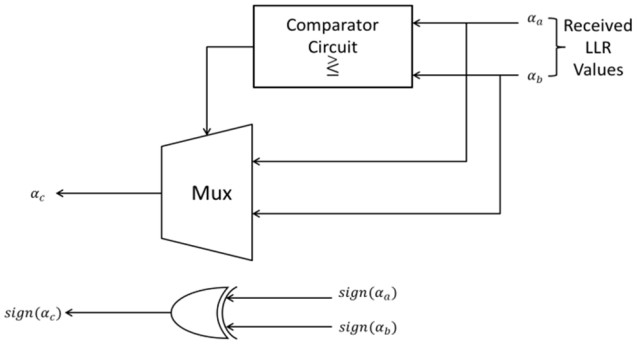


Fig. 7. f-function circuit

2. *g -function circuit:* The g -function circuit is implemented based on based on equation (9) as discussed in previous section is shown in Fig. 8. To implement this, we used an adder/subtractor circuit which will work depends on previous estimated bit. Multiplexer gives the output LLR, depends on previous estimated bit.

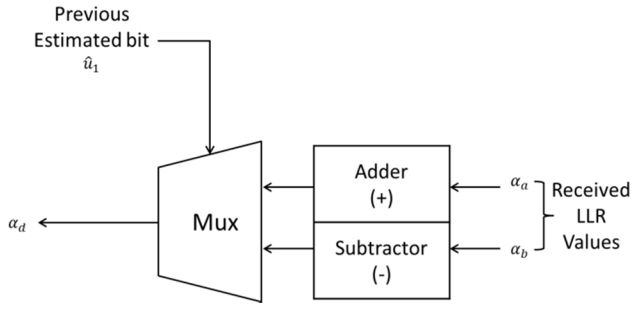


Fig. 8. g-function circuit

3. Polar decoder 4-bit: The polar decoder is implemented using f −function and g −function circuit. The design of this 4-bit polar decoder follows the circuit graph shown in Fig. 9. This circuit graph shows the interconnection between f −function and g −function to form combinational logic for 4-bit polar decoder. The RTL schematic of 4-bit polar decoder using combinational logic is shown in Fig. 10. The simulation and synthesis of 4-bit polar decoder are done on Xilinx platform.

4. Polar decoder 8-bit: According to circuit flow diagram shown in Fig. 11, the 8-bit polar decoder can be implemented using two 4-bit component codes. Here we design 8-bit polar using 4-bit polar decoder and some f −function and g −function. The RTL schematic of 8-bit polar decoder is shown in Fig. 12. The simulation and synthesis of 4-bit polar decoder are done on Xilinx platform.

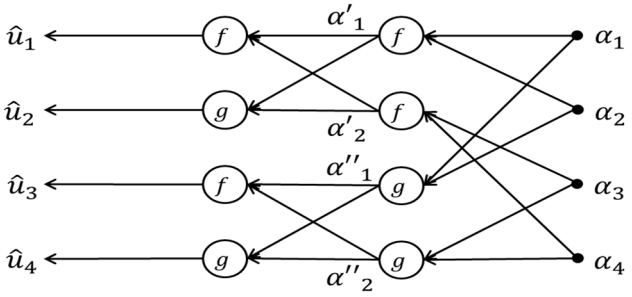


Fig. 9. Circuit graph of polar decoder (4-bit)

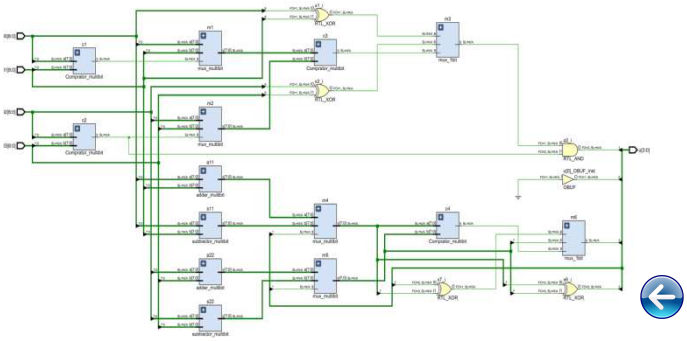


Fig. 10. RTL Schematic of polar decoder (4-bit) using combinational logic

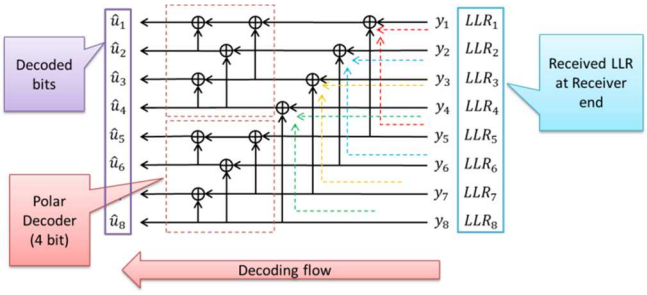


Fig. 11. Polar decoder graph for N=8 with using 4-bit polar decoder

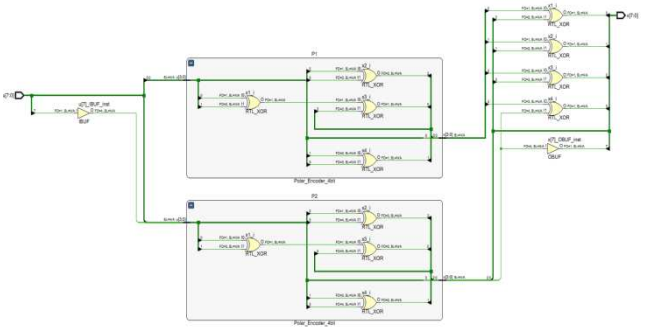


Fig. 12. RTL Schematic of polar decoder using two 4-bit polar decoder

B. Sequential Bit decoding approach:

As SC polar decoder is sequential in nature, the bits at receiving side will be decoded one by one. Decoding of next bits depends on preceding bits. Hence the roles of f and g function are important in this case. Sequential bit decoding approach of polar decoder used three types of function as

discussed in section III. These are f −function, g −function and partial sum or xor function. The design of these functions have to be done very carefully to get correct output, as they will used many of times in overall circuit of decoder. To design polar decoder for 8-bit, here we will follow polar decoder graph as shown in Fig. 13. As per decoder graph, we designed the polar decoder in the Verilog HDL by considering pre-designed functions (f, g and xor) as components in it. Simulations and synthesis are done on Xilinx. The RTL schematic view of SC polar decoder is shown in Fig. 14. The final outputs are decoded bits, whereas the internal bits and LLR values are stored in memory for decoding the bits.

The external input LLR values are given in pair to f-function as $y_1\, y_5$, $y_2\, y_6$, $y_3\, y_7$ and $y_4\, y_8$ to f-function f_1^1, f_2^1, f_3^1 and f_4^1 respectively at first stage. These f-functions calculate the internal LLR values and generate output LLR values, which will be fed to nest stage f functions denoted by f_1^2 and f_2^2. Here the output of $f_1^1\ f_3^1$ and $f_2^1\ f_4^1$ become the inputs to second stage f-function f_1^2 and f_2^2 respectively. The outputs of these f-functions feed forwarded as inputs to f-function of stage three. Finally at stage three, the f-function f_1^3 decoded the first bit u_1. Using this pre-decoded bit u_1 and output LLR values of f_1^2 and f_2^2, the g-function decoded second bit u_2. The process flow of decoding u_1 and u_2 bits using f and g function is shown by color dotted line in Fig. 13. Once u_1 and u_2 bits are decoded, it goes reverse back using xnor-function, f-function and g-function to decode the remaining bits. All these output bits are decoded in sequential way.

