

3.4.4 Number of books and chapters in edited volumes/books published per teacher during the last five years (5)

3.4.4.1: Total number of books and chapters in edited volumes / books published, and papers in national/international conference-proceedings year wise during last five years

Sl. No	Name of the teacher	Title of the book/chapters published	Title of the paper	Title of the proceedings of the conference	Name of the conference	National / International	Year of publication	ISBN/ISSN number of the proceeding	Affiliating Institute at the time of publication	Name of the publisher
<b>CIVIL</b>										
1	SUJIT KUMAR PRADHAN	5 <sup>th</sup> International symposium on asphalt pavement & environment, Lecture notes in Civil Engineering,	Impacts of recycling agent on superpave mixture containing RAP.	Proceedings of the 5th International Symposium on Asphalt Pavements & Environment (APE)	International Airfield and Highway Pavements Conference 2019	INTERNATIONAL	2020	ISBN-978-3-030-29779-4 <a href="https://link.springer.com/chapter/10.1007/978-3-030-29779-4_24">https://link.springer.com/chapter/10.1007/978-3-030-29779-4_24</a>		Springer Nature, Switzerland
2	SUJIT KUMAR PRADHAN	Lecture Notes in Civil Engineering, Springer	Effect of Softer Binder on Bituminous Mixture Containing Reclaimed Asphalt Pavement (RAP) Material	International Conference on Recent Developments in Sustainable Infrastructure: Research and Practices (ICRDSI 2020),	ICRDSI 2020	INTERNATIONAL	2020	ISBN-978-981-16-7509-6 <a href="https://link.springer.com/chapter/10.1007/978-981-16-7509-6_6">https://link.springer.com/chapter/10.1007/978-981-16-7509-6_6</a>		KIIT
3	A. K. Bhoi, J. N. Mandal, A. Juneja	Advancements in Unsaturated Soil Mechanics, CHAPTER - Feasibility Study of Bagasse Ash as a Filling Material	Feasibility Study of Bagasse Ash as a Filling Material	Proceedings of the 3rd GeoMEast International Congress and Exhibition, Egypt 2019 on Sustainable Civil Infrastructures – The Official International Congress of the Soil-Structure Interaction Group in Egypt (SSIGE)	GeoMEast 2019. Egypt	INTERNATIONAL	2020	Print ISBN: 978-3-030-34205-0, Electronic ISBN: 978-3-030-34206-7 <a href="https://link.springer.com/chapter/10.1007/978-3-030-34206-7_7">https://link.springer.com/chapter/10.1007/978-3-030-34206-7_7</a>	IIT Bombay	Springer International Publishing
4	Sahu, S. K., and Sahoo, D. R.,		Monotonic Behavior of Rc Beams With High-Strength Steel Shear Stirrups”	fib Symposium 22-24 Nov, 2020 Sanghai China.		INTERNATIONAL	2020	Page no.634-639	IIT DELHI	Sanghai China.
5	PRATIK ACHARYA, T.K. NATH, RAMBABU NIMMA	LECTURE NOTES IN INTELLIGENT SYSTEMS , ICIMIB 2020	Sediment rating curve and sediment Concentration Estimation for Mahanadi river.	Intelligent Systems, Springer Link	ICMIB 2020	INTERNATIONAL	2020	PAGE-95-104, ISBN: 978-981-33-6081-5 <a href="https://link.springer.com/chapter/10.1007/978-981-33-6081-5_9">https://link.springer.com/chapter/10.1007/978-981-33-6081-5_9</a>	IGIT Sarang,	SPRINGER, LNNS-VOLUME 185
<b>ELECTRICAL</b>										
6	Dr. Bibhu Pasad Panigrahi	Recent Advances in Power Electronics and Drive	Genetic Algorithm Optimized Direct Torque Control of Mathematically Modeled Induction Motor Drive Using PI and Sliding Mode Controller			International	2020	ISBN-978-981-15-8585-2 <a href="https://link.springer.com/chapter/10.1007/978-981-15-8586-9_32">https://link.springer.com/chapter/10.1007/978-981-15-8586-9_32</a>	IGIT, Sarang	Springer Nature

7	Dr. Bibhu Pasad Panigrahi		Regulated Soft-Switching Power Supply Using Buck-Boost Converter	Computational Intelligence for Smart Power System and Sustainable Energy (CISPSSE),International Conference on	Computational Intelligence for Smart Power System and Sustainable Energy	International	2020	10.1109/CISPSSE49931.2020 <a href="https://ieeexplore.ieee.org/document/9212245">https://ieeexplore.ieee.org/document/9212245</a>	IGIT, Sarang	IEEE
8	Dr. Pranati Das		Heading plane Control of an Autonomous Underwater Vehicle: A novel Fuzzy and Model Reference Adaptive Control Approach	2020 Third International Conference on Advances in Electronics, Computers and Communications (ICAECC)	2020 Third International Conference on Advances in Electronics, Computers and Communications (ICAECC)	International	2020	ISBN-978-1-7281-8045-8 <a href="https://ieeexplore.ieee.org/document/9339495">https://ieeexplore.ieee.org/document/9339495</a>	IGIT, Sarang	IEEE
9	Dr. Pranati Das	Advances in Intelligent Systems and Computing ((AISC,volume 1053)	Automatic Extraction of Vessels from Newly Accessible Dataset	Soft Computing: Theories and Applications	Soft Computing: Theories and Applications	International	2020	ISBN-978-981-15-0750-2 <a href="https://link.springer.com/chapter/10.1007/978-981-15-0751-9_105">https://link.springer.com/chapter/10.1007/978-981-15-0751-9_105</a>	IGIT, Sarang	Springer Nature
10	Dr. Pranati Das	Lecture Notes in Electrical Engineering ((LNEE,volume 665)	A Novel Low Contrast Image Enhancement Using Adaptive Multi-Resolution Technique and SVD	Advances in Electrical Control and Signal Systems	Advances in Electrical Control and Signal Systems	International	2020	ISBN-978-981-15-5261-8 <a href="https://link.springer.com/chapter/10.1007/978-981-15-5262-5_79">https://link.springer.com/chapter/10.1007/978-981-15-5262-5_79</a>	IGIT, Sarang	Springer Nature
11	Dr. Pranati Das	Lecture Notes in Networks and Systems ((LNNS,volume 109)	Dictionary Design for Block-Based Intra-image Compression	Advances in Intelligent Computing and Communication	Advances in Intelligent Computing and Communication	International	2020	ISBN-978-981-15-2773-9 <a href="https://link.springer.com/chapter/10.1007/978-981-15-2774-6_27">https://link.springer.com/chapter/10.1007/978-981-15-2774-6_27</a>	IGIT, Sarang	Springer Nature
12	Dr. Rabindra Behera		Regulated Soft-Switching Power Supply Using Buck-Boost Converter	2020 International Conference on Computational Intelligence for Smart Power System and Sustainable Energy (CISPSSE)	2020 International Conference on Computational Intelligence for Smart Power System and Sustainable	International	2020	ISBN-978-1-7281-7275-0 <a href="https://ieeexplore.ieee.org/document/9212245">https://ieeexplore.ieee.org/document/9212245</a>	IGIT, Sarang	IEEE
		<b>MECHANICAL</b>								
13	Sudhanshu Bhushan Panda, Antaryami Mishra, Narayan Chandra Nayak	AI in Manufacturing and Green Technology: Methods and Applications	Design for manufacturing of automotive components: A Knowledge based integrated approach			International	2020	ISBN 9781003032465, doi.org/10.1201/9781003032465.	IGIT Sarang	Taylor & Francis
14	Supriya Sahu, B.B. Choudhury	Advances in Intelligent System and Computing, Soft Computing in Data Analytics	Dynamic behavior analysis of an industrial robot using FEM	Springer,Book Chapter	2019	International		<a href="https://link.springer.com/chapter/10.1007/978-981-13-0514-6_20">https://link.springer.com/chapter/10.1007/978-981-13-0514-6_20</a>		
15	Supriya Sahu, B.B. Choudhury	Computational Intellisence in Data Mining	PSO based p+F14+C13:E16+C12:E16+F14+C13:E16+C13:E16	Springer,Book Chapter	ICCIDM,2019	International				

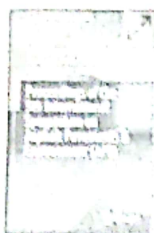

16	Dr. B.B.Choudhury	Learning and Analytics in Intelligent Systems	Autonomous Track Designing Approach in a Settled and Unsettled Environment	Applications of Robotics in Industry Using Advanced Mechanisms	ARIAM: International Conference on Application of Robotics in Industry using Advanced	International	2020	978-3-030-30273-3 <a href="https://link.springer.com/chapter/10.1007/978-3-030-30271-9_20">https://link.springer.com/chapter/10.1007/978-3-030-30271-9_20</a>	IGIT Sarang	Springer
17	Dr. B.B.Choudhury	Learning and Analytics in Intelligent Systems	Kinematics Analysis of a 6-DOF Industrial Robot	Applications of Robotics in Industry Using Advanced Mechanisms	ARIAM: International Conference on Application of Robotics in Industry using Advanced	International	2020	978-3-030-30273-3 <a href="https://link.springer.com/chapter/10.1007/978-3-030-30271-9_30">https://link.springer.com/chapter/10.1007/978-3-030-30271-9_30</a>	IGIT Sarang	Springer
18	Dr. B.B.Choudhury	Learning and Analytics in Intelligent Systems	FPGA Implementation of Modified Swarm Optimization Based Control Strategy for a Mobile Robot	Applications of Robotics in Industry Using Advanced Mechanisms	ARIAM: International Conference on Application of Robotics in Industry using Advanced	International	2020	978-3-030-30273-3 <a href="https://link.springer.com/chapter/10.1007/978-3-030-30271-9_26">https://link.springer.com/chapter/10.1007/978-3-030-30271-9_26</a>	IGIT Sarang	Springer
19	Dr. B.B.Choudhury	Robotic Systems: Concepts, Methodologies, Tools, and Applications	Fuzzy Logic Based Path Planning for Industrial Robot			International	2020	978-1-799-81754-3 <a href="https://www.researchgate.net/publication/284887204_Implementation_of_Fuzzy-Based_Robotic_Path_Planning">https://www.researchgate.net/publication/284887204_Implementation_of_Fuzzy-Based_Robotic_Path_Planning</a>	IGIT Sarang	IGI Global
20	Dr. B.B.Choudhury	Advances in Intelligent Systems and Computing	An effective trajectory planning for a material handling robot using PSO algorithm	Computational Intelligence in Data Mining	ICCIDM 2018	International	2020	978-981-13-8676-3 <a href="https://link.springer.com/chapter/10.1007/978-981-13-8676-3_7">https://link.springer.com/chapter/10.1007/978-981-13-8676-3_7</a>	IGIT Sarang	Springer
21	Dr. B.B.Choudhury	Advances in Intelligent Systems and Computing	PSO Based Path Planning of a Six-Axis Industrial Robot	Computational Intelligence in Data Mining	ICCIDM 2018	International	2020	978-981-13-8676-3 <a href="https://link.springer.com/chapter/10.1007/978-981-13-8676-3_19">https://link.springer.com/chapter/10.1007/978-981-13-8676-3_19</a>	IGIT Sarang	Springer
22	Dr. B.B.Choudhury	Advances in Intelligent Systems and Computing	Selection of Industrial Robot Using Fuzzy Logic Approach	Computational Intelligence in Data Mining	ICCIDM 2018	International	2020	978-981-13-8676-3 <a href="https://link.springer.com/chapter/10.1007/978-981-13-8676-3_20">https://link.springer.com/chapter/10.1007/978-981-13-8676-3_20</a>	IGIT Sarang	Springer
23	Mr. P.R.Dhal	Learning and Analytics in Intelligent Systems	Fabrication and Study of Mechanical Properties of Human Hair Reinforced Linear Low Density Polyethylene Composite	Applications of Robotics in Industry Using Advanced Mechanisms	ARIAM: International Conference on Application of Robotics in Industry using Advanced	International	2020	978-3-030-30273-3 <a href="https://link.springer.com/chapter/10.1007/978-3-030-30271-9_3">https://link.springer.com/chapter/10.1007/978-3-030-30271-9_3</a>	IGIT Sarang	Springer