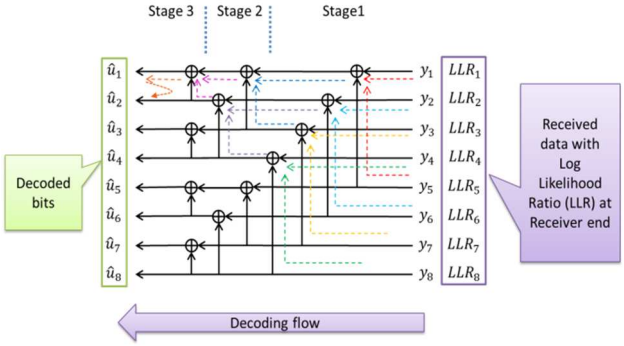


Fig. 13. Polar decoder graph for N=8 with flow details

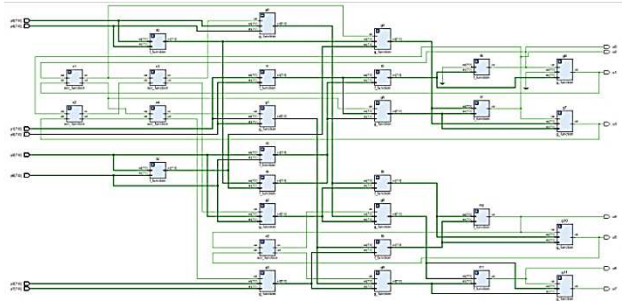


Fig. 14. RTL Schematic of Polar decoder (8-bit) by bit decodeing approach

V. RESULTS

As per the functionality of polar decoders, both polar decoders i.e. by using combinational logic and using sequential bit-decoding approach is same, only we found difference in delay and area (used LUTs). We reduce the latency in the case of combinational logic as compare to sequential bit-decoding approach design polar decoder. The synthesis result of SC polar decoder using combinational logic and using sequential bit decoding approach are shown in Table. I. SC polar decoder using combinational logic is efficient in terms of latency as compare to using sequential bit decoding approach. While with respect to area and dynamic power, the sequential bit decoding approach has performed better than polar decoder using combinational logic. But the delay parameter has a great role for high-speed communication. It will make a great difference while designing higher bits polar decoder like 32, 64 –bits and so on. Table. I also show the comparison of proposed design with existing design mention in various literatures. As compare to work given in [13], the proposed work has remarkable result for latency and area as well as dynamic power. The proposed work is based on 2-bit SC decoder [14] with iterative decomposition technique. The work proposed in [12] has combinational and pipeline combinational decoder with ASIC synthesis result. Out of the proposed work present, we found 16-bit combinational decoder result is related to our result shown in Table.I.

TABLE I. COMPARASION BASED ON PERFORMANCE PARAMETER

Paramet-er	**Proposed Polar Decoder**		**[13]**		
	Using sequential bit-decoding approach	***Using combinati-onal logic***	***2b SC decoder***	***2b SC decoder with iterative decompos-ition technique***	**[12]** ***(16-bit) combinat-onal decoder***
Latency	3.351ns	3.105ns	(1.5n-2)	(1.5n-2)	--
Area (LUTs)	446	470	488	259	1479
Dynamic Power (W)	4.141	4.59	5.881	3.261	--

**n- is no. of cycle*

VI. CONCLUSIONS

In this paper, we proposed the polar decoder by using combinational logic and by using sequential bit decoding approach. The combinational logic for f function, g-function and 4-bit polar decoder are designed, where 8-bit polar decoder is designed using two 4-bit polar decoder. Polar decoder using sequential bit decoding approach is design with f, g and xor function. These function are followed their mathematical equations. The proposed work has remarkable result as compare to existing one. Polar decoder using combinational logic is more efficient as compare to using sequential bit decoding approach in case delay parameter. But with respect to area and dynamic power, the sequential bit decoding approach has performed better than polar decoder using combinational logic. Combinational logic makes design simple and will have the scope to design for more number of bits. The proposed work is designed using Verilog HDL. The synthesis and simulation are done on Xilinx.

REFERENCES

[1] C. E. Shannon, “A mathematical theoryss of communication,” Bell Syst. Tech. J., vol. 27, pp. 379–423, 623–656, 1948.

[2] E. Arıkan, “Channel polarization: A method for constructing capacity-achieving codes for symmetric binary-input memory less channels” IEEE Trans. Inf. Theory, vol. 55, no. 7, pp. 3051–3073, Jul. 2009.

[3] C. Berrou, A. Glavieux, and P. Thitimajshima, “Near Shannon limit errorcorrecting coding and decoding: turbo-codes,” in IEEE Int. Conf. Commun. (ICC), vol. 2, pp. 1064–1070 vol.2, May 1993.

[4] R. G. Gallager, “Low Density Parity-Check Codes” PhD thesis, MIT Press, Cambridge, MA, 1963.

[5] D. J. C. MacKay and R. M. Neal, “Near shannon limit performance of low density parity check codes,” Electron. Lett., vol. 33, pp. 457–458, Mar 1997.

[6] S. Shao et al., “Survey of Turbo, LDPC, and Polar Decoder ASIC Implementations,” IEEE Commun. Surv. Tutorials, vol. 21, no. 3, pp. 2309–2333, 2019.

[7] “3GPP RAN WG1 Meeting 86bis, R1-1610690, Way Forward on Observations for eMBB Data Channel Coding,” Samsung, Qualcomm Incorporated, Nokia, ASB, KT Corporation, Intel Corporation, Lisbon, Portugal, Technical Specification (TS), 10th –15th October 2016.

[8] “3GPP TSG RAN WG1 87, R1-1611109, Evaluation on Channel coding Candidates for eMBB Control Channel,” ZTE Microelectronics,, Reno, USA, Technical Specification (TS), 14th – 18th November 2016.

[9] S. A. Hashemi, C. Condo, M. Mondelli, and W. J. Gross, “Rate-flexible fast polar decoders,” IEEE Trans. Signal Process., vol. 67, no. 22, pp. 5689–5701, 2019.

[10] Tal and A. Vardy, “List Decoding of Polar Codes,” IEEE Trans. Inf. Theory, vol. 61, no. 5, pp. 2213–2226, 2015.

[11] R. G. Maunder, “The implementation challenges of polar codes” AccelerComm White Paper, Feb. 2018.

[12] O. Dizdar and E. Arikan, “A High-Throughput Energy-Efficient Implementation of Successive Cancellation Decoder for Polar Codes Using Combinational Logic,” IEEE Trans. Circuits Syst. I Regul. Pap., vol. 63, no. 3, pp. 436–447, 2016.

[13] H. S. Kalluru and Z. Abbas, "Optimal Power-Area Polar Decoder Design based on Iterative Decomposition Technique," IEEE 16th India Council International Conference (INDICON), pp. 1-4, 2019.

[14] Bo Yuan, “Low-Latency Successive-Cancellation Polar Decoder Architectures Using 2-Bit Decoding” IEEE Transactions on Circuits And Systems-I: Regular Papers, Vol. 61, No. 4, April 2014.

2nd IEEE International Conference on Range Technology (ICORT-2021)

IEEE KOLKATA SECTION | IEEE Bhubaneswar Subsection

IEEE Communications and Computer Societies Joint Chapter, CH10943

Certificate of Appreciation

This is to certify that

Swapnil P. Badar & Kamalesh Khanchandani

Presented a technical paper entitled

Implementation of Combinational Logic for Polar Decoder

at 2nd IEEE International Conference on Range Technology (ICORT-2021)

during 05-06 August 2021

H K Ratha
General Chair, ICORT-2021


DIGITAL
INNOVATION
EDITORS
Laxmikant Baburao Deshmukh
Mayur Anil Dande
Wechansing Zyamsing Suliya
Bilal Tafazzul Husain
BLOOMSBURY

DIGITAL INNOVATION

Editors

Laxmikant Baburao Deshmukh
Mayur Anil Dande
Wechansing Zyamsing Suliya
Bilal Tafazzul Husain

BLOOMSBURY
NEW DELHI • LONDON • OXFORD • NEW YORK • SYDNEY

BLOOMSBURY INDIA
Bloomsbury Publishing India Pvt. Ltd
Second Floor, LSC Building No. 4, DDA Complex,
Pocket C – 6 & 7, Vasant Kunj,
New Delhi 110070

BLOOMSBURY, BLOOMSBURY PRIME and the Diana logo are
trademarks of Bloomsbury Publishing Plc

First published in India 2022
This edition published 2022

ISBN: 978-93-93715-14-2
2 4 6 8 10 9 7 5 3 1

Typeset by Fortune Graphics, Naraina, New Delhi
Printed and bound in India by Replika Press Pvt. Ltd

To find out more about our authors and books, visit
www.bloomsbury.com and sign up for our newsletters

Contents

Taxonomy and Open Challenges of an Innovative Bio-Inspired PSO Algorithm for Optimization in Big Data Analytics Application

Amitkumar Manekar

Abstract: *Nature-inspired and Bio-inspired computing and artificial intelligence encompass a wide variety of contemporary computer science, mathematics, and biological disciplines. Biomimetic computer optimization techniques are indeed a brilliant way to launch innovative and effective competitiveness methodologies that are based on the concepts and inspiration of biological evolution. In recent decades, bio-inspired optimization algorithms gained popularity in machine learning for overcoming significant challenges in engineering and science. Unfortunately, these problems are frequently regressive and governed by many regressive constraints, creating numerous problems such as time limitations and high dimensionality in choosing the optimum solution. Recent advancements attempt to integrate bio-inspired optimization algorithms to solve the problems of traditional optimization algorithms, which represent a potential approach for tackling complex optimization problems. The state-of-the-art of some contemporary bio-inspired algorithms, gap analysis, and their implementations are presented in this paper.*

Keywords: Genetic Bee Colony Algorithms, Fish Swarm Algorithm, Artificial Algae Algorithm, Chicken Swarm Optimization, Grey Wolf Algorithm, Cat Swarm Optimization, Bioinspired Algorithms, Particle Swarm Optimization

Introduction

The study of optimization is associated with identifying the optimal solutions to various challenges. Day after day, we invented a lot of operations which we endeavored to refine in necessary to come at the optimal resolution; for illustration, the trip to work may be maximized based on the number of parameters such as traffic and distance. On the other hand, the introduction of smart vehicles demands an optimization with a number of goals in mind, namely reduced wind resistance, lower fuel consumption, and increased muscle potency [1]. These optimum solutions are determined by altering the algorithm's parameters to give the solution a maximum or minimum value. As a result, numerous optimization methods have been proposed in past years with the objective of boosting existing solutions [2][3].