24	Mr. M.K.Muni	Innovative Product Design and Intelligent Manufacturing Systems	Path Planning of the Mobile Robot Using Fuzzified Advanced Ant Colony Optimization	Lecture Notes in Mechanical Engineering	ICIPDIMS 2019	International	2020	978-981-15-2696-1 <a href="https://link.springer.com/chapter/10.1007/978-981-10-8055-5_13">https://link.springer.com/chapter/10.1007/978-981-10-8055-5_13</a>	IGIT Sarang	springer
25	Dr. D.K.Behera	Advances in Intelligent Systems and Computing	Shifted Peterson Network: A New Network for Network-on-Chip	Computational Intelligence in Pattern Recognition	CIPR 2019	International	2020	978-981-13-9042-5 <a href="https://link.springer.com/chapter/10.1007/978-981-13-9042-5_51">https://link.springer.com/chapter/10.1007/978-981-13-9042-5_51</a>	IGIT Sarang	springer
26	Dr. S Sahu	Advances in Intelligent Systems and Computing	PSO Based Path Planning of a Six-Axis Industrial Robot	Computational Intelligence in Data Mining	ICCIDM 2018	International	2020	978-981-13-8676-3 <a href="https://link.springer.com/chapter/10.1007/978-981-13-8676-3_19">https://link.springer.com/chapter/10.1007/978-981-13-8676-3_19</a>	IGIT Sarang	Springer
27	Dr. S Sahu	Robotic Systems: Concepts, Methodologies, Tools, and	Fuzzy Logic Based Path Planning for Industrial Robot			International	2020	978-1-799-81754-3	IGIT Sarang	IGI Global
28	Dr. R.N.Sethi	Materialstoday Proceedings	Study of Dry-Sliding Wear Behaviour of Cu-SiCp Metal Matrix Composites			International	2020	<a href="https://www.sciencedirect.com/science/article/abs/pii/S2214785320301759">https://www.sciencedirect.com/science/article/abs/pii/S2214785320301759</a>	IGIT Sarang	Elsevier
29	Mr. G K Ghosh	Materialstoday proceedings	Numerical simulation of weld nugget in resistance spot welding process			International	2020	<a href="https://www.sciencedirect.com/science/article/abs/pii/S2214785320335999">https://www.sciencedirect.com/science/article/abs/pii/S2214785320335999</a>	IGIT Sarang	Elsevier
30	Mr. G K Ghosh	Materialstoday proceedings	Rheological properties analysis of MWCNT/graphene hybrid-gear oil (SAE EP-90) nanolubricants			International	2020	<a href="https://www.sciencedirect.com/science/article/abs/pii/S2214785320317636">https://www.sciencedirect.com/science/article/abs/pii/S2214785320317636</a>	IGIT Sarang	Elsevier
31	Mr. Sudhanshu Bhushan Panda	AI in Manufacturing and Green Technology: Methods and Applications	Design for manufacturing of automotive components: A Knowledge based integrated approach			International	2020	ISBN 9781003032465, <a href="https://doi.org/10.1201/9781003032465">doi.org/10.1201/9781003032465</a> . <a href="https://link.springer.com/chapter/10.1007/978-981-15-2696-1_10">https://link.springer.com/chapter/10.1007/978-981-15-2696-1_10</a>	IGIT Sarang	Taylor & Francis
32	Mr. D. Nayak	Lecture Notes in Mechanical Engineering	Dynamic Stability Analysis of an Asymmetric Sandwich Beam on a Sinusoidal Pasternak	Innovative Product Design and Intelligent Manufacturing Systems	ICIPDIMS 2019	International	2020	978-981-15-2696-1	IGIT Sarang	springer
33	Mr. D. Nayak	Lecture Notes in Mechanical Engineering	Static Stability Investigation of an Asymmetric Sandwich Beam in Temperature Environment	Advances in Mechanical Engineering	ICRIDME 2018	International	2020	978-981-15-0124-1 <a href="https://link.springer.com/chapter/10.1007/978-981-15-0124-1_107">https://link.springer.com/chapter/10.1007/978-981-15-0124-1_107</a>	IGIT Sarang	springer
		<b>CHEMICAL</b>								

34	Dr. H. Sutar, R. Murmu		High Density Polyethylene (HDPE) and polypropylene (PP) blend: An Experimental Approach		New Advances in Materials Science and Engineering		2019	ISBN(Print): 978-93-89246-08-7		
35	Dr. H. Sutar, Prof. D. Roy, Prof. S. C. Mishra and R. Murmu		Study of Sliding Wear Behavior of Plasma Sprayed Red Mud Composite Coatings on Mild Steel		Book Publisher			ISBN (Print): 978-93-89816-04-4		
<b>Metallurgy</b>										
36	J.Pany, R.K.Barik, S.K.Sahoo, S.C.Patnaik, J.Majhi, A.B.Patnaik		Mathematical modeling for the prediction of wear rate of Al-12.6Si/TiB <sub>2</sub> <i>in situ</i> composites	Materials Today: Proceedings (2020).	ICPCM	International	2020	<a href="https://doi.org/10.1016/j.matpr.2020.03.493">https://doi.org/10.1016/j.matpr.2020.03.493</a> <a href="https://www.sciencedirect.com/science/article/abs/pii/S2214785320322744">https://www.sciencedirect.com/science/article/abs/pii/S2214785320322744</a>	NIT Rourkela	Elsevier
37	P Nayak, AK Biswal, SK Sahoo		Processing and characterization of Fe-35Mn biodegradable metallic materials	Materials Today: Proceedings (2020).	ICPCM	International	2020	<a href="https://doi.org/10.1016/j.matpr.2020.02.966">https://doi.org/10.1016/j.matpr.2020.02.966</a> , <a href="https://www.sciencedirect.com/science/article/abs/pii/S2214785320317569">https://www.sciencedirect.com/science/article/abs/pii/S2214785320317569</a>	NIT Rourkela	Elsevier
38	Sandeep K.Sahoo, B.Sarangi, S.C.Patnaik, Jogendra Majhi, Asutya K.Biswal, Bhabani		Studies on in-situ TiB <sub>2</sub> reinforced Al-Si alloys synthesized by stir casting method	Materials Today: Proceedings (2020).	ICPCM	International	2020	<a href="https://www.sciencedirect.com/science/article/abs/pii/S2214785320318952">https://www.sciencedirect.com/science/article/abs/pii/S2214785320318952</a>	NIT Rourkela	Elsevier
39	A.B. Pattnaik and B.B. Jha		Acoustic Emission during tensile deformation of 2.25Cr-1Mo steel	Proceedings of the 3rd Asian Symposium on Materials & Processing ASMP 2012, IIT Madras, Chennai, 30-31, August 2012	Accepted for publication as conference proceeding	International	2020	<a href="https://www.sciencedirect.com/science/article/abs/pii/S0921509316300065">https://www.sciencedirect.com/science/article/abs/pii/S0921509316300065</a>	IIT Madras	
40	I Tripathy, SP Rout, M Mallik		Effect of temperature and pressure on diffusivity of nitinol pellet bonded with steel plate	Materials Today Proceeding(2020)	ICPCM	International	2020	<a href="https://doi.org/10.1016/j.matpr.2020.02.892">https://doi.org/10.1016/j.matpr.2020.02.892</a> <a href="https://www.sciencedirect.com/science/article/abs/pii/S2214785320316825">https://www.sciencedirect.com/science/article/abs/pii/S2214785320316825</a>	NIT Rourkela	Elsevier
41	J. Parida, S. C. Pattnaik, S. C. Mishra, A. Behera		Effect of heat treatment on wear behaviour of Al-7 wt%Si- X wt% Mg alloys	Materials Today Proceeding(2020), Volume 33, Part 8, 2020, Pages 4976-4980	ICPCM	International	2020	<a href="https://doi.org/10.1016/j.matpr.2020.02.828">https://doi.org/10.1016/j.matpr.2020.02.828</a> <a href="https://www.sciencedirect.com/science/article/abs/pii/S2214785320316187">https://www.sciencedirect.com/science/article/abs/pii/S2214785320316187</a>	NIT Rourkela	Elsevier
<b>ETC</b>										

42	BIKASH CHANDRA SAHOO		DESIGN AND VALIDATION OF AN ANTENNA ARRAY FOR CRAN APPLICATIONS	DESIGN AND VALIDATION OF AN ANTENNA ARRAY FOR CRAN APPLICATIONS	2020 IEEE International Conference for Convergence in Engineering	International	2020	978-1-7281-7340-5 <a href="https://ieeexplore.ieee.org/abstract/document/9290665">https://ieeexplore.ieee.org/abstract/document/9290665</a>	I.G.I.T., SARANG	IEEE
43	DEBAPRIYA PARIDA		Real-time Environment Monitoring System using ESP8266 and ThingSpeak on Internet of Things Platform	Intelligent Computing and Control Systems (ICCS), 2019 International Conference on	2019 International Conference on Intelligent Computing and	International	2020	Electronic ISBN:978-1-5386-8113-8 <a href="https://ieeexplore.ieee.org/document/9065451">https://ieeexplore.ieee.org/document/9065451</a>	IGIT, Sarang	IEEE
44	Dillip Dash		Design and Validation of an Antenna Array for Cloud Radio Access Network Application		International Conference for Convergence in Engineering	International	2020	978-1-7281-7340-5 <a href="https://ieeexplore.ieee.org/abstract/document/9290665">https://ieeexplore.ieee.org/abstract/document/9290665</a>	IGIT Sarang	IEEE
45	Kodanda Dhar Sa		Design and Validation of an Antenna Array for Cloud Radio Access Network Application		International Conference for Convergence in Engineering	International	2020	978-1-7281-7340-5 <a href="https://ieeexplore.ieee.org/abstract/document/9290665">https://ieeexplore.ieee.org/abstract/document/9290665</a>	IGIT Sarang	IEEE
46	Soumya Ranjan Mishra		Design and Validation of an Antenna Array for Cloud Radio Access Network Applications		IEEE International Conference for Convergence in	International	2020	<a href="https://ieeexplore.ieee.org/abstract/document/9290665">https://ieeexplore.ieee.org/abstract/document/9290665</a>	VSSUT, Burla	IEEE
47	Dr.(Mrs)Urmila Bhanja	Lecture Notes on Data Engineering and Communication Technologies book series(LNDECT,volume 37)	Analysis of different channel models in FSO		International conference on data science and management,ICD SM-2019	International	2020	Print ISBN : 978-981-15-0977-3 Online ISBN :978-981-15-0978-0 <a href="https://link.springer.com/chapter/10.1007/978-981-15-0978-0_35">https://link.springer.com/chapter/10.1007/978-981-15-0978-0_35</a>	IGIT Sarang	Springer
48	Dr.(Mrs)Urmila Bhanja	Lecture Notes on Data Engineering and Communications Technologies	PDF Analysis of Different Channel Models in FSO			International	2020	Print ISBN 978-981-15-0977-3 <a href="https://link.springer.com/chapter/10.1007/978-981-15-0978-0_35">https://link.springer.com/chapter/10.1007/978-981-15-0978-0_35</a>		Springer
49	Dr.(Mrs)Urmila Bhanja	Advances in Intelligent Systems and Computing	Some Routing Schemes and Mobility Models for Real Terrain MANET				2020	Print ISBN978-981-15-1883-6 <a href="https://link.springer.com/chapter/10.1007/978-981-15-1884-3_49">https://link.springer.com/chapter/10.1007/978-981-15-1884-3_49</a>		Springer
50	Dr.(Mrs)Urmila Bhanja		3D Waveguides for Nano Photonic Application		ICNNEE		2020	<a href="https://dx.doi.org/10.2139/ssrn.3517742">https://dx.doi.org/10.2139/ssrn.3517742</a>		
51	Dr.(Mrs)Urmila Bhanja	Lecture Notes on Data Engineering and Communications Technologies ((LNDECT,volume	Investigation of Graphene Nanoparticles in a Nanocomposite Film via Photonic Crvstal Fiber Through				2020	Print ISBN978-981-15-0977-3 <a href="https://link.springer.com/chapter/10.1007/9">https://link.springer.com/chapter/10.1007/9</a>		Springer