The conveyance of data is utilized to make successful judgments for big data analytics in IoT-based smart cities. During data collection and processing from smart devices on IoT networks, information is recorded and processing on cloud servers. Additionally, to process the huge quantity of observations, automatically massively scalable cloud computing is necessary, which may enhance the system's performance [4]. Conventional cloud-based data processing systems, according the literature, are unable to achieve performance requirement

Life has been digitalized up to much extent. Digital endeavors have become central to everything. This book provides deep insights into significant and crucial changes due to touch of digital innovations in all the walks of business entities. The distinguished ways with which leaders, organizations, people have traversed can be experienced and replicated by the experimenters, learners and practitioners in the field of Management. This book will further contribute to comprehend the connection of digital dimensions to business world and will prove to be a bridge between generation of the youth and the experienced. Considering academics, the content in the book will enrich the teaching-learning phenomenon through case methodology.

The chapters in this book are categorized into sections given below:

1. Digital marketing
2. Technological innovations
3. Digital finance
4. Digital learning and education

Dr. Laxmikant Baburo Deshmukh, B.E. (Mechanical Engineering), M.B.A. (Marketing), Ph.D (Business Management) & V-SAT is an Associate Professor at Department of Business Administration and Research, Shri Sant Gajanan Maharaj College of Engineering, Shegaon, Maharashtra for last 17 years and has over sixteen publications to his credit. His areas of research interest are production Operations Management, Sales and Distribution Management, Logistics & supply chain management, Marketing Management etc. He is recognized PhD Supervisor of Sant Gadge Baba Amravati University.

Dr. Mayur A. Dande, M.B.A., Ph.D, UGC-NET is an assistant Professor in the department of Business Administration and Research, Shri Sant Gajanan Maharaj College of Engineering, Shegaon, Dist. Buldana, Maharashtra. His areas of Research interest include – Rural Marketing, Consumer Behavior, Brand Management, Business ethics, Non-profit Organizations, and Entrepreneurship. He is having around 20 research papers published.

Prof. Wechansing Zyamsing Suliya is an Assistant Professor in Department of Business Administration and Research, Shri Sant Gajanan Maharaj College of Engineering, Shegaon, for 10 years. He published 4 research papers in entrepreneurship and human resource management field. He is pursuing his Ph.D in Mutual entrepreneurship in Rural Area. He is locally from tribal society, has keen interest in rural development and psychology. He is an author (website-professoronline.in), blogger, poet (website: poemarticle.com), and singer.

Prof. Bilal Tafazzul Husain is an Assistant Professor in the Department of Business Administration and Research in Shri Sant Gajanan Maharaj College of Engineering, Shegaon. His expertise lies in the area of finance and is also fluent in the subject of business research methodology and strategic management. Catering his research interests he is investigating the unexplored areas of risk management in the field of Business Management trying to get a doctorate in the same.

MRP ₹799 (incl. of all taxes)

BLOOMSBURY PRIME

ISBN 978-93-93715-14-2

90100

9 789393 715142

www.bloomsbury.com


DIGITAL
INNOVATION
EDITORS
Laxmikant Baburao Deshmukh
Mayur Anil Dande
Wechansing Zyamsing Suliya
Bilal Tafazzul Husain
BLOOMSBURY

DIGITAL INNOVATION

Editors

Laxmikant Baburao Deshmukh
Mayur Anil Dande
Wechansing Zyamsing Suliya
Bilal Tafazzul Husain

BLOOMSBURY
NEW DELHI • LONDON • OXFORD • NEW YORK • SYDNEY

BLOOMSBURY INDIA
Bloomsbury Publishing India Pvt. Ltd
Second Floor, LSC Building No. 4, DDA Complex,
Pocket C – 6 & 7, Vasant Kunj,
New Delhi 110070

BLOOMSBURY, BLOOMSBURY PRIME and the Diana logo are
trademarks of Bloomsbury Publishing Plc

First published in India 2022
This edition published 2022

ISBN: 978-93-93715-14-2
2 4 6 8 10 9 7 5 3 1

Typeset by Fortune Graphics, Naraina, New Delhi
Printed and bound in India by Replika Press Pvt. Ltd

To find out more about our authors and books, visit
www.bloomsbury.com and sign up for our newsletters

Contents

Interactive Smart Mirror Using Raspberry Pi 4

Akshay J. Agrawal, Vaishnavi S. Kanherkar, Kalyani U. Bonde, Radhika S. Jadhav and Amit S. Manekar

Abstract: *IoT is a very emerging trend in today's world it has a variety of application in our life. We are living in 21st century where all the work is done using technology and has become an integrated part of life. The internet of things which is very trending now-a-days is used in various electronic devices as we want all our work to be in fractions of a second. We come up with solutions to problems which are very familiar to everybody, as we all go to corporate offices at one time of our lifetime. As anyone go in any office for the very first time we don't know anything about that office like about the infrastructure, various departments and all. When we don't know anything we ask the receptionist for help and this is time consuming. To solve this time consuming problems Smart Mirror is introduced which will act as the information desk for new visitors, employees and clients. Also we have made our mirror multitasked more information about that is available in this paper. Moreover we have added matrix server in our mirror so that calling and chatting can also be done with this mirror. This paper contains the problem statement and detailed technology stack along with our project development idea and our results and conclusion. The internet of things, AI is used to implement this project.*

Keywords: IOT, Smart Mirror, Raspberry Pi, Voice Command, Magic Mirror, Matrix

Introduction

In this globe of fierce competition, each one needs a comfortable life and stay updated with latest technology. Modern man has proposed high tech technology to make his life at ease. People think necessary to be attached with the external world and they are willing to grab the information easily. Whether it is through the television or internet, people must have to be in contact with the present events happening all over the world. Internet of Things (IoT) is a theory where an entity having the capability to gather and transmit information over a network without the human contact to human or human to system. Due to this technology people can do their task in faster and efficient way. In this we will design and develop a smart mirror that symbolized an useful interface for glancing data in a co-operate office.

In market various smart mirrors are available that acts as a mirror which display date, time, image gallery but it is not sufficient as we can make our mirror more interactive. The main property of the mirror will be that it will totally work as a computer or we can say more than a computer. Now all will think that we have computer already then why one go for this mirror, so the reason for this will be mirror will be available at the 50% cost of the computer. Our mirror broadcast current temperature, weather details, and to-do list along with that we have added the feature of voice command. In addition to that we have added matrix to our

Life has been digitalized up to much extent. Digital endeavors have become central to everything. This book provides deep insights into significant and crucial changes due to touch of digital innovations in all the walks of business entities. The distinguished ways with which leaders, organizations, people have traversed can be experienced and replicated by the experimenters, learners and practitioners in the field of Management. This book will further contribute to comprehend the connection of digital dimensions to business world and will prove to be a bridge between generation of the youth and the experienced. Considering academics, the content in the book will enrich the teaching-learning phenomenon through case methodology.

The chapters in this book are categorized into sections given below:

1. Digital marketing
2. Technological innovations
3. Digital finance
4. Digital learning and education

Dr. Laxmikant Baburo Deshmukh, B.E. (Mechanical Engineering), M.B.A. (Marketing), Ph.D (Business Management) & V-SAT is an Associate Professor at Department of Business Administration and Research, Shri Sant Gajanan Maharaj College of Engineering, Shegaon, Maharashtra for last 17 years and has over sixteen publications to his credit. His areas of research interest are production Operations Management, Sales and Distribution Management, Logistics & supply chain management, Marketing Management etc. He is recognized PhD Supervisor of Sant Gadge Baba Amravati University.

Dr. Mayur A. Dande, M.B.A., Ph.D, UGC-NET is an assistant Professor in the department of Business Administration and Research, Shri Sant Gajanan Maharaj College of Engineering, Shegaon, Dist. Buldana, Maharashtra. His areas of Research interest include – Rural Marketing, Consumer Behavior, Brand Management, Business ethics, Non-profit Organizations, and Entrepreneurship. He is having around 20 research papers published.

Prof. Wechansing Zyamsing Suliya is an Assistant Professor in Department of Business Administration and Research, Shri Sant Gajanan Maharaj College of Engineering, Shegaon, for 10 years. He published 4 research papers in entrepreneurship and human resource management field. He is pursuing his Ph.D in Mutual entrepreneurship in Rural Area. He is locally from tribal society, has keen interest in rural development and psychology. He is an author (website-professoronline.in), blogger, poet (website: poemarticle.com), and singer.

Prof. Bilal Tafazzul Husain is an Assistant Professor in the Department of Business Administration and Research in Shri Sant Gajanan Maharaj College of Engineering, Shegaon. His expertise lies in the area of finance and is also fluent in the subject of business research methodology and strategic management. Catering his research interests he is investigating the unexplored areas of risk management in the field of Business Management trying to get a doctorate in the same.

MRP ₹799 (incl. of all taxes)

BLOOMSBURY PRIME

ISBN 978-93-93715-14-2

90100

9 789393 715142

www.bloomsbury.com


DIGITAL
INNOVATION
EDITORS
Laxmikant Baburao Deshmukh
Mayur Anil Dande
Wechansing Zyamsing Suliya
Bilal Tafazzul Husain
BLOOMSBURY

DIGITAL INNOVATION

Editors

Laxmikant Baburao Deshmukh
Mayur Anil Dande
Wechansing Zyamsing Suliya
Bilal Tafazzul Husain

BLOOMSBURY
NEW DELHI • LONDON • OXFORD • NEW YORK • SYDNEY

BLOOMSBURY INDIA
Bloomsbury Publishing India Pvt. Ltd
Second Floor, LSC Building No. 4, DDA Complex,
Pocket C – 6 & 7, Vasant Kunj,
New Delhi 110070

BLOOMSBURY, BLOOMSBURY PRIME and the Diana logo are
trademarks of Bloomsbury Publishing Plc

First published in India 2022
This edition published 2022

ISBN: 978-93-93715-14-2
2 4 6 8 10 9 7 5 3 1

Typeset by Fortune Graphics, Naraina, New Delhi
Printed and bound in India by Replika Press Pvt. Ltd

To find out more about our authors and books, visit
www.bloomsbury.com and sign up for our newsletters

Contents

A Review on Pose Estimation and its Recent Progress

Om Masne, Mohit Bohra, Gita Fase, Kshitij Khillare and Amitkumar Manekar

Abstract: *Pose estimation is a challenge in computer vision field which has been researched for quite some time, reason being the richness of applications that can benefit from such technology. Pose estimation is one of the main components in problems which include the approximation of object placement and location relative to the reference frame. It is the task of using techniques such as machine learning methods to calculate the pose of a character from a video or image by approximating the spatial locations of key body joints.*

Keywords: Human Pose Estimation, Pose Estimation, Deep Learning, 2-D Pose Estimation, 3-D Pose Estimation, Multi-Person Pose Estimation

Introduction

Pose estimation is the procedure of approximating the location of the connections in some human body or other objects and subjects. It has uses in tracking the motion of a person or object, detecting gestures, analysis of changes in pose of a subject, human fall detection, etc. Pose estimation is generally of 2 types – 2-D pose estimation and 3-D pose estimation. 2-D pose estimation results in accurate position approximation in a particular plane or axis. In 3D pose estimation, the results are generated in multiple planes or axis which can be used when the results need to be used in 3D world. Pose estimation can be done by using images of a subject or by using video for input and the output can then be used in the required fashion.

Many known methods of pose estimation include Deep Cut, Regional Multi-Person Pose Estimation (Alpha Pose), Pose Net, High-Resolution Net (HR Net), Open Pose, Dense Pose. Each method has its pros and cons. Some have better results with single object estimation while some give better results when the environment is more supportive. Pose estimation has applications in human activity estimation, motion transfer between objects, training robots, detection of gestures, augmented reality, human fall detection, motion tracking for consoles, full body / sign language communication (for use in accessibility, or a traffic policemen signal understanding), a person falling or is sick.

Other applications include the analysis of basketball, volleyball, tennis, badminton, and other sports, application of posture learning for body works or exercise and fitness, applications in supervision enhancement and defence.

Litrature Survey

Pose Estimation

Pose estimation (PE) is widely explored in computer vision field. It includes approximating the structure of a subject's body segments from input data obtained by camera or other devices,

Life has been digitalized up to much extent. Digital endeavors have become central to everything. This book provides deep insights into significant and crucial changes due to touch of digital innovations in all the walks of business entities. The distinguished ways with which leaders, organizations, people have traversed can be experienced and replicated by the experimenters, learners and practitioners in the field of Management. This book will further contribute to comprehend the connection of digital dimensions to business world and will prove to be a bridge between generation of the youth and the experienced. Considering academics, the content in the book will enrich the teaching-learning phenomenon through case methodology.

The chapters in this book are categorized into sections given below:

1. Digital marketing
2. Technological innovations
3. Digital finance
4. Digital learning and education

Dr. Laxmikant Baburo Deshmukh, B.E. (Mechanical Engineering), M.B.A. (Marketing), Ph.D (Business Management) & V-SAT is an Associate Professor at Department of Business Administration and Research, Shri Sant Gajanan Maharaj College of Engineering, Shegaon, Maharashtra for last 17 years and has over sixteen publications to his credit. His areas of research interest are production Operations Management, Sales and Distribution Management, Logistics & supply chain management, Marketing Management etc. He is recognized PhD Supervisor of Sant Gadge Baba Amravati University.

Dr. Mayur A. Dande, M.B.A., Ph.D, UGC-NET is an assistant Professor in the department of Business Administration and Research, Shri Sant Gajanan Maharaj College of Engineering, Shegaon, Dist. Buldana, Maharashtra. His areas of Research interest include – Rural Marketing, Consumer Behavior, Brand Management, Business ethics, Non-profit Organizations, and Entrepreneurship. He is having around 20 research papers published.

Prof. Wechansing Zyamsing Suliya is an Assistant Professor in Department of Business Administration and Research, Shri Sant Gajanan Maharaj College of Engineering, Shegaon, for 10 years. He published 4 research papers in entrepreneurship and human resource management field. He is pursuing his Ph.D in Mutual entrepreneurship in Rural Area. He is locally from tribal society, has keen interest in rural development and psychology. He is an author (website-professoronline.in), blogger, poet (website: poemarticle.com), and singer.

Prof. Bilal Tafazzul Husain is an Assistant Professor in the Department of Business Administration and Research in Shri Sant Gajanan Maharaj College of Engineering, Shegaon. His expertise lies in the area of finance and is also fluent in the subject of business research methodology and strategic management. Catering his research interests he is investigating the unexplored areas of risk management in the field of Business Management trying to get a doctorate in the same.

MRP ₹799 (incl. of all taxes)

BLOOMSBURY PRIME

ISBN 978-93-93715-14-2

90100

9 789393 715142

www.bloomsbury.com

SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

Approved by AICTE | Affiliated to Anna University | Accredited by NBA
'A' Grade Accreditation by NAAC | ISO 9001:2015 Certified

SRM Nagar, Kattankulathur - 603 203

Department of Electronics and Communication Engineering

National Conference on Emerging Trends in Communication Engineering, Computing Systems and Applications (ETCECSA 2022)

Certificate of Participation

This is to certify that **Prof. ANIKET SHAHADE** of **Shri Sant Gajanan Maharaj College of Engineering, Shegaon** has presented the paper titled **A Review on Smart Attendance Monitoring System Using Deep Learning Approach** in the **National Conference on "Emerging Trends in Communication Engineering, Computing Systems and Applications" (ETCECSA 2022)** on 27th April 2022.