52	Dr.(Mrs)Urmila Bhanja		Energy Efficiency and BER analysis of Concatenated FEC Coded MIMO-OFDM-FSO System			International	2019	Electronic ISBN:978-1-6654-0239-2 <a href="https://ieeexplore.ieee.org/document/9716656/figures#figures">https://ieeexplore.ieee.org/document/9716656/figures#figures</a>	IGIT Sarang	IEEE
53	Dr.(Mrs)Urmila Bhanja		Energy saving Techniques for impairment aware future backbone all optical networks		E-Odisha Summit	National		<a href="https://www.sciencedirect.com/science/article/pii/S1389128617300762">https://www.sciencedirect.com/science/article/pii/S1389128617300762</a>	IGIT Sarang	
	<b>CSE</b>									
54	Prahallad Kumar Sahu; Ramesh kumar Sahoo; Nilambar Sethi; Srinivas Sethi	2020 International Conference on Computer Science, Engineering and Applications (ICCSEA)	Emotion Classification Based On EEG Signals In a Stable Environment	2020 International Conference on Computer Science, Engineering and Applications (ICCSEA)		National	2020	Electronic ISBN:978-1-7281-5830-3 <a href="https://ieeexplore.ieee.org/document/9132966">https://ieeexplore.ieee.org/document/9132966</a>		IEEE

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ISAP APE 2019: **Proceedings of the 5th International Symposium on Asphalt Pavements & Environment (APE)**, pp 246–255

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## Impacts of Recycling Agent on Superpave Mixture Containing RAP

[Sujit Kumar Pradhan](#)  & [Umesh Chandra Sahoo](#)

Conference paper | [First Online: 30 August 2019](#)

**1118** Accesses | **1** Citations

Part of the [Lecture Notes in Civil Engineering](#) book series (LNCE, volume 48)

### Abstract

This research presents the laboratory outcomes in which the influence of pongamia oil, a locally available non-edible oil as rejuvenator on the performance of hot mix asphalt containing reclaimed asphalt pavement was assessed. A research study has been taken up in three stages to assess the potential of rejuvenator. First stage focussed on determining optimum dosage of rejuvenator. The aged binder was then mixed with the rejuvenator at varying rates and the rheological

  
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International Congress and Exhibition "Sustainable Civil Infrastructures"  
 GeoMEast 2019: **Advancements in Unsaturated Soil Mechanics** pp 81–94

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## Feasibility Study of Bagasse Ash as a Filling Material

A. K. Bhoi , J. N. Mandal & A. Juneja

Conference paper | [First Online: 01 November 2019](#)

**298** Accesses | **1** Citations

Part of the [Sustainable Civil Infrastructures](#) book series (SUCI)

### Abstract

India is the second most sugarcane producer in the world and generates 10 million tons of bagasse ash every year. Bagasse ash is generally spread as fertilizer in the field. It is the most frequent method of disposing of bagasse ash. However, it contains heavy metals which may lead to adverse effect on the yielding of the crop. Hence, some scholars recommend not using bagasse ash as fertilizer. Previous studies indicated that bagasse ash has been significantly used as a fine aggregate in concrete. As a fine aggregate bagasse ash also has the potential to be an alternative filling material.

  
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### Unconfined Compressive Strength of Geopolymer Cement

*International Conference on Artificial Intelligence in Manufacturing & Renewable Energy (ICAIMRE) 2019*

5 Pages

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Date Written: March 9, 2020

#### Abstract

Red mud is produced by the production of alumina and its disposal is now a global problem. Every year large amounts of red mud are released from the bauxite calcination method and its use has become an urgent problem. The initial study investigates the possible reuse of red mud through geopolymerization and its reaction with other solid waste, such as fly ash. This document offers a concept that studies the geopolymerization of red mud, the main industrial leftover from the refining of alumina and fly ash, an industrial leftover from the burning of coal, consuming minimum materials. Different synthesis factors (for example, the ratio of red mud / fly ash, sodium metasilicateNonahydrate solution in a solid mixture (ratio of red mud and fly ash), diverse concentrations of sodium metasilicateNonahydrate solution, etc.). They are altered to have an effect on the evaluation of mechanical properties of the final geopolymer product. In this study, the ratio of red mud to fly ash was maintained at 50:50 as a constant ratio, the solution to the solid mixture as 1 and the change in concentration of the sodium metasilicateNonahydrate solution (2M-6M). The outputs of the unconfined compression test display that these aspects have a substantial impact on the mechanical characteristics of the synthesized geopolymer. Depending on the synthesis circumstances, the unconfirmed compressive strengths range from 2.391 kg / cm<sup>2</sup> to 10.963 kg / cm<sup>2</sup> and high values can be compared with some types of Portland cement. The results shows the two most important industrial leftovers, red mud and fly ash, can be reutilised to produce geopolymers that can substitute Portland cement and can further be used in the construction of civil infrastructure.

**Keywords:** Red mud, Fly ash, Waste recycling, Geopolymer cement, Concentration of sodium metasilicateNonahydrate solution, Unconfined compressive strength

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# Behaviour of Geosynthetics Clay Liner Under Direct Shear Test



Aditya Kumar Bhoi, Sunil Kumar Ahirwar, and Jnanendra Nath Mandal

**Abstract** Geosynthetics clay liner system is a key component of the engineered landfill. Both the internal and interface strengths of geosynthetics clay liner are very important for evaluating landfill stability. This paper presents a study on interface shear strength behaviour between geosynthetics clay liner and sand, and geosynthetics clay liner and Powai soil making use of a direct shear test. The experiments were carried out using dry state and submerged state of sand, and optimum moisture content and submerged condition of Powai soil. The interface shear strength of geosynthetics clay liner and sand, and geosynthetics clay liner and Powai soil found to be lower than the corresponding shear strength of sand and Powai soil. The apparent adhesion was increased, and interface friction angle was reduced during submerged condition.

**Keywords** Geosynthetics clay liner · Interface shear strength · Direct shear test

## 1 Introduction

Liner system is one of the most essential parts of the engineered landfill. The liner served as a hydraulic barrier to entrap the leachate within the landfill, with an aim to save groundwater from being polluted [1, 2]. Geosynthetics clay liners (GCLs) are one of the most prominent products in modern era to serve as liner, which is made

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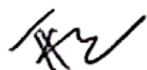
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© Springer Nature Singapore Pte Ltd. 2021  
S. Patel et al. (eds.), *Proceedings of the Indian Geotechnical Conference 2019*,  
Lecture Notes in Civil Engineering 133,  
[https://doi.org/10.1007/978-981-33-6346-5\\_1](https://doi.org/10.1007/978-981-33-6346-5_1)

  
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## Flow Regimes over Triangular Weir and its Influence on Computing Coefficient of Discharge - An Experimental Study

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### Abstract

The present study aims to establish a stage-discharge relationship over a triangular notch to corroborate the influence of full scale stage height on the performance of V-notch weir. Experiments were carried out in the Water Resources Engineering Laboratory of Civil Engineering Department, National Institute of Technology, Agartala, India, in a rectangular open-channel glass-walled 0.90 m wide, 0.80 m deep and 15 m long flume. A thin triangular notch (V-notch angle = 60°) was used to study the rating curve. Experimental runs for calibration were conducted within flow rates of 0.00015 m<sup>3</sup>/s to 0.062 m<sup>3</sup>/s. From the experimental investigations a stage-discharge relationship is proposed. The variation of discharge coefficient is compared with the ratio of pitch height of the triangular notch to the upstream water head. At the low stage of water, discrete fluctuations in the discharge values were noticed and the data plots revealed two distinct flow regimes namely, clinging flow zone and free flow zone. At the low flow rate, the clinging zone is attributed to the attachment of nappe of flowing flows with the downstream side of the V-notch weir; whereas in the high flow rate water flows over the V-notch crest as jet flow which refer to free fall zone. The uncertainty analysis of observed flow rates revealed a well agreement with the actual discharge with errors less than 1%.

**Keywords:** V-notch weir, coefficient of discharge, clinging flow zone, free flow zone, rectangular open channel.

### INTRODUCTION

In general, a triangular weir is always preferable for measuring wide range of flow rates in open channel flows without surface tension effects those are associated with flows at low water heads. The performance of triangular weir in full scale stage height is also significant for accurate calibration. In particular, the water head acting over the notch and the upstream water that approaches the notch for which the surface becomes curved are the two important factors for full scale performance study of a triangular notch. In open channel flows, significant progress has been achieved in understanding the flow constraints and uncertainty associated to calibration of triangular weir. Venetis (1970) represent a statistically method for computing uncertainty associated to stage-discharge curves, based on nonlinear regression method. Dymond and Christian (1982) illustrated the possible errors accounted for different physical parameters other than river stage to develop a rating curve. Mohamad H. El Hattab et al. (2019) conducted an experimental study and illustrated the calibration process of a V-notch weir to obtain full scale performance. They observed underestimation of weir discharge at low heads and which is attributed to the approach channel geometry. For triangular weir the total discharge may be determined by integrating the elemental flow strips over the V-notch crest and expressed as

$$Q = \frac{8}{15} C_d \sqrt{2g} \tan \frac{\alpha}{2} H^{\frac{5}{2}} \quad \dots(1)$$

where  $Q$  is the flow rate (m<sup>3</sup>/s);  $C_d$  is the coefficient of discharge;  $g$  is the gravitational acceleration, 9.81 m/s<sup>2</sup>;  $\alpha$  is the V-notch angle (degrees); and  $H$  is the head over the V-notch (m).

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# Analysis on Trustworthiness of Secondary Users using Machine Learning Approaches in Cognitive Radio Network Environment.

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#### Abstract:

The trustworthiness of Secondary Users (SUs) can be measured through its past and present trust values with sensing reputations given by the neighboring nodes in Cognitive Radio Network (CRN). Basing on these values, it is cleared that whether the SUs can be utilized the free channels of Primary Users (PUs) or not. In this paper, it has been proposed a model to analyze the trustworthiness of Secondary Users (SUs) in Cognitive Radio Network (CRN) with the help of Machine Learning (ML) approaches. It is desired to achieve more accuracy on the predicted data in the process of calculating trustworthiness and spectrum sensing reputation of SUs in Cognitive Radio Network (CRN). It has been also helped to sense the correct number of malicious users, suspicious users and honest users among the total number of SUs. For the simulation work WEKA software has been used, which is a collection of machine learning algorithms for data mining task. Three different types of classifiers of machine learning approaches have been analyzed in this simulation work such as Naive Bayes, Decision Tree and Bayes Network. From this analysis, it is observed that Decision Tree and Bayes Network are performing better than Navies Bayes in terms of providing high accuracy.

**Published in:** 2020 IEEE International Symposium on Sustainable Energy, Signal Processing and Cyber Security (ISSC)

Date of Conference: 16-17 Dec 2020 NSPEC Accession Number: 2020 20506325

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#### Metadata

**Abstract:** Emotion defines as human behavior used to know the feeling, expression sentiment of humans inside the brain. So Emotion can explain its statics through voice interaction, words, facial expression, and body language. The main objective of this paper is to analyze the accuracy of the responded data by electroencephalograph (EEG) through machine learning algorithms. After predicting the accuracy we are trying to classify results with classification learning techniques. So here we have considered different lobes points of a human brain by using the NIM32 device for converting EEG signal to raw data format. From different types of lobes point we are using two pairs of points (P3-O1, T4-T6). We used Naive Bayes and Decision trees to classify and accuracy of our data in a stable environment with different situations. The above techniques give better accuracy on the EEG signal data source as 95.4% with ROC, 83.2% with Precision, 83.1% with Recall.

**Published in:** 2020 International Conference on Computer Science, Engineering and Applications (ICCSEA)

**Date of Conference:** 13-14 March 2020

**INSPEC Accession Number:** 19806173

**Date Added to IEEE Xplore:** 03 July 2020

**DOI:** 10.1109/ICCSEA49143.2020.9132966

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**Abstract:** Sensing is emerged as a vital parameter to monitor current status of environment and infrastructures. In this paper, we simulate and analyze the performance of the Wi-Fi and Bluetooth in terms of energy consumption in Crowdsensing environment. For short range wireless communication, Bluetooth has emerged as a capable and energy efficient platform as compared to the Wi-Fi in context to energy. A model has been proposed to compute the energy used by considering Wi-Fi and Bluetooth with an idle mode of LTE. It is considered as derived values of transmission time and power consumption of Bluetooth instead of their fixed values.

**Published in:** 2020 International Conference on Computer Science, Engineering and Applications (ICCSEA)

**Date of Conference:** 13-14 March 2020

**INSPEC Accession Number:** 19747607

**Date Added to IEEE Xplore:** 03 July 2020

**DOI:** 10.1109/ICCSEA49143.2020.9132901

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**Conference Location:** Gunupur, India

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# Space Vector PWM With Common-Mode Voltage Reduction for Six-Phase Drive

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**Abstract**— Common-mode voltage (CMV) is one of the major reasons for electromagnetic interference. Its destructive effects on the machine windings, insulation is well known and it is one of the major sources of bearing failure in variable speed drives. Extensive analysis on CMV have been reported in previous literature in case of three-phase machine fed by voltage source inverter. Pulse width modulation has produced reduced CMV at the cost of increased current distortion and have been studied extensively during the last two decades or so. Specific advantage offered by multiphase machine, makes it suitable candidate for high power application. The common mode voltage issue is as prevalent as it is in case of its three-phase counterpart. This paper analyses the Common-mode voltage (CMV) produced by the two level six-phase voltage source inverter fed multi-phase machine and proposes a modified PWM technique for its reduction

**Keywords**— Induction machine, Voltage source inverter, multiphase drive, Common mode voltage

## I. INTRODUCTION

Multiphase induction machines are gaining increased importance in recent times, because of certain advantages when compared to their three-phase counterparts such as high-reliability [1], fault tolerance capability [2], greater torque density, and less torque ripple [3]. Multiphase machines have found their application indispensable in case of electric vehicle [4] ship propulsion, and electric aircraft. Last few years have shown a sharp rise in the research activities in multiphase drives with regard to different voltage levels, different phase number, and control techniques adopted to control the drives. Multiphase machines have higher number of windings, which is greater than three, in the same stator. So, the current per phase is reduced. The most common type of multiphase machine is the one, in which, one of the three-phase winding set leads the other by 30 electrical degrees. This kind of machine is also known as split-phase, dual-three-phase, dual stator winding induction machine or asymmetrical dual three-phase induction machine. The number of coils per pole pair is same as the number of stator phases in a three-phase machine that is always greater than three [5]. So, it is very easy to convert a three-phase machine to a multiphase machine with phases more than three, simply by reconnecting its coil terminals. Multiple three-phase winding sets are separated by  $\frac{\pi}{n}$ , for even number of three-phase sets and separated by  $\frac{2\pi}{n}$ , for an odd number of three-phase sets, where  $n$  is the number of stator windings [6]. Two VSIs are the preferred one for multiphase application for simplicity [7].

Wherever, voltage source inverters are used for variable speed drives, the problem common mode voltages

(CMV) becomes unavoidable. The CMV is a major concern for the multiphase machines like their three-phase counterparts [8]. Common-mode voltage results in common-mode currents that lead to bearing damage and produces electromagnetic interference [9][10]. It also damages the winding insulation. Common-mode currents in such cases comprise of circulating bearing currents, rotor ground currents and capacitive currents, resulting due to high  $dv/dt$  at the motor terminals along with the electrostatic discharge machining (EDM) currents. The existing solution for the three-phase systems, to this problem, can be divided into two groups namely (i) hardware solutions and (ii) software solutions. Hardware solutions are (a) common-mode choke (b) passive and active filters (iii) different topology for the inverter. These solutions are able to overcome the problem of CMV to some extent, but, at the same time, it has resulted in increased size, weight, cost and complexity. On the other hand, software solutions, largely based on switching signal or modulation technique modification have been very successful. In the present scenario, highly efficient digital signal processors (DSPs), as well as Field programmable gate arrays (FPGAs), are easily available. So, it becomes much easier to implement the software solutions.

There exists a number of solutions (PWM based) for CMV reduction in three-phase machine fed from either two-level inverter or multilevel inverter. These methods are largely based on the principle of eliminating the zero switching states with the help of active switching states in case of space vector PWM [11]–[14]. Interleaved carriers [15] are used in case of Multilevel inverter. The open end winding configuration for CMV reduction in case of five-phase induction motor drive is a simple extension of the three-phase principle [16]. CMV methods based on carrier-based PWM (CPWM), multiphase inverters do reduce the CMV, but the current distortion is higher [17]. A generalized method for reduction of CMV, based on reference order is developed in [18] for an odd number of phases. Reduction of CMV in five-phase induction motor drives has been studied at large in [19][20]. So overall, there is a lack of research when it comes to the reduction of CMV in dual three phase induction machine DTIM.

The performance of the drive is first studied with conventional SVPWM. Then modified SVPWM method is developed to reduce the CMV. The two methods are compared to establish the advantage of RCMV method over the CSVPWM method. The modified SVPWM method avoids the inverter states that produce the highest CMV. In a two-level inverter, there are two such states namely  $V_0$  and  $V_7$ , that produces a CMV of  $V_{dc}/2$ . In other cases of the inverter state, CMV is limited to  $V_{dc}/6$ . So, these null states are replaced by an active zero state, which is synthesized by using two anti-parallel vectors.



# Simulation Study of Two Area Multi Unit Power Systems using PI-PD Controller with RFB and UPFC

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**Abstract**—Change in frequency with load is a great concern. In this paper a load frequency problem is address by taking two area power systems with hydro and wind power plant in each unit with PID/PI-PD. Then RFB and UPFC are introduced in the system to improve the system performance. In all the cases PID/PI-PD controller is used and the parameters of controller, RFB and UPFC are tuned using Differential Evolution (DE) algorithm. The whole system is design in MATLAB/SIMULINK model; different load pattern is applied in place of step load and pulse load results show that with PI-PD controller the improvement of system occurs in terms of deviation of frequency and tie line power.

**Keywords**— Load Frequency Control (LFC); Proportional Integral - Proportional Derivative (PI-PD); Unified Power Flow Controller (UPFC); Redox Flow Battery (RFB)

## I. INTRODUCTION

The increasing demand of load forced to install more generators, as most of the power generating through thermal power plant leads to burning of more fuel hence environment pollution. The fossil fuel energy is limited which force to think about the renewable energy sources. One of such energy is wind energy which can contribute a good amount of power to the grid. But the disadvantages with the wing energy that the speed throughout the year is not constant lead to design of automatic voltage regulator, controller and better optimization technique. Till now so many paper has been published taking thermal power systems. But in the different state of India where coal energy is not available but hydro energy is plenty available we can thing about synchronizing hydro and wind energy and supply the energy to the consumers. Again such type of systems can be interconnected by tie line so the reserve capacity can be reduce and can supply deficit power to the needed area. In the load frequency control problem the area control error is fed to the controller to minimize the frequency and tie line power deviation [1-2]. In this paper a two area power system with hydro and wind power plant in each area is taken with PID/PI-PD controller. The proposed model is design in MATLAB/SIMULINK with PID controller, where the parameters are tuned using DE algorithm. As we know if there is any mismatch occurs in between generation and demand leads to change in frequency. And if the deviation is large the system may collapse [3-4]. This problem can be minimized by installing

fast acting energy storage devices. But installing such devices in all the units make the system price increase. So different power electronic devices can be installed in the power system to increase the power transmission capability [5-7].

## II. DESCRIPTION OF SYSTEM

In this paper a two area power system with hydro and wind power plant in each area is taken for simulation study. Further a RFB and UPFC is connected in each area and performance of the system is analyzed.

### A. Modelling of Hydro power plant

The Hydro unit; consisting of governing system, turbine, generator and load are design using SIMULINK by transfer function of the corresponding equations [8].

### B. Modelling of RFB

The RFB provides better energy storage function compare to SMES. Its operation is simpler at normal temperature and losses are very small. Its mathematical representation shown in equation (1)

$$\Delta P_{RFB} = \left[ \frac{K_{RFB}}{1 + sT_{RFB}} \right] \Delta F(s) \quad (1)$$

### C. Modelling of UPFC

There are different types of FACTS device used in the power system to improve the flow of power, transient stability and reduced oscillations in transmission line. The UPFC is one of the most important FACTS devices that used in series with the tie-line in a two area multi unit power system and its mathematical representation shown in equation (2).

$$\Delta P_{UPFC}(s) = \left[ \frac{1}{1 + sT_{UPFC}} \right] \Delta F(s) \quad (2)$$

### D. Controller Structure

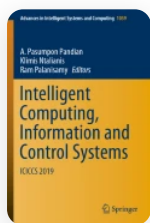
The structure of PI-PD controller represented in the below Fig. 2. It is consisting of two controller that are PI and PD controller. The input of PI controller connected to area

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# Optimal Participation of Hybrid Renewable Energy Sources in Standalone Microgrid

| Conference paper | First Online: 19 October 2019

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## Abstract

Being a tropical country, India has huge potential of sustainable energy tanks like solar, wind and micro-hydro energy to deliver electricity to the remote areas in a stand-alone mode. The nonlinear nature of renewable energy sources poses severe issues to the

# Performance Analysis of 6-Pulse HVDC-VSC Using Particle Swarm Optimization(PSO) based controller in d-q Reference Frame Under Transient AC Fault Conditions

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**Abstract**—This paper provides the PSO based control scheme for regulation of active power and reactive power flow across the HVDC-VSC.VSC-HVDC system provides freedom of individual and independent control of active and reactive power in synchronous reference frame.PSO is based on the principle of “survival of the fittest”, originating from the idea of describing the mechanism of natural selection of the best food location.PSO provides the scope of self-tuning of the PI controller i.e with the change in system operating condition, the controller adjusts itself or tunes itself , thereby regulating the active power and reactive power. Also, PSO depend on the value of the objective function thereby making the computation less tedious and easy for implementation. The system is subjected to AC faults, and the response of the system is validated using MATLAB/SIMULINK platform.

**Keywords**—HVDC, VSC, PSO, PI

## I. INTRODUCTION

The preference of HVDC over HVAC is due to a number of factors such as reasonable cost, less losses and uninterrupted supply of electrical power.It can be used as an interconnecting bridge between AC systems of different frequencies. The essential operations in the HVDC are rectification and inversion; serving the purpose of an interface between the electric signals viz. AC and DC[1].The advancement in the field of power electronic became the breakthrough that led to the increased popularity of the HVDC in the area of power systems. VSC-HVDC offers the perk or fringe benefit of individual and independent control of active power and reactive power. It makes use of bidirectional semiconductor switches such as IGBTs and GTOs. It is also desirable due to its ability to supply power to a passive AC network. It can operate in low power and provides the mileage of power reversal[2].

The pioneers who introduced the concept of PSO which is an artificial intelligence optimization technique, were James Kennedy and Russell Eberhart. It has an upper hand over the conventional Ziegler- Nicols tuning based PI controller in the sense that PSO is a artificial intelligence technique which requires less computation and is easy to implement. It has low CPU and memory requirement[3,4,5].PSO is suitable and desirable for solution of complicated and hard optimisation problems. Its application goes to variant of fields like

ANN,machine learning, character recognitions and many other similar applications. In all these applications, PSO has proven itself as a robust and fast optimization technique in solution of non-linear, non-differentiable and multi-modal problem[6,7,8].

The control system of VSC-HVDC system is made up of two loops which is why it is called as dual loop system. The system contains an inner loop and an outer loop. The outer loop is responsible for generating reference current and the inner loop is responsible for regulation of active power and reactive power. The outer loop and inner loop employs the conventional PI controllers which are tuned using PSO.The operating characteristics and dynamic stability of the VSC-HVDC system is defined by the controllers used in the system. So,it is desirable to select optimal values of the parameter, $k_p$  and  $k_i$  for the PI controller[9,10,11,12].