Co-Conveners

Dr. N. Usha Bhanu, Professor,
Dr. S. Ramesh, Associate Professor,

Convener

Dr. Komala James,
Professor & Head

Organizing Chair

Dr. B. Chidhambararajan,
Principal

Premier Reference Source

Implementing Data Analytics and Architectures for Next Generation Wireless Communications

Chintan Bhatt, Neeraj Kumar, Ali Kashif Bashir,
and Mamoun Alazab

IGI Global
PUBLISHER of TIMELY KNOWLEDGE

Implementing Data Analytics and Architectures for Next Generation Wireless Communications

Chintan Bhatt
Charotar University of Science and Technology, India

Neeraj Kumar
Thapar University, India

Ali Kashif Bashir
Manchester Metropolitan University, UK

Mamoun Alazab
Charles Darwin University, Australia

A volume in the Advances in Wireless Technologies and Telecommunication (AWTT) Book Series

Published in the United States of America by
IGI Global
Information Science Reference (an imprint of IGI Global)
701 E. Chocolate Avenue
Hershey PA, USA 17033
Tel: 717-533-8845
Fax: 717-533-8661
E-mail: cust@igi-global.com
Web site: http://www.igi-global.com

Library of Congress Cataloging-in-Publication Data

Names: Bhatt, Chintan M., 1988- editor. | Kumar, Neeraj (Computer scientist) editor. | Bashir, Ali Kashif, 1982- editor. | Alazab, Mamoun, 1980- editor.
Title: Implementing data analytics and architectures for next generation wireless communications / Chintan Bhatt, Neeraj Kumar, Ali Kashif Bashir, and Mamoun Alazab, editors.
Description: Hershey, PA : Information Science Reference (an imprint of IGI Global), [2021] | Includes bibliographical references and index. | Summary: "This book covers the existing and emerging theoretical and practical challenges in the design, development and implementation of big data algorithms, protocols, architectures, and applications for next-generation wireless communications and their applications in smart cities"-- Provided by publisher.
Identifiers: LCCN 2021000192 (print) | LCCN 2021000193 (ebook) | ISBN 9781799869887 (hardcover) | ISBN 9781799869894 (paperback) | ISBN 9781799869900 (ebook)
Subjects: LCSH: Computer network architectures. | Big data. | Wireless communication systems. | Internet of things. | Artificial intelligence.
Classification: LCC TK5105.52 .I47 2021 (print) | LCC TK5105.52 (ebook) | DDC 621.39/81--dc23
LC record available at https://lccn.loc.gov/2021000192
LC ebook record available at https://lccn.loc.gov/2021000193

This book is published in the IGI Global book series Advances in Wireless Technologies and Telecommunication (AWTT) (ISSN: 2327-3305; eISSN: 2327-3313)

British Cataloguing in Publication Data
A Cataloguing in Publication record for this book is available from the British Library.

Table of Contents

Chapter 10
Analysis of Bluetooth Versions (4.0, 4.2, 5, 5.1, and 5.2) for IoT Applications

S. D. Padiya
https://orcid.org/0000-0002-7462-0187
Shri Sant Gajanan Maharaj College of Engineering, Shegaon, India

V. S. Gulhane
Sipna's COET, India

ABSTRACT

IoT includes many sensors that have to collect the data and send it to the superior nodes; for such interaction between the IoT devices, various wireless technologies are available, like infrared, Li-Fi, WI-Fi, Zigbee, Bluetooth, etc. Among all the available, Bluetooth proved the most promising short-range wireless communication technology due to various factors. To fulfil the increasing demand for wireless connectivity, the Bluetooth SIG must continuously perform up-gradation. Here, analysis of Bluetooth versions are discussed based on the characteristics such as speed, bandwidth, range, power, message capacity, beacon provision, compatibility, reliability, errors detection, correction capability, advertisement packets, duty cycle, slot availability masks, and many more. This analysis concluded that all the versions have their own set of merits and limitations. For the basic IoT applications (limited functionalities), Bluetooth 4.0/4.2 is a good choice, while for the complex IoT applications (advance functionalities), Bluetooth 5/ 5.1/ 5.2 is better.

INTRODUCTION

The Internet of Things (IoT) involves various wireless communication technologies to makes devices capable of interacting with each other. Nowadays, IoT with various dedicated sensors, devices and wireless communication technologies making a human lifestyle easier and smarter. Therefore, in our personal lives, IoT devices are becoming more prevalent and pervasive. Due to the IoT era, sensors are everywhere

DOI: 10.4018/978-1-7998-6988-7.ch010

Implementing Data Analytics and Architectures for Next Generation Wireless Communications

Wireless communication is continuously evolving to improve and be a part of our daily communication. This leads to improved quality of services and applications supported by networking technologies. We are now able to use LTE, LTE-Advanced, and other emerging technologies due to the enormous efforts that are made to improve the quality of service in cellular networks. As the future of networking is uncertain, the use of deep learning and big data analytics is a point of focus as it can work in many capacities at a variety of levels for wireless communications.

Implementing Data Analytics and Architectures for Next Generation Wireless Communications addresses the existing and emerging theoretical and practical challenges in the design, development, and implementation of big data algorithms, protocols, architectures, and applications for next generation wireless communications and their applications in smart cities. The chapters of this book bring together academics and industrial practitioners to exchange, discuss, and implement the latest innovations and applications of data analytics in advanced networks. Specific topics covered include key encryption techniques, smart home appliances, fog communication networks, and security in the internet of things. This book is valuable for technologists, data analysts, networking experts, practitioners, researchers, academicians, and students.

Topics Covered

- Artificial Intelligence
- Big Data
- Data Analytics
- E-Health Systems
- Encryption Techniques
- Fog Computing
- Internet of Things
- Network Optimization
- Network Security
- Smart Cities
- Smart Home
- Wireless Communications
- Wireless Networks

IGI Global
PUBLISHER of TIMELY KNOWLEDGE

701 E. Chocolate Avenue
Hershey, PA 17033, USA
www.igi-global.com

ISBN 978-1-7998-6989-4
90000
9 781799 869894

S. D. Padiya
V. S. Gulhane

IoT with BLE Beacons

Research Opportunities, Planning and Strategy

LAP LAMBERT Academic Publishing

S. D. Padiya
V. S. Gulhane

IoT with BLE Beacons

Research Opportunities, Planning and Strategy

LAP LAMBERT Academic Publishing

Imprint
Any brand names and product names mentioned in this book are subject to trademark, brand or patent protection and are trademarks or registered trademarks of their respective holders. The use of brand names, product names, common names, trade names, product descriptions etc. even without a particular marking in this work is in no way to be construed to mean that such names may be regarded as unrestricted in respect of trademark and brand protection legislation and could thus be used by anyone.

Cover image: www.ingimage.com

Publisher:
LAP LAMBERT Academic Publishing
is a trademark of
Dodo Books Indian Ocean Ltd., member of the OmniScriptum S.R.L Publishing group
str. A.Russo 15, of. 61, Chisinau-2068, Republic of Moldova Europe
Printed at: see last page
ISBN: 978-620-3-84811-3

CHAPTER 1
INTERNET OF THINGS (IoT)

1.1 Introduction

The Internet of Things (IoT) means a network with physical objects considered as "things", like sensors and actuators for the purpose of interconnection, and data exchange with each other over internet to make system easier. In 1982 at Carnegie Mellon University was discussed for the concept of Internet connected machine "Coca-Cola Vending Machine" with ability to report its inventory and temperature status of drink to the system. In 1999 at MIT's Auto-ID Center the term "Internet of Things" was coined by Mr. Kevin Ashton of P&G with role of radio-frequency identification (RFID) to allow computers to manage all individual things.

For the intercommunication purpose IoT devices have connections with each other, now a day many IoT systems involve smart sensor networks, which have mainly connected by a wireless communication medium, generally known as a Wireless Sensor Network (WSN). Due to small size and limited computational power, nodes of such networks are called, 'motes'. Motes can also directly connect to the Internet to integrate the web servers. The facility of motes interaction with web servers allows for creating a web of sensors called Web of Things (WoT).

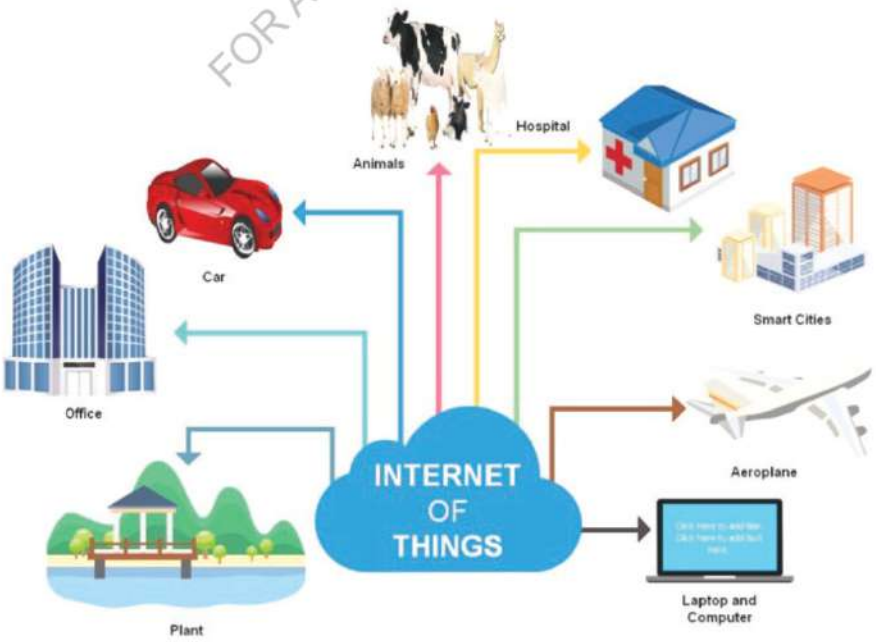


Figure 1.1) Application Areas of IoT

IoT with BLE Beacon comes with an basic knowledge with research opportunities, planning and strategy. The book includes basic of Internet of Things, Wireless Sensor Network, Data Aggregation in WSN, Bluetooth, Bluetooth Low Energy and BLE Beacons.

Chapter 1 includes introduction, architecture, taxonomy and research opportunities of IoT.

Chapter 2 includes introduction, architecture, characteristic, security parameters, and applications of WSN.

Chapter 3 includes introduction, challenges, and types of data aggregation in WSN.

Chapter 4 includes introduction with versions of Bluetooth.

Chapter 5 includes introduction, working, features, market demand, configurations, network topology, protocols and profiles, architecture, versions and applications.

Chapter 6 includes introduction, features, market demand, configurations, applications and research opportunities of BLE Beacon.

Prof. S. D. Padiya, assistant professor at SSGMCE, Shegaon (M.S.), India. Having more than 10 years teaching experience and pursuing Ph.D. to design and develop featherweight telemetry protocol for BLE Beacon in IoT.

Dr. V. S. Gulhane, professor at Sipna's COET, Amravati (M.S), India. Having more than 20 years of teaching experience.

9 786203 848113

2020-21

VIT
Vellore Institute of Technology

Virtual International Conference on
Product Design, Development and Deployment

CERTIFICATE

THE CERTIFICATE IS PRESENTED TO

Dr./Mr./Ms. Madhao Baliram Bhambere of
Yeshwantrao Chavan College Of Engineering, Nagpur has presented a paper entitled

Recent designs of fins for the heat transfer enhancement of thermal systems: A review

in "Virtual International Conference on Product Design, Development and Deployment (PD^3-2021)" held at Vellore Institute of Technology, Vellore during 11th and 12th SEPTEMBER 2021.

Dr. Renold Elsen S
Organising Secretary

Dr. Srinivasan Narayanan
Organising Secretary

Dr. Vasudevan. R
Conference Chair

Organised by
School of Mechanical Engineering, Vellore Institute of Technology, Vellore.

IOP Conference Series
Proceedings services for science
Materials Science and Engineering (MSE)

International Conference

on

Advances in Mechanical Engineering – 2022

(ICAME -2022)

(Online Mode)

27 - 28 May, 2022

CERTIFICATE

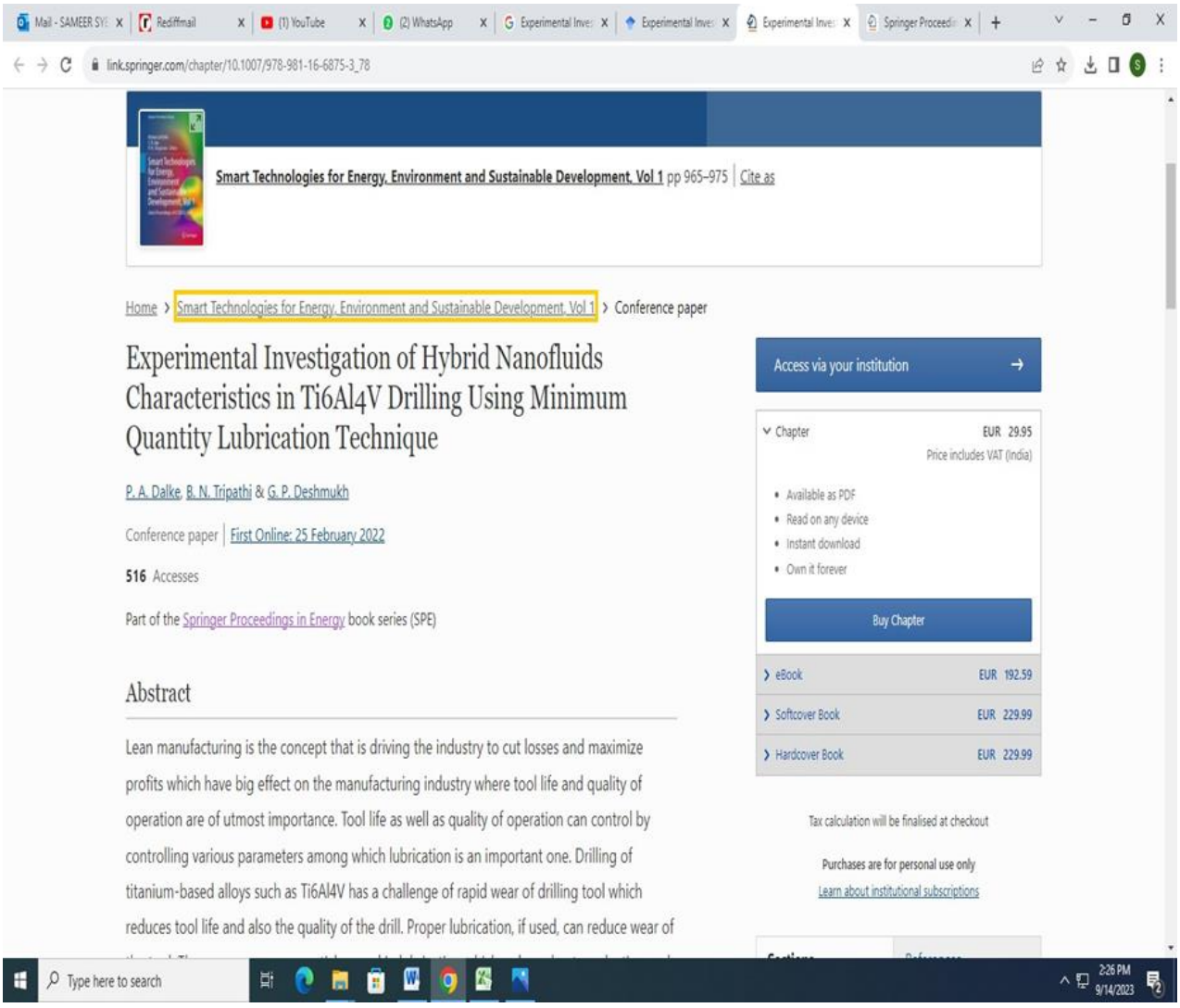
This is to certify that Dr. / Mr. / Miss. / Mrs. **Madhao Bhambere** has Presented a Research / Review Paper titled **Numerical analysis of heat transfer from perforated fins of an induction motor housing** in **International Conference on Advances in Mechanical Engineering – 2022 (ICAME -2022)**, Jointly Organized by Department of Mechanical Engineering, G H Raisoni College of Engineering, Nagpur, India & G H Raisoni Institute of Engineering & Technology, Nagpur, India during **27th & 28th May 2022.**

Dr. Rupesh Shelke	Prof. Tejpal Parshiwanikar	Dr. Sachin Untawale	Dr. Vivek Kapur
Convener	Convener	Director GHRCE	Director GHRIET

ICAME-2022-76-A

Shri Gajanan Shikshan Sanstha's
SHRI SANT GAJANAN MAHARAJ COLLEGE OF ENGINEERING
SHEGAON – 444203, DIST. BULDANA (MAHARASHTRA STATE), INDIA
"Recognized by A.I.C.T.E., New Delhi" Affiliated to Sant Gadge Baba Amravati University, Amravati
"Approved by the D.T.E., M.S. Mumbai"

Ph : +918669638081/82
Fax : 091-7265-252346
Email.principal@ssgmce.ac.in, registrar@ssgmce.ac.in
Website- www.ssgmce.ac.in



G H Raisoni College of Engineering, Nagpur, India

(An Autonomous Institute, NAAC A+, NIRF-139th Rank in 2020, 2nd Rank in ARIIA PAN India, Self Financed Institute Category)

Springer

International Conference
On
Smart Technologies for Energy, Environment & Sustainable Development (ICSTEESD-20)
E-Conference under the scheme of Grant for Organizing Conference (GOC)

In Association with

Kyushu Sangyo Japan University, Japan | University of Agder, Norway | GHR Labs & Research Center
MIE University, Kyushu Sangyo, Japan | University of Ruhuna, Sri Lanka | University of Dundee Scotland, UK

4th & 5th December, 2020

Jointly Organized by
Department of Mechanical, Electrical & Civil Engineering

This is to certify that **Piyush Dalke** has Presented Research Paper titled on **Experimental investigation of hybrid nanofluids characteristics in ti6al4v drilling using minimum quantity lubrication technique** in International Conference on Smart Technologies for Energy, Environment & Sustainable Development (ICSTEESD-20), sponsored by AICTE, New Delhi and organized by G H Raisoni College of Engineering, Nagpur, India during 4th & 5th December, 2020.