## II. VSC-HVDC SYSTEM

Fig.1 shows the configuration of the VSC-HVDC system. Fig.1 shows two VSC stations namely, VSC-I which is the rectifier station and VSC-II which is the inverter station. The model also consists of DC capacitors which are energy storing elements. The DC output of the converter becomes ripple free because of the use of the capacitor. The DC link is represented as  $Z_{trans}(R_{dc}, L_{dc})$ .The AC filter i.e  $Z_{filter}$  is made up of  $R_{filter}$  and  $L_{filter}$  is responsible for eliminating harmonics.

$$C_{dc} \frac{V_{dc}}{dt} = i_{dc} - i_{dc,trans} \quad (1)$$

$$L_{filter} \frac{di_d}{dt} = R_{filter}i_d + \omega L_{filter}i_q + V_{d,inv} - V_{d,pcc} \quad (2)$$

$$L_{filter} \frac{di_q}{dt} = R_{filter}i_q + \omega L_{filter}i_d + V_{q,inv} - V_{q,pcc} \quad (3)$$

Here,  $C_{dc}$ ,  $V_{dc}$ ,  $i_{dc}$  and  $i_{dc,trans}$  refers to DC-link capacitance, DC-link voltage, DC current and DC current in the transmission line respectively.

“Equation (1)” refers to the DC side equation of inverter. Equation “(2)” and “(3)” gives the dynamic equation for AC side of the VSC-HVDC model in d-q reference frame. “Equation (4)”, “(5)” and “(6)” gives the value of active power, DC power on the DC link and reactive power in the inverter side.  $V_{d,inv}$  and  $V_{q,inv}$  are the transformed values of

# Performance Analysis of 6-Pulse HVDC-VSC using Deadbeat Controller in d-q Reference Frame under AC Fault Conditions

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**Abstract**—This paper proposes the implementation of deadbeat controller in synchronous reference frame for the control of HVDC-VSC. The performance of 6 pulse HVDC-VSC is analyzed and behavior of the quantities of HVDC-VSC system under AC faults is studied. The advantages of this controller over the conventional PI controller are fast tracking ability, precise, robust and fast dynamic response to the grid transient disturbances. The simulation test results are verified using MATLAB/SIMULINK platform under AC faults.

**Index Terms**— HVDC, VSC, PI

## I. INTRODUCTION

High voltage direct current(HVDC) system evolved during the era when the concerns of engineers predominantly were transmission losses and economic rates. The HVDC systems are cost effective and their transmission losses are also considerably reduced. The advantages of HVDC over high voltage alternating current (HVAC) led to its vast use. Also for offshore renewable energy generation, HVDC has proved to be feasible [1]. Initially line commutated converter(LCC) were used as the rectifier station and inverter station. The disadvantage of LCC though, is that it does not have full controllability of the system quantities. With the advent of power electronics, the voltage source converter(VSC) based HVDC came into practice. This breakthrough led to the use of VSC based HVDC system. VSC-HVDC offers a plethora of advantages over the LCC-HVDC transmission [1]. Unlike the LCC-HVDC system, VSC-HVDC does not require an external commutation circuit. Moreover, its operation is bidirectional without requiring to make any change in the voltage polarity. In addition to that, the active power and the reactive power can be controlled independently and individually in case of the VSC-HVDC system [1],[2]. It has the capability of feeding power to weak AC systems and passive networks. Also, its application goes further in feeding small scale power generation as in the case of solar and wind. Also it has the perk of being able to power loads at far and remote end [2],[3].

HVDC transmission system consists of two VSCs connected through a high voltage DC line(HVDC). Due to rapid controllability of the VSC-HVDC systems the AC voltage

DC link voltage, active power and reactive power can be efficiently controlled. The conventional PI controller is used widely but operations beyond the bandwidth may lead to instability behavior in the system. Since it needs effective tuning as well as operates in a specific bandwidth, the PI controller can be replaced by the deadbeat controller. So, the development of such a controller that copes up with the uncertain parameters and effortless tuning comes into picture. Using such a controller the behavior of the system under the grid transient disturbances and faults can be tracked [3],[4],[5].

In this paper the deadbeat control scheme is used for the control of active and reactive power. The control technique involves dual loop viz. a slow outer loop and a fast inner loop [5], [6]. The outer loop consists of a PI controller whereas the fast inner loop functions as dead beat controller. The deadbeat controller is responsible for faster tracking and it gives fast response to any grid transient disturbances. It is also an effective controller in coordinating with other converters. Under fluctuation in the value of parameters due to transient and faults, its tracking behavior is analyzed in the paper [7],[8].

The outline of the paper is like this. Modelling of the VSC-HVDC system is presented in Section II, Section III gives a detailed study of control technique, Section IV describes the design of proposed deadbeat controller, and simulation test results are presented in Section V. At the end the conclusion is summarized in Section VI.

## II. VSC-HVDC SYSTEM

Fig.1 shows the configuration of the VSC-HVDC system. Fig.1 shows two VSC stations namely, VSC-I which is the rectifier station and VSC-II which is the inverter station. The model also consists of DC capacitors which are energy storing elements. The DC output of the converter becomes ripple free because of the use of the capacitor. The DC link is represented as  $Z_{trans}(R_{dc}, L_{dc})$ . The AC filter i.e  $Z_{filter}$  is made up of  $R_{filter}$  and  $L_{filter}$  is responsible for eliminating harmonics.

$$C_{dc} \frac{V_{dc}}{dt} = i_{dc} - i_{dc,trans} \quad (1)$$

Here,  $C_{dc}$ ,  $V_{dc}$ ,  $i_{dc}$  and  $i_{dc,trans}$  refers to DC-link capacitance, DC-link voltage, DC current and DC current in the transmission line.

Aradhana Khillo  
19/5/23

# Performance Analysis of 6-Pulse 2-level HVDC-VSC using Particle Swarm Optimization (PSO) based Controller in d-q Reference Frame under AC Fault Conditions

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**Abstract**— This paper provides the PSO based control scheme for regulation of active power and reactive power flow across the HVDC-VSC. PSO is based on the principle of “survival of the fittest”, originating from the idea of describing the mechanism of natural selection of the best food location. The tuning of the PI controller using the computational intelligence based tuning technique is observed to outdo many conventional tuning techniques with respect to convergence speed and precision. Also, PSO provides the scope of self-tuning of the PI controller i.e with the change in system operating condition, the controller adjusts itself or tunes itself, thereby regulating the active power and reactive power. Also, PSO depend on the value of the objective function thereby making the computation less tedious and easy for implementation. The system is subjected to AC faults, and the response of the system is validated using MATLAB/SIMULINK platform.

**Index Terms**— HVDC, VSC, PSO, PI

## I. INTRODUCTION

With the advancements and innovations in the field of power electronics, the preference of high voltage direct current (HVDC) transmission over high voltage alternating current (HVAC) has considerably increased. It paved the way for the operation of converters which improves the quality of output signal and HVDC system control. HVDC serves as an interface between DC and AC signal, where the conversion of these two signals take place. Rectifier converts AC to DC and inverter converts DC back to AC [1]. The preference of voltage source controller- high voltage direct current (VSC - HVDC) system over the line controlled converter- high voltage direct current (LCC-HVDC) system is due to the fact the former offers the leeway of individual and independent control of active power and reactive power. Also, it offers the mileage of flow of active power in both the directions without changing the polarity of the DC power [2]. It can supply power to passive network. It acts as “firewall” as it has the ability of preventing outages of cascaded AC system from one system to another. The LCC-HVDC system requires an extra commutation block for providing commutation [3,4].

The control technique of VSC-HVDC system is essential in conversion, transmission, and improvement of the performance of HVDC system. It is important to ensure optima

-l power transfer with stable voltage and minimum loss [5]. The control scheme employed over here uses PSO based PI controller. It has an upper hand over the conventional Ziegler-Nicols tuning based PI controller in the sense that it requires less computation and is easy to implement. It has low CPU and memory requirement [6,7]. The pioneers who introduced the concept of PSO which is an artificial intelligence optimization technique, were James Kennedy and Russell Eberhart. PSO is suitable and desirable for solution of complicated and hard optimisation problems. Its application goes to variant of fields like ANN, machine learning, character recognitions and much other similar application. In all these applications, PSO has proven itself as a robust and fast optimization technique in solution of non-linear, non-differentiable and multi-modal problem [8].

In the paper, the control block is developed and modelled. The block comprises two loops outer loop and an inner loop. So, the name dual loop control technique for VSC- HVDC system is appropriate. Both the loops includes PSO based PI controller. The PSO technique is used for the tuning of these PI controllers [9]. In this paper, the voltage, current, active power and reactive power is controlled.

The outline of the paper goes like this:- Section II presents the modelling of the VSC-HVDC system is present, Section III gives the detailed information of controller strategy, Section IV and Section V describes the design of the dual loop PSO based PI controller and simulation test results, respectively, and finally Section-VI summarises the whole paper.

## II. VSC-HVDC SYSTEM

Fig.1 shows the configuration of the VSC-HVDC system. Fig.1 shows two VSC stations namely, VSC-I which is the rectifier station and VSC-II which is the inverter station. The model also consists of DC capacitors which are energy storing elements [17]. The DC output of the converter becomes ripple free because of the use of the capacitor. The DC link is represented as  $Z_{trans}(R_{dc}, L_{dc})$ . The AC filter i.e  $Z_{filter}$  is made up of  $R_{filter}$  and  $L_{filter}$  is responsible for eliminating harmonics.

$$C_{dc} \frac{V_{dc}}{dt} = i_{dc} - i_{dc,trans} \quad (1)$$

Here,  $C_{dc}$ ,  $V_{dc}$ ,  $i_{dc}$  and  $i_{dc,trans}$  refers to DC-link capacitance, DC-link voltage, DC current and DC current in the transmission line.

# Performance Analysis of 6-Pulse HVDC-VSC Using Deadbeat Controller in d-q Reference Frame Under DC Fault Condition paper

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**Abstract**— The objective of the paper is to analyze the performance of a proposed control technique for VSC based HVDC transmission system and study the behavior of the quantities over DC faults and disturbances. The study is based on a 2-level VSC converter to which a deadbeat control scheme is applied. The analysis is carried on in the  $d - q$  reference frame. The advantages of this technique over the conventional PI controller are fast tracking ability, precise, robust and fast dynamic response to the grid transient disturbances. The system is subjected to DC faults, and the response of the system is validated using MATLAB/SIMULINK platform.

**Keywords**— HVDC, VSC, Deadbeat controller,  $i_d-i_q$  controller

## I. INTRODUCTION

Since years the concern of engineers and scientists has been use of HVDC transmission for long distance. With the advancement in the field of electronics and semi-conductor devices, the use of solid state switching devices came into limelight. This breakthrough paved way for the use of VSC based HVDC system. VSC based HVDC system offer a plethora of advantages over the LCC based HVDC transmission[1]. Unlike the LCC-HVDC system, VSC-HVDC requires no external commutation block to carry out the commutation process. Moreover, its function is bidirectional in nature. It doesn't make any change in the voltage polarity. In addition to that, there is provision of independent and individual control of active power and the reactive power in case of the VSC-HVDC system [1], [2]. It has the capability of feeding power to weak AC systems and passive networks. Also, its application goes further in feeding small scale power generation as in the case of solar and wind. It can also be used to power loads at far and remote end [2], [3].

In the past various control schemes have been popularly used such as the traditional PI controller. Its disadvantage, though is that it functions only over a pre-specified bandwidth range. Operations beyond the bandwidth may lead to instability behaviour in the system. So, the development of such a controller that copes up with the uncertain parameters and effortless tuning, comes into picture. Using such a controller the behaviour of the system under the grid transient disturbances and faults can be tracked [3],[4],[5].

The paper presents the use of the deadbeat control scheme for the control of active as well as reactive power. The control technique involves dual loop viz. a slow outer loop and a fast inner loop [5], [6]. The outer loop consists of a PI controller whereas the fast inner loop functions as dead beat controller. The deadbeat control is responsible for faster tracking and it gives fast response to any grid transient disturbances. It is also an effective controller in coordinating with other converters. Under any fluctuation in the value of parameters due to transient and faults, its tracking behavior is analyzed in the paper [7].