Dr. R. S. Shelke	Dr. P. M. Daigavane	Dr. B. V. Khode	Dr. S. B. Jaju	Dr. Sachin Untawale
General Chair	General Chair	General Chair	Organizing Chair	Director

AICTE Sponsored First National Conference on Innovation Management

NCIM-22

Organized by

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering, Shegaon

Certificate of Participation

This is to Certify that Mr./Miss/Mrs./Prof./Dr. **H.M. Jha "Bidyarthi"**

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering Shegaon

has participated in First National Conference on Innovation Management (NCIM-22)

organized on 22nd and 23rd April, 2022 and presented a research paper titled

Assessing the Need of Personalizing Activities and Role to Drive Academic Innovation

Dr. L. B. Deshmukh
Asso. Prof. & Co-Coordinator
NCIM

Dr. H M Jha "Bidyarthi"
Prof. & Head, Coordinator
NCIM

Prof. Dr. S B Somani,
Patron & Principal
SSGMCE, Shegaon

AICTE Sponsored First National Conference on Innovation Management

NCIM-22

Organized by

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering, Shegaon

Certificate of Participation

This is to Certify that Mr./Miss/Mrs./Prof./Dr. **H.M. Jha "Bidyarthi"**

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering Shegaon

has participated in First National Conference on Innovation Management (NCIM-22)

organized on 22nd and 23rd April, 2022 and presented a research paper titled

Millennial Trend in Disruptive Innovation

Dr. L. B. Deshmukh
Asso. Prof. & Co-Coordinator
NCIM

Dr. H M Jha "Bidyarthi"
Prof. & Head, Coordinator
NCIM

Prof. Dr. S B Somani,
Patron & Principal
SSGMCE, Shegaon

AICTE Sponsored First National Conference on Innovation Management

NCIM-22

Organized by

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering, Shegaon

Certificate of Participation

This is to Certify that Mr./Miss/Mrs./Prof./Dr. **Dr. Laxmikant Deshmukh**

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering, Shegaon

has participated in First National Conference on Innovation Management (NCIM-22)

organized on 22nd and 23rd April, 2022 and presented a research paper titled

DIGITAL MARKETING: AN INNOVATIVE APPROACH TOWARDS TRADITIONAL MARKETING

Dr. L. B. Deshmukh
Asso. Prof. & Co-Coordinator
NCIM

Dr. H M Jha "Bidyarthi"
Prof. & Head, Coordinator
NCIM

Prof. Dr. S B Somani,
Patron & Principal
SSGMCE, Shegaon

AICTE Sponsored First National Conference on Innovation Management

NCIM-22

Organized by

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering, Shegaon

Certificate of Participation

This is to Certify that Mr./Miss/Mrs./Prof./Dr. **Dr. Laxmikant B. Deshmukh**

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering Shegaon

has participated in First National Conference on Innovation Management (NCIM-22)

organized on 22nd and 23rd April, 2022 and presented a research paper titled

INNOVATIVE MARKETING STRATEGIES OF LEADING SHOE MANUFACTURES -A STUDY

Dr. L. B. Deshmukh
Asso. Prof. & Co-Coordinator
NCIM

Dr. H M Jha "Bidyarthi"
Prof. & Head, Coordinator
NCIM

Prof. Dr. S B Somani,
Patron & Principal
SSGMCE, Shegaon

AICTE Sponsored First National Conference on Innovation Management

NCIM-22

Organized by

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering, Shegaon

Certificate of Participation

This is to Certify that Mr./Miss/Mrs./Prof./Dr. **Dr. Laxmikant Deshmukh**

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering Shegaon

has participated in First National Conference on Innovation Management (NCIM-22)

organized on 22nd and 23rd April, 2022 and presented a research paper titled

Petroleum swap: An innovative approach to enhance Petroleum Customer Service Level (CSL)

Dr. L. B. Deshmukh
Asso. Prof. & Co-Coordinator
NCIM

Dr. H M Jha "Bidyarthi"
Prof. & Head, Coordinator
NCIM

Prof. Dr. S B Somani,
Patron & Principal
SSGMCE, Shegaon

AICTE Sponsored First National Conference on Innovation Management

NCIM-22

Organized by

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering, Shegaon

Certificate of Participation

This is to Certify that Mr./Miss/Mrs./Prof./Dr. **Dr. P. M. Kuchar**

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering Shegaon

has participated in First National Conference on Innovation Management (NCIM-22)

organized on 22nd and 23rd April, 2022 and presented a research paper titled

Recipe for Inclusive Growth– Women Empowerment

Dr. L. B. Deshmukh
Asso. Prof. & Co-Coordinator
NCIM

Dr. H M Jha "Bidyarthi"
Prof. & Head, Coordinator
NCIM

Prof. Dr. S B Somani,
Patron & Principal
SSGMCE, Shegaon

AICTE Sponsored First National Conference on Innovation Management

NCIM-22

Organized by

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering, Shegaon

Certificate of Participation

This is to Certify that Mr./Miss/Mrs./Prof./Dr. **Dr. Pavan M. Kuchar**

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering Shegaon

has participated in First National Conference on Innovation Management (NCIM-22)

organized on 22nd and 23rd April, 2022 and presented a research paper titled

MEN AND WOMEN FROM MARS AND VENUS AT WORK

Dr. L. B. Deshmukh
Asso. Prof. & Co-Coordinator
NCIM

Dr. H M Jha "Bidyarthi"
Prof. & Head, Coordinator
NCIM

Prof. Dr. S B Somani,
Patron & Principal
SSGMCE, Shegaon

AICTE Sponsored First National Conference on Innovation Management

NCIM-22

Organized by

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering, Shegaon

Certificate of Participation

This is to Certify that Mr./Miss/Mrs./Prof./Dr. **Dr. Pavan M. Kuchar**

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering, Shegaon

has participated in First National Conference on Innovation Management (NCIM-22)

organized on 22nd and 23rd April, 2022 and presented a research paper titled

Revitalizing Non Profits- An Enquiry Into Innovative Inputs By Vinoba Bhave And Baba Amte

Dr. L. B. Deshmukh
Asso. Prof. & Co-Coordinator
NCIM

Dr. H M Jha "Bidyarthi"
Prof. & Head, Coordinator
NCIM

Prof. Dr. S B Somani,
Patron & Principal
SSGMCE, Shegaon

AICTE Sponsored First National Conference on Innovation Management

NCIM-22

Organized by

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering, Shegaon

Certificate of Participation

This is to Certify that Mr./Miss/Mrs./Prof./Dr. **Dr. Mayur A. Dande**

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering Shegaon

has participated in First National Conference on Innovation Management (NCIM-22)

organized on 22nd and 23rd April, 2022 and presented a research paper titled

Diffusing Family Business Innovations- A case of Treasure Trove "Khandelwal Jewellers"

Dr. L. B. Deshmukh
Asso. Prof. & Co-Coordinator
NCIM

Dr. H M Jha "Bidyarthi"
Prof. & Head, Coordinator
NCIM

Prof. Dr. S B Somani,
Patron & Principal
SSGMCE, Shegaon

AICTE Sponsored First National Conference on Innovation Management

NCIM-22

Organized by

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering, Shegaon

Certificate of Participation

This is to Certify that Mr./Miss/Mrs./Prof./Dr. **Dr. M. A. Dande**

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering Shegaon

has participated in First National Conference on Innovation Management (NCIM-22)

organized on 22nd and 23rd April, 2022 and presented a research paper titled

Recipe for Inclusive Growth– Women Empowerment

Dr. L. B. Deshmukh
Asso. Prof. & Co-Coordinator
NCIM

Dr. H M Jha "Bidyarthi"
Prof. & Head, Coordinator
NCIM

Prof. Dr. S B Somani,
Patron & Principal
SSGMCE, Shegaon

AICTE Sponsored First National Conference on Innovation Management

NCIM-22

Organized by

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering, Shegaon

Certificate of Participation

This is to Certify that Mr./Miss/Mrs./Prof./Dr. **Dr. Mayur A. Dande**

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering Shegaon

has participated in First National Conference on Innovation Management (NCIM-22)

organized on 22nd and 23rd April, 2022 and presented a research paper titled

MEN AND WOMEN FROM MARS AND VENUS AT WORK

Dr. L. B. Deshmukh
Asso. Prof. & Co-Coordinator
NCIM

Dr. H M Jha "Bidyarthi"
Prof. & Head, Coordinator
NCIM

Prof. Dr. S B Somani,
Patron & Principal
SSGMCE, Shegaon

AICTE Sponsored First National Conference on Innovation Management

NCIM-22

Organized by

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering, Shegaon

Certificate of Participation

This is to Certify that Mr./Miss/Mrs./Prof./Dr. **Dr. Mayur A. Dande**

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering Shegaon

has participated in First National Conference on Innovation Management (NCIM-22)

organized on 22nd and 23rd April, 2022 and presented a research paper titled

Revitalizing Non Profits- An Enquiry Into Innovative Inputs By Vinoba Bhave And Baba Amte