The outline of the paper is like this. Modeling of the VSC based HVDC system is presented in Section II. In Section III, a detailed study of control strategy is given. Section IV describes the design of proposed deadbeat controller, and simulation test results are presented in Section V. Section VI i.e the end, concludes summarizing the whole paper.

## II. VSC-HVDC SYSTEM

The VSC-HVDC system is shown in Fig.2. The system consists of two VSC stations viz. VSC-I and VSC-II. Rectifier station is named as VSC-I whereas inverter station is named as VSC-II. The two converter stations function individually and are independent in their operation [8]. The model consists of DC capacitors acting as energy storing element, responsible for ripple free DC output voltage of the converter. DC filters located across the capacitors serve the purpose of filtering the third order harmonics due to reactive current in the converter. The DC transmission line is represented as  $Z_{trans}(R_{dc}, L_{dc})$ . The AC filters namely  $Z_{filter}$  comprises of  $R_{filter}$  and  $L_{filter}$ , which eliminates 11<sup>th</sup> and 13<sup>th</sup> order harmonics.

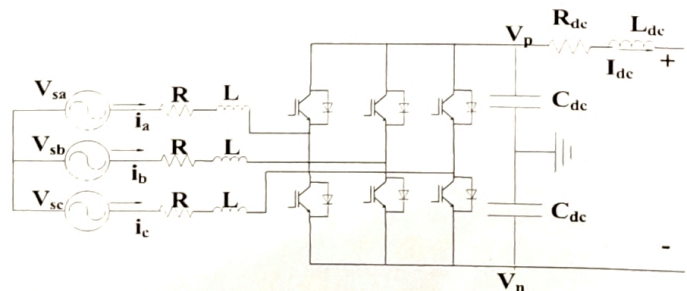


Fig.1.6-pulse 2-level VSC

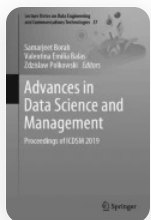
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# PDF Analysis of Different Channel Models in FSO


| Conference paper | First Online: 14 January 2020

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## Advances in Data Science and Management



[Chinmayee Panda](#) , [K. Pitambar Patra](#), [Asutosh Padhy](#) & [Urmila Bhanja](#)

 **Part of the book series:** [Lecture Notes on Data Engineering and Communications Technologies](#) ((LNDECT, volume 37))

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## Abstract

Recently free-space optical communication (FSO) is a high-demanding technique due to the high ability it offers. But it is limited to certain fields due to some drawbacks. Generally, this communication is used for short range applications due to the presence of various atmospheric hazards. Here we are analyzing and comparing the PDF of various channel models such as Gamma-Gamma, log-normal, Nakagami, Weibull distribution, K-distribution, and Negative exponential.

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# An Attack Resistance Model for Trustworthiness Evaluation in VANET

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**Abstract**— Security in vehicular adhoc network (VANET) is a challenging issue. Eavesdropper or attacker breaches security of VANET often due to the dynamicity of vehicular adhoc network with random arrivals and departures of vehicles. In addition, the wireless media also makes VANET vulnerable to an attack [1]. In this paper, a novel dual authentication (DA) algorithm is proposed to counteract few different attacks such as denial of service, sybil attack, replay attack, eavesdropping, and masquerade attack. It is found from the results that the proposed technique is robust against different types of VANET attacks such as sybil attack, replay attack, denial of service, masquerade attack, message suppression attack, and dual authentication failure. Furthermore, a novel trustworthiness evaluation scheme is designed for estimating trustworthiness of each vehicle in VANET. DA algorithm is implemented in JAVA and trustworthiness evaluation is implemented in PHP at the server.

**Keywords**— VANET, Replay Attack, Sybil Attack, Denial of Service, Dual Authentication Algorithm, Trustworthiness

## I. INTRODUCTION

The progress and improvement of distributed networks has played a decisive role for researchers to keep considering novel solutions for various vehicular adhoc network (VANET) applications such as transportation, vehicle-to-infrastructure (V2I) and vehicle-to-vehicle (V2V) communications, disaster management systems and lots more. Vehicular ad-hoc network systems are designed so as to serve the purpose of remote monitoring and information sharing with other vehicles in the network. Thus, VANET communication involves sharing of large volumes of data both at the private and public levels over a network that requires safety at a greater level. In VANET, the vehicular units can join the network and leave it within no time, which is why robust and quickly deployable network connectivity is required. Maintenance of huge volumes of data for node/vehicle registration and trustworthiness evaluation is yet another concern in VANET. Security in VANET indicates the ability to determine the driver's responsibility while maintaining driver's privacy. Information about the vehicles attributes or the information about the drivers must be exchanged securely and timely; else the message be fatal leading to collision of vehicles [2]. Hence, for the present scenario security requirement is the most challenging issue in VANET [1].

## II. LITERATURE REVIEW

Mejri et al. have presented a survey on various VANET security challenges and possible cryptographic solutions. The paper presents the communication architecture of VANETS outlining its privacy and security challenges, which should be taken care to make such networks safe and usable in practice. The paper also compares various cryptographic schemes that are separately suggested for VANETs, evaluates the efficiency of proposed solutions and explores some future trends for intelligent transportation systems (ITS). The paper also defines different attacks and the possible cryptographic solutions. However, the solutions proposed are not robust, which stands as a drawback [1]. Recently, Li et al. have addressed on trustworthiness of both data and nodes in VANET. Data and node verify trustworthiness of traffic data and nodes. In this work, authors have proposed an attack-resistant trust management scheme (ART) for VANETs, which is able to detect various malicious attacks and also evaluates the trustworthiness of both data and mobile nodes in VANETs. Data trust is estimated based on the data collected from multiple vehicles. Node trust is assessed in two dimensions. First one is functional trust, which indicates how likely a node fulfills its functionality and the second one is recommendation trust. The recommendation trust is based on recommendations from other nodes in a VANET that evaluate the trustworthiness of a particular node/vehicle. The effectiveness of the proposed ART scheme is validated through extensive experiments. However, the message is not secured among clients and server as the data is not encrypted between a client and a server [2]. Apu et al. have addressed a model for trustworthy communications in a heterogeneous network. This model is designed for finding trustworthy routes. However, in this work trustworthiness of individual nodes/vehicles is not estimated. Moreover, the paper makes use of public key encryption, which is resistant to traditional cryptanalysis attacks only [3]. Gurnathan et al. have proposed a Trust and Q-learning based Security (TQS) model to detect the misbehaving nodes in an Ad Hoc on Demand Distance-Vector (AODV) routing protocol [4]. In this paper, the misbehaving nodes are avoided and isolated by the proposed Q-learning mechanism using the historical forwarding and responding behavior of the misbehaving nodes. However, the trustworthiness is evaluated using data transmission rate and control packet of vehicle-to-vehicle (V2V) communication, which makes it less reliable and accurate. Moreover, data packet parameters are not robust and there is no server-controlled communication in this work [4]. Yao et al. have addressed a

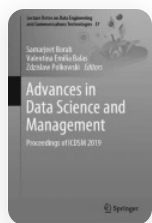


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# Investigation of Graphene Nanoparticles in a Nanocomposite Film via Photonic Crystal Fiber Through Regression Analysis


| Conference paper | First Online: 14 January 2020

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## Advances in Data Science and Management


[S. K. Mohanty](#), [U. Bhanja](#), [C. S. Mishra](#) & [G. Palai](#) 

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## Abstract

The concentration of graphene nanoparticle in nanocomposite film is estimated in this paper with the help of photonic crystal fiber which is processed through regression analysis, and subsequently, a mathematical model is developed to design a correlation between input and output parameter. Finally, a fourth-order model is divulged in this research pertaining to the vis-à-vis entering of signal emerging for fiber and concentration of a graphene nanoparticle in a nanocomposite film. The fourth-order equation is disclosed as regression analysis, which is part of big data analysis.

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## 3D Waveguides for nano photonic application

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### **Abstract:**

Silicon and gallium arsenide (GaAs) based three dimensional photonic structure is realized here to envisage at Terahertz mirror device, which is purely belonged to the application of nano photonic devices. Further plane wave expansion technique pertaining to the mathematical formulation is disclosed in this research to evaluate the photonic bandgap of silicon and gallium arsenide crystal structure. Aside this, lattice spacing and diameter of air holes of both the structure play key role to understand the above said application, which controls the reflection and transmission of signal. Finally it is revealed that with the proper combination of lattice spacing and diameter of air holes of the said 3D structure determines a range of Terahertz frequency. Finally, the outcome of the paper claims that the proposed structure can be a suitable candidate for nano photonic application

### **Keywords:**

PWE; 3D waveguide; Photonic mirror

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## I. INTRODUCTION

A waveguide is a structure that guides waves, such as electromagnetic waves or sound waves, which amplitudes decrease according to the inverse square law as they expand into three dimensional spaces [1]. Different types of waveguides are there such as hollow conductive metal pipe is used to carry high frequency such as radio waves particularly microwaves. An optical fiber guides high frequency light, but it will not guide the microwaves of a much lower frequency [2].

Optical mirrors have a smooth, highly polished, plane or curved surface for reflecting light the reflecting surface is a thin coating of silver or aluminium on glass [3]. An optical coating is one or more thin layers of material deposited on an optical component such as a lens or mirror, when light fall optical waveguide, where some amount of light reflects and some amount of light transmits [4-6]. One is antireflection coating which reduces unwanted reflections and other is the high-reflector

coating which reflects more than 99.99% of the light, when falls on them [7-8].

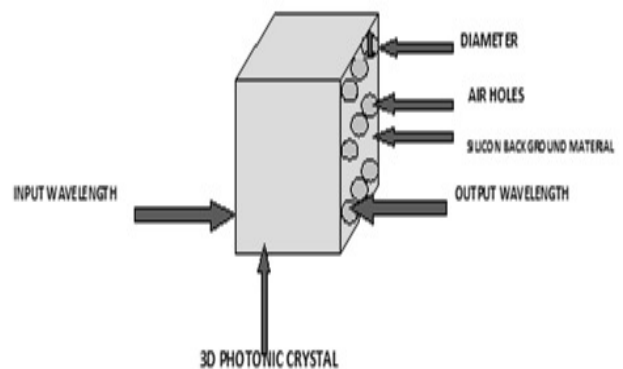



Fig. 1 3D photonic crystal structure

## II. Structure analysis

The proposed structure in this research for possible mirror application, gallium arsenide and silicon is a backbone of the same, which is shown in figure 1. Here the structure is considered 3x3 air holes, where diameter of lattice spacing plays vital role to envisage the mirror application. Aside this, input

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Gandhi institute for technological advancement

Date Written: January 11, 2020


### Abstract

Silicon and gallium arsenide (GaAs) based three dimensional photonic structure is realized here to envisage at Terahertz mirror device, which is purely belonged to the application of nano photonic devices. Further plane wave expansion technique pertaining to the mathematical formulation is disclosed in this research to evaluate the photonic bandgap of silicon and gallium arsenide crystal structure. Aside this, lattice spacing and diameter of air holes of both the structure play key role to understand the above said application, which controls the reflection and transmission of signal . Finally it is revealed that with the proper combination of lattice spacing and diameter of air holes of the said 3D structure determines a range of Terahertz frequency. Finally, the outcome of the paper claims that the proposed structure can be a suitable candidate for nano photonic application.

**Keywords:** PWE;3D waveguide; Photonic mirror

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3. C S Mishra , G Palai



Urmila Bhanja

## Some routing schemes and mobility models for real terrain MANET

Authors Banoj Kumar Panda, Urmila Bhanja, Prasant Kumar Pattnaik

Publication date 2020

Conference Machine Learning and Information Processing: Proceedings of ICMLIP 2019

Pages 523-534

Publisher Springer Singapore

Description The primary challenges in mobile ad hoc network (MANET) are presence of obstacles, mobility, energy efficiency and network in dynamic topology environment. Efficient routing with obstacles avoidance in dynamic topology is a critical issue in MANET. Many mobility patterns have been recommended for the movement of nodes in presence of obstacles in MANET terrain. Some obstacles avoiding routing techniques are also proposed by some popular researchers. In this paper, many related articles have been reviewed and briefly discussed. The paper outlines advantages and drawbacks of each approach to get possible research scope in route planning in dynamic MANET topology in presence of obstacles.

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# PDF Analysis of Different Channel Models in FSO


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## Abstract

Recently free-space optical communication (FSO) is a high-demanding technique due to the high ability it offers. But it is limited to certain fields due to some drawbacks. Generally, this communication is used for short range applications due to the presence of various atmospheric hazards. Here we are analyzing and comparing the PDF of various channel models such as Gamma-Gamma, log-normal, Nakagami, Weibull distribution, K- distribution, and Negative exponential.

## Chapter



## Effect of Adaptive Depth-First Sphere Decoding Scheme to MIMO-OFDM System in FSO

By [Chinmayee Panda \(/search?contributorName=Chinmayee Panda&contributorRole=author&redirectFromPDP=true&context=ubx\)](#), [Urmila Bhanja \(/search?contributorName=Urmila Bhanja&contributorRole=author&redirectFromPDP=true&context=ubx\)](#)

Book [AI in Manufacturing and Green Technology \(https://www.taylorfrancis.com/books/mono/10.1201/9781003032465/ai-manufacturing-green-technology?refId=91219e85-485f-45ff-bb56-f904a6478cf7&context=ubx\)](https://www.taylorfrancis.com/books/mono/10.1201/9781003032465/ai-manufacturing-green-technology?refId=91219e85-485f-45ff-bb56-f904a6478cf7&context=ubx)

Edition	1st Edition
First Published	2020
Imprint	CRC Press
Pages	8
eBook ISBN	9781003032465

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## ABSTRACT



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# Investigation of Graphene Nanoparticles in a Nanocomposite Film via Photonic Crystal Fiber Through Regression Analysis

| Conference paper | First Online: 14 January 2020

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[S. K. Mohanty](#), [U. Bhanja](#), [C. S. Mishra](#) & [G. Palai](#) 



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## Abstract

The concentration of graphene nanoparticle in nanocomposite film is estimated in this paper with the help of photonic crystal fiber which is processed through regression analysis, and subsequently, a mathematical model is developed to design a correlation between input and output parameter. Finally, a fourth-order model is divulged in this research pertaining to the vis-à-vis entering of signal emerging for fiber and

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# PDF Analysis of Different Channel Models in FSO


| Conference paper | First Online: 14 January 2020

| pp 355–361 | [Cite this conference paper](#)



## Advances in Data Science and Management

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 Part of the book series: [Lecture Notes on Data Engineering and Communications Technologies](#) ((LNDECT, volume 37))

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## Abstract

Recently free-space optical communication (FSO) is a high-demanding technique due to the high ability it offers. But it is limited to certain fields due to some drawbacks. Generally, this communication is used for short range applications due to the presence of various atmospheric hazards. Here we are analyzing and comparing the PDF of various channel models such as Gamma-Gamma, log-normal, Nakagami, Weibull distribution, K- distribution, and Negative exponential.

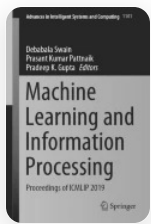


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# Some Routing Schemes and Mobility Models for Real Terrain MANET

| Conference paper | First Online: 24 March 2020

| pp 523–534 | [Cite this conference paper](#)



## Machine Learning and Information Processing



[Banoj Kumar Panda](#), [Urmila Bhanja](#) & [Prasant Kumar Pattnaik](#) 

 **Part of the book series:** [Advances in Intelligent Systems and Computing \(\(AISC, volume 1101\)\)](#)

 1174 [Accesses](#)  5 [Citations](#)

## Abstract

The primary challenges in mobile ad hoc network (MANET) are presence of obstacles, mobility, energy efficiency and network in dynamic topology environment. Efficient routing with obstacles avoidance in dynamic topology is a critical issue in MANET. Many mobility patterns have been recommended for the movement of nodes in presence of obstacles in MANET terrain. Some obstacles avoiding routing techniques are also proposed by some popular researchers. In this paper, many related articles have been reviewed and briefly discussed. The paper outlines advantages and drawbacks of each approach to get possible research scope in route planning in dynamic MANET topology in presence of obstacles.

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# Some Routing Schemes and Mobility Models for Real Terrain MANET



Banoj Kumar Panda, Urmila Bhanja and Prasant Kumar Pattnaik

**Abstract** The primary challenges in mobile ad hoc network (MANET) are presence of obstacles, mobility, energy efficiency and network in dynamic topology environment. Efficient routing with obstacles avoidance in dynamic topology is a critical issue in MANET. Many mobility patterns have been recommended for the movement of nodes in presence of obstacles in MANET terrain. Some obstacles avoiding routing techniques are also proposed by some popular researchers. In this paper, many related articles have been reviewed and briefly discussed. The paper outlines advantages and drawbacks of each approach to get possible research scope in route planning in dynamic MANET topology in presence of obstacles.

**Keywords** MANET · Terrain · Routing techniques

## 1 Introduction

Disaster recovery during natural calamities like volcanic eruption, earthquake, tsunami, hurricanes and tornados or man-made calamity like explosions, fires and military operations are hampered when the MANET performance diminishes due to presence of obstacle in the terrain area. In addition to that performance of MANET also reduces due to node mobility, network congestion and insufficient node energy. A number of protocols are developed to improve the performance [1–4]. To develop

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D. Swain et al. (eds.), *Machine Learning and Information Processing*,  
Advances in Intelligent Systems and Computing 1101,  
[https://doi.org/10.1007/978-981-15-1884-3\\_49](https://doi.org/10.1007/978-981-15-1884-3_49)

523

# PDF Analysis of Different Channel Models in FSO



Chinmayee Panda, K. Pitambar Patra, Asutosh Padhy and Urmila Bhanja

**Abstract** Recently free-space optical communication (FSO) is a high-demanding technique due to the high ability it offers. But it is limited to certain fields due to some drawbacks. Generally, this communication is used for short range applications due to the presence of various atmospheric hazards. Here we are analyzing and comparing the PDF of various channel models such as Gamma-Gamma, log-normal, Nakagami, Weibull distribution, K- distribution, and Negative exponential.

**Keywords** FSO · Turbulences · PDF · Channel models · Modulation

## 1 Introduction

Free-space optical communication (FSO) is the technique used in optical communication where the carrier signal is the light signal in free space. In FSO the energy beam is gathered and transmitted through space to the destination [1]. The source can be a LED or LASER and the destination can be a photo diode (PIIN or APD). The IR or visible energy along with the data is modulated by using different modulation schemes at the source and accepted by the photo detector at the destination after being transmitted through the FSO channel. An effective FSO system has various characteristics such as, it has the ability to operate at high power levels for longer distance, low power consumption, can operate over wide temperature range. The various advantages of FSO includes low initial investment; it has straight forward deployment system, high bandwidth, high data rate, high speed transmission, lesser radio frequency interference, etc. [2]. The actual data is distorted at the receiver end due to various atmospheric turbulences such as rain, dust, snow, fog, or smoke and different phenomenons like scintillation, absorption, and scattering. When energy waves (such as light, sound, and various electromagnetic waves) are caused to depart

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© Springer Nature Singapore Pte Ltd. 2020  
S. Borah et al. (eds.), *Advances in Data Science and Management*,  
Lecture Notes on Data Engineering and Communications Technologies 37,  
[https://doi.org/10.1007/978-981-15-0978-0\\_35](https://doi.org/10.1007/978-981-15-0978-0_35)

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# Path Planning of the Mobile Robot Using Fuzzified Advanced Ant Colony Optimization



Saroj Kumar, Krishna Kant Pandey, Manoj Kumar Muni and Dayal  
R. Parhi

**Abstract** Ant colony optimization (ACO) is a probabilistic optimization method. In this analysis, its application has been explored in mobile robotics for path planning. It provides multi-feedback information and robustness to the mobile robot during navigation. Due to the robustness of the advanced fuzzified ant colony optimization (FACO), the path planning task has been executed in the unstructured environment, and collision-free navigation has been achieved smoothly. For fuzzified advanced ant colony optimization (FAACO), path pheromone update scheme is divided into two categories like favorable and unfavorable path. Using these, path pheromone as the problems of conventional ACO like slow convergence has been sorted out. The advanced FACO improves the evaporation rate of pheromone to accelerate the convergence speed. Finally, the simulation results show the proposed method conquered the previous drawback.

**Keywords** FAACO · Path planning · Optimization · Robot

## 1 Introduction

Since the last decade, the development of mobile robotics science has been reached at a higher level of research, due to its autonomy and effectiveness as compared to a human. Nowadays, robots are becoming advance and it is replacing approximately every phase of human life. Among the different types of robotic development, the development that replaces the human and their work is a very challenging task. The mobile robots have many applications, but mobile robots are frequently used in a big platform such as medical, automation, manufacturing, mining, and industries. However, for the smooth operation of the robot, it is necessary to conduct path planning and navigational control task during the operational time. Therefore, in this paper, an advanced FACO technique has been proposed for the path planning of the

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© Springer Nature Singapore Pte Ltd. 2020  
BBVL. Deepak et al. (eds.), *Innovative Product Design and Intelligent  
Manufacturing Systems*, Lecture Notes in Mechanical Engineering,  
[https://doi.org/10.1007/978-981-15-2696-1\\_101](https://doi.org/10.1007/978-981-15-2696-1_101)

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# Path Planning of a Humanoid Robot Using Rule-Based Technique



**Manoj Kumar Muni, Priyadarshi Biplab Kumar, Dayal R. Parhi,  
Asita Kumar Rath, Harish Chandra Das, Animesh Chhotray,  
Krishna Kant Pandey and Kitty Salony**

**Abstract** This paper describes the effective route organization of a humanoid robot in an unknown environment. Rule-based technique is examined for steering of the humanoid robot in chaotic environments. The prime objective of the humanoid is set as to reach the target without hitting the obstacles. Various rules are developed based on the direction of motion, the distance between the humanoid and target, the distance between the humanoid and obstacles, and the angle between the robot and adjacent obstacles. The rules considered are cultured to find out the target angle of the humanoid from its current location. The proposed methodology has been

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# Sugeno Fuzzy Logic Analysis: Navigation of Multiple Humanoids in Complex Environments

Manoj Kumar Muni<sup>1\*</sup>, Dayal R. Parhi<sup>2</sup>, PriyadarshiBiplab Kumar<sup>3</sup>, Krishna Kant Pandey<sup>4</sup>, Saroj Kumar<sup>5</sup>, Animesh Chhotray<sup>6</sup>

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## Abstract

*This paper presents sugeno fuzzy system with hybridized membership functions for the determination of exact turning angles for the humanoid robots during their path traversal from starting point to goal point. This helps the robot to reach the destination effectively by avoiding the hurdles in the path and obtains the global minimal path. The hybridized membership functions used in the sugeno fuzzy approach plays a key role in providing the exact turning angles to avoid hurdles. Image sensors and ultrasonic sensors are used for mapping the environment and, also provide the hurdle distances to the fuzzy controller as input parameter. The hurdle distances from the robot in front, left and right direction are the input parameter to the fuzzy controller and exact turning angle is the output parameter from the controller. The developed controller is carried out in both simulation and experimental environment having complex hurdles. A comparison has been made between the results of both simulation and experimental scenarios and, a good agreement is found among those with minimal deviations.*

**Keywords:** Humanoid NAO; Sugeno Fuzzy Controller; Hybrid MF; V-REP; Simulation.

## I. Introduction

For the research analysis humanoid NAO H25 developed by Aldebaran robotics [1] is considered. Now a days humanoid robots gain their popularity towards research as they look like humans and they can easily work in industries by reducing human effort. To do the same the motion planning strategy of the humanoid must be efficient. So path planning of humanoids is a challenging research work for the researchers. In this paper sugeno fuzzy controller is used for the motion planning analysis which utilizes the input parameters and provides the output parameter to the robot for smooth navigation of single as well as multiple humanoids in environments having complex hurdles. Several researchers have used many optimization techniques for the navigation of mobile robots and some of them are listed below.