Dr. L. B. Deshmukh
Asso. Prof. & Co-Coordinator
NCIM

Dr. H M Jha "Bidyarthi"
Prof. & Head, Coordinator
NCIM

Prof. Dr. S B Somani,
Patron & Principal
SSGMCE, Shegaon

AICTE Sponsored First National Conference on Innovation Management

NCIM-22

Organized by

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering, Shegaon

Certificate of Participation

This is to Certify that Mr./Miss/Mrs./Prof./Dr. **Dr. S. M. Mishra**

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering Shegaon

has participated in First National Conference on Innovation Management (NCIM-22)

organized on 22nd and 23rd April, 2022 and presented a research paper titled

Recipe for Inclusive Growth– Women Empowerment

Dr. L. B. Deshmukh
Asso. Prof. & Co-Coordinator
NCIM

Dr. H M Jha "Bidyarthi"
Prof. & Head, Coordinator
NCIM

Prof. Dr. S B Somani,
Patron & Principal
SSGMCE, Shegaon

AICTE Sponsored First National Conference on Innovation Management

NCIM-22

Organized by

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering, Shegaon

Certificate of Participation

This is to Certify that Mr./Miss/Mrs./Prof./Dr. **Dr. Satya Mohan Mishra**

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering Shegaon

has participated in First National Conference on Innovation Management (NCIM-22)

organized on 22nd and 23rd April, 2022 and presented a research paper titled

MEN AND WOMEN FROM MARS AND VENUS AT WORK

Dr. L. B. Deshmukh
Asso. Prof. & Co-Coordinator
NCIM

Dr. H M Jha "Bidyarthi"
Prof. & Head, Coordinator
NCIM

Prof. Dr. S B Somani,
Patron & Principal
SSGMCE, Shegaon

AICTE Sponsored First National Conference on Innovation Management

NCIM-22

Organized by

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering, Shegaon

Certificate of Participation

This is to Certify that Mr./Miss/Mrs./Prof./Dr. **Dr. Satya Mohan Mishra**

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering Shegaon

has participated in First National Conference on Innovation Management (NCIM-22)

organized on 22nd and 23rd April, 2022 and presented a research paper titled

Revitalizing Non Profits- An Enquiry Into Innovative Inputs By Vinoba Bhave And Baba Amte

Dr. L. B. Deshmukh
Asso. Prof. & Co-Coordinator
NCIM

Dr. H M Jha "Bidyarthi"
Prof. & Head, Coordinator
NCIM

Prof. Dr. S B Somani,
Patron & Principal
SSGMCE, Shegaon

AICTE Sponsored First National Conference on Innovation Management

NCIM-22

Organized by

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering, Shegaon

Certificate of Participation

This is to Certify that Mr./Miss/Mrs./Prof./Dr. **Wechansing Z. Suliya**

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering Shegaon

has participated in First National Conference on Innovation Management (NCIM-22)

organized on 22nd and 23rd April, 2022 and presented a research paper titled

An analysis of life management by public in India during pandemic Covid-19

Dr. L. B. Deshmukh
Asso. Prof. & Co-Coordinator
NCIM

Dr. H M Jha "Bidyarthi"
Prof. & Head, Coordinator
NCIM

Prof. Dr. S B Somani,
Patron & Principal
SSGMCE, Shegaon

AICTE Sponsored First National Conference on Innovation Management

NCIM-22

Organized by

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering, Shegaon

Certificate of Participation

This is to Certify that Mr./Miss/Mrs./Prof./Dr. **Wechansing Z. Suliya**

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering Shegaon

has participated in First National Conference on Innovation Management (NCIM-22)

organized on 22nd and 23rd April, 2022 and presented a research paper titled

A study and analysis of vibrant hands worked for rural development of India.

Dr. L. B. Deshmukh
Asso. Prof. & Co-Coordinator
NCIM

Dr. H M Jha "Bidyarthi"
Prof. & Head, Coordinator
NCIM

Prof. Dr. S B Somani,
Patron & Principal
SSGMCE, Shegaon

AICTE Sponsored First National Conference on Innovation Management

NCIM-22

Organized by

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering, Shegaon

Certificate of Participation

This is to Certify that Mr./Miss/Mrs./Prof./Dr. **Wechansing Z. Suliya**

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering Shegaon

has participated in First National Conference on Innovation Management (NCIM-22)

organized on 22nd and 23rd April, 2022 and presented a research paper titled

An Analysis of rural potential for fulfillment of basic needs for rural economic development model in tribal rural area of Nimad Region, Madhya Pradesh

Dr. L. B. Deshmukh
Asso. Prof. & Co-Coordinator
NCIM

Dr. H M Jha "Bidyarthi"
Prof. & Head, Coordinator
NCIM

Prof. Dr. S B Somani,
Patron & Principal
SSGMCE, Shegaon

AICTE Sponsored First National Conference on Innovation Management

NCIM-22

Organized by

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering, Shegaon

Certificate of Participation

This is to Certify that Mr./Miss/Mrs./Prof./Dr. **Wechansing Z. Suliya**

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering Shegaon

has participated in First National Conference on Innovation Management (NCIM-22)

organized on 22nd and 23rd April, 2022 and presented a research paper titled

A need of productive mental health, for organizational and individual growth

Dr. L. B. Deshmukh
Asso. Prof. & Co-Coordinator
NCIM

Dr. H M Jha "Bidyarthi"
Prof. & Head, Coordinator
NCIM

Prof. Dr. S B Somani,
Patron & Principal
SSGMCE, Shegaon

AICTE Sponsored First National Conference on Innovation Management

NCIM-22

Organized by

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering, Shegaon

Certificate of Participation

This is to Certify that Mr./Miss/Mrs./Prof./Dr. **Prof. Vishal Vinayakrao Patil**

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering Shegaon

has participated in First National Conference on Innovation Management (NCIM-22)

organized on 22nd and 23rd April, 2022 and presented a research paper titled

Dynamically Continuous Innovations in Financial Services –

A Case of AU Small Finance Bank (Badlaav Hamse Hai)

Dr. L. B. Deshmukh
Asso. Prof. & Co-Coordinator
NCIM

Dr. H M Jha "Bidyarthi"
Prof. & Head, Coordinator
NCIM

Prof. Dr. S B Somani,
Patron & Principal
SSGMCE, Shegaon

AICTE Sponsored First National Conference on Innovation Management

NCIM-22

Organized by

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering, Shegaon

Certificate of Participation

This is to Certify that Mr./Miss/Mrs./Prof./Dr. **Mr. Vishal V. Patil**

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering Shegaon

has participated in First National Conference on Innovation Management (NCIM-22)

organized on 22nd and 23rd April, 2022 and presented a research paper titled

MEN AND WOMEN FROM MARS AND VENUS AT WORK

Dr. L. B. Deshmukh
Asso. Prof. & Co-Coordinator
NCIM

Dr. H M Jha "Bidyarthi"
Prof. & Head, Coordinator
NCIM

Prof. Dr. S B Somani,
Patron & Principal
SSGMCE, Shegaon

AICTE Sponsored First National Conference on Innovation Management

NCIM-22

Organized by

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering, Shegaon

Certificate of Participation

This is to Certify that Mr./Miss/Mrs./Prof./Dr. **Mr. Vishal V. Patil**

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering Shegaon

has participated in First National Conference on Innovation Management (NCIM-22)

organized on 22nd and 23rd April, 2022 and presented a research paper titled

Revitalizing Non Profits- An Enquiry Into Innovative Inputs By Vinoba Bhave And Baba Amte

Dr. L. B. Deshmukh
Asso. Prof. & Co-Coordinator
NCIM

Dr. H M Jha "Bidyarthi"
Prof. & Head, Coordinator
NCIM

Prof. Dr. S B Somani,
Patron & Principal
SSGMCE, Shegaon

AICTE Sponsored First National Conference on Innovation Management

NCIM-22

Organized by

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering, Shegaon

Certificate of Participation

This is to Certify that Mr./Miss/Mrs./Prof./Dr. **Bilal T. Husain**

Department of Business Administration and Research

Shri Sant Gajanan Maharaj College of Engineering Shegaon

has participated in First National Conference on Innovation Management (NCIM-22)

organized on 22nd and 23rd April, 2022 and presented a research paper titled

Identification and assessment of risks involved in construction projects in

Western Vidarbha from the perspective of civil contractors

Dr. L. B. Deshmukh
Asso. Prof. & Co-Coordinator
NCIM

Dr. H M Jha "Bidyarthi"
Prof. & Head, Coordinator
NCIM

Prof. Dr. S B Somani,
Patron & Principal
SSGMCE, Shegaon