Zhar et al. [2] presented fuzzy logic controller with proximity sensors and genetic algorithm to obtain quick efficient collision free path in the unknown multi hurdle environment. Panda and Choudhury [3] used the concept of genetic algorithm for the dynamic path planning of mobile robots in unrecognized dynamic environment. Hossain and Ferdous [4] proposed bacterial foraging optimization technique for the navigation of mobile robots and obtained shortest feasible path in unknown environment with moving hurdles. Karami and Hasanzadeh [5] presented adaptive

genetic algorithm in two dimensional complex environment for the motion planning of mobile robots. Pandey et al. [6] presented ANFIS controller scheme for effective and collision free navigation of mobile robots in unknown static environment. Sudhakara and Ganapathy [7] developed an enhanced A\* optimization technique for best path traversal with avoiding hurdles for mobile robots while moving from starting state to goal node. Das et al. [8] presented a novel improved gravitational search method to optimize the trajectory path followed by multiple mobile robots in a dynamic environment. Bakdi et al. [9] proposed adaptive fuzzy controller and implemented genetic algorithm for collision free smooth path during navigation of wheeled indoor mobile robots in cluttered environment. Wang et al. [10] developed particle swarm optimization method in combination with MAKLINK graph and A\* algorithm for motion planning of mobile robots, and obtained motion space model of the robot with shortest path between start point to end point. Patle and Parhi [11] proposed firefly algorithm for navigation of mobile robots by using the concepts of intelligence mechanism. Aouf et al. [12] developed a new revolutionary technique by combining TLBO and ANFIS for effective navigation of mobile robots in strange environment with optimal path trajectory and minimum traversal time towards goal. Lamini et al. [13] presented genetic algorithm with improved crossover

# Path Planning and Control of Mobile Robots Using Modified Tabu Search Algorithm in Complex Environment

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## Abstract:

An innovative modified Tabu search technique is developed for the effective navigation of mobile robots in complex environment. The method is modified to improve the efficiency of mobile robot towards having optimized path in short duration of time. Tabu search method works on the principle of getting shortest path by forming a Tabu list, which informs the mobile robot not to visit the previously visited positions and helps the robot in obtaining the obstacle negotiation angle. The modified Tabu search method helps the mobile robot to travel from any source to target location in any environment with suitable obstacle negotiation angle avoiding hurdles in its path. The developed modified algorithm has been incorporated in mobile robots and various trials were carried out in different environments to confirm the effectiveness of modified algorithm.

## Key Words:

Tabu Search Algorithm, Mobile Robot, V-REP, Obstacle Avoidance.

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## I. INTRODUCTION

For the effective use of mobile robots, it is highly essential that the robots should travel the optimized path having global minima points in less time. So the path planning of mobile robots is an attractive field of research till now, which aims to find a collision free global path in any environment consisting of complex obstacles. For this purpose distance and time are the main criteria for consideration and many techniques have been developed to obtain the shortest path such as, Alexopoulos and Griffin [1] used A\* algorithm and obtained collision free path in shortest time for mobile robots. Gun and Parker [2] proposed D\* search algorithm and obtained the optimal motion planning for multiple robots. GE and CUI [3] developed a new potential field method for the path planning of mobile robots in movable target and obstacle prone environment. Hachour [4] presented a new motion planning algorithm in unknown environment with static obstacles, so that the mobile robot can navigate effectively avoiding obstacles. Gueaieb and Miah [5] presented a novel RFID technique for navigation of mobile robots in unknown environment and workspace. Mohanta et al. [6] proposed a GA-Petri optimization algorithm for the navigation of multiple mobile robots in various environments with presence of different obstacles. Yun et al. [7] developed a GA algorithm in order to support the mobile robot during motion traversal in unrecognized and unknown environment. Tuncer and Yildirim [8] developed an improved genetic algorithm with a new mutation technique for the

effective navigation of mobile robots in complex environments. Zhang et al. [9] proposed a multiobjective particle swarm optimization technique for the motion strategy of mobile robots in dynamic terrains. Goyal and Nagla [10] presented modified A\* algorithm with increasing the virtual size of the obstacles by  $(2n+1)$  times during navigation of mobile robots from any source location to target position. Duchon et al. [11] used SLAM, based on grid map for the reactive navigation of mobile robots. Mohanty and Parhi [12] proposed a hybridized technique comprising of FIS, ANN and ANFIS for effective navigation of autonomous mobile robot. Weerakoon et al. [13] proposed a new deadlock free artificial potential field algorithm for mobile robot motion planning. Patle et al. [14] developed a modified firefly algorithm for motion planning of mobile robots in complex crowded environment and optimizes the path distance along with obstacle avoidance. Rath et al. [15-16] have used fuzzy logic technique to avoid obstacles on path during navigation. Pandey et al. [17] have used ANFIS controller for path planning of mobile robot in an unknown static environment. Rath et al. [18-19] have used soft computing techniques for the navigation of humanoid robots, and successfully achieved the goal. Pandey and Parhi [20] have used behavior based neural network for the motion control and path search of mobile robot in a hazy environment.

From the survey, it can be concluded that, though different techniques have been developed for navigation and motion planning of mobile robots but

# An Effective Path Planning of a Mobile Robot



S. Pattanayak, S. C. Sahoo and B. B. Choudhury

**Abstract** Recent advances in mobile robot path planning are turns into a prevalence research field. This paper proffers a metaheuristic approach to optimize the mobile robot path length by adopting particle swarm optimization (PSO) algorithm. This approach reckons the curtail path length between staring and goal point for the mobile robot without any physical contact to the obstacles. A static environment with known obstacles position is designed for evaluation of path length by this method. Total nine numbers of obstacles are taken into consideration for this study. The program for PSO optimization approach was written using MATLAB software.

**Keywords** Mobile robot · Path planning · PSO

## 1 Introduction

Development of new advanced industries and their requirement of continuous production, working in hazardous situation, and unattended machining operation limit the working of human beings. Therefore, it is necessary to develop a robot that can be controlled through a cellular phone/laptop/remote controller. The path in which robot reaches its destination is a challenging task for the designer. So the path is selected in such a way that the collision with obstacles can be completely avoided also the path length should be as small as possible. Path planning proce-

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# Inverse Kinematics Solution of a 6-DOF Industrial Robot



Kshitish K. Dash, B. B. Choudhury and S. K. Senapati

**Abstract** A vital part of many industrial robot manipulators is to reach required position and orientation of end effectors so as to complete the pre-defined task. To get this, one should have knowledge of kinematics, i.e. inverse kinematics (IK). Though inverse kinematics never gives a closed form solution, it is too difficult to solve such problem of an industrial robot. There are so many analytical and other simulation methods which are adopted to solve this IK problem for our 6-DOF industrial pick and place robot. In this paper, artificial neural networks (ANN) are used and simulated by using MATLAB.

**Keywords** Industrial robot • Inverse kinematics • ANN

## 1 Introduction

Kinematics of robot indicates the analytic behaviour of the movement of robot manipulator. By taking appropriate kinematics models of an industrial robot, the kinematic behaviour, i.e. inverse kinematics and forward kinematics, can be analysed. These two spaces utilized as a part of kinematics demonstrating are known as Cartesian space and Quaternion space. The alteration among two Cartesian coordinate takes place in form of rotation and a translation as soon in Fig. 1. So many methods are adopted to solve forward kinematics and inverse kinematics problems of an industrial pick and place robot. out of different method Jacobian matrix and Denvit-Hertenberg theory is useful for analytic solution of straight forward kinematics and Screw theory is useful for inverse kinematic solution.

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# Kinematics Analysis of a 6-DOF Industrial Robot

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**Abstract.** Industrial robots are mostly used in the production industry these days to reduce labour costs and increase precision of operation. Many more industries are taking the benefits of these robots for their batch production. Many researches are being carried out for the improvement of design, control and interpretation of trajectory, kinematic and dynamic analysis and on many relevant fields to increase its capabilities. Kinematic analysis forms the basics of mechanical interpretation of any industrial robot as it helps engineers for further analysis like inverse kinematics and dynamic analysis. In forward kinematics end effector positions are determined from the joint angles. In inverse kinematics, calculate a sets of possible joint angles necessary for reach a particular station of known coordinate. As the inverse kinematics involves tedious and lengthy multistep mathematical calculations, till date none of the existing methods of calculation of inverse kinematics has been proved without any flaws. Hence researches are still going on by different persons in-order to develop a simpler and more accurate ways to solve the inverse kinematic problems. Therefore there is a concept about the kinematics of an industrial robot is provided to make easy the further development on industrial robot. Kinematics analysis for a 6-degree of freedom industrial robot is presented by this paper. In the kinematic analysis both the forward as well as inverse kinematic of an aristo m-tab 6-DOF robot are considered. For the forward kinematic all the homogeneous matrix of the every joint is calculated mathematically by considering the DH parameters, kinematic diagram and rotation of the joint. The co-ordinate of the end effector is obtained by multiplication of homogeneous matrix of the each joint. An analytic method is proposed for the inverse kinematic analysis. After solving the inverse kinematic equations the possible solutions are cross checked by the use of virtual robot module.

**Keywords:** Degree of freedom (DOF) · Virtual robotic module (VRM) · Denavit-Hartenberg (D-H)

## 1 Introduction

Robotics is a branch of engineering which deals with the design, modelling, construction, operation and using of robots as well as software programming which is essential to command robots. Now a day's robots are giving instructions to the people

# An Effective Trajectory Planning for a Material Handling Robot Using PSO Algorithm



S. Pattanayak and B. B. Choudhury

**Abstract** This paper utilizes the potentiality of PSO algorithm to design and optimize the trajectory for a material handling robot. This approach is based on the behavior of fish schooling and birds flocking. Layout of the Institute machine shop is selected as an environment for determining the trajectory length. Total fifteen numbers of obstacles (machines) are acknowledged during this analysis. The selected approach not only delivers curtail path length but also generates a traffic-free trajectory. The material handling robot is not colliding with any machines during movement. The programming codes for the selected approach are written, compiled, and run through a software: MATLAB.

**Keywords** Material handling robot · Trajectory planning · Obstacle avoidance · Particle swarm optimization

## 1 Introduction

Requirement of endless supply of raw materials, tools, and other necessary accessories to a machining station, warehouse in the least possible time to avoid starving condition in a processing station. It limits the working of human beings in any industries. These limitations are possibly overcome by the development of a mobile material handling robot, which can be guided wirelessly through any electronic gadgets. Flexibility of material handling system directly related with the production rate which indirectly point out the level of automation of the industry. The time required

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H. S. Behera et al. (eds.), *Computational Intelligence in Data Mining*, Advances in Intelligent Systems and Computing 990, [https://doi.org/10.1007/978-981-13-8676-3\\_7](https://doi.org/10.1007/978-981-13-8676-3_7)



# Autonomous Track Designing Approach in a Settled and Unsettled Environment

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**Abstract.** This paper presents an approach that is used to amend the issues appears during trajectory designing for a mobile material handling robot in settled and dynamic/unsettled environment. Algorithms like artificial potential field approach (APF) is employed to eradicate the issues arises in deciding the shortest possible track in unsettled surrounding. Curtail track length, computational time, travel time, track smoothness, feasibility and crash free track are addressed in this paper. Two distinctive surrounding setups are designed in this paper. One involves only stationary/settled obstacles. While second surrounding involves both stationary and unsettled obstacles. The simulation practice indicates that Artificial Potential field technique is found appropriate when the surrounding involves both static and dynamic obstacles. Also track generated by this approach not only shorter but also requires less computational time for generating the optimal track. The selected approach is also capable for generating the travel time needed to chase the optimal path, as the speed of the robot is defined in the program. So the travel time associated with that track is determined. Some experimental trials are also performed to determine the value of actual travel length and time. From the study, it is concluded that the path generated by this approach in unsettled environment not only crash free, but also smooth and requires less computational and travel time.

**Keywords:** Mobile material handling robot · Crash free track designing · Artificial potential field algorithm

## 1 Introduction

Material handling robot is an integral part of the industry. As the flexibility of the material handling robot decides the automation level in the industry. A material handling robot takes part in handling of raw part, tool and other necessary accessories to and from ware house to the desired location. A material handling robot may also assist in loading and unloading of raw/finished part at the workstations. From a survey, it is conveyed that the actual machining time is 5% of total production time [1]. The rest of the time will be spend in material handling, tool orientation, and other activities. A lot of production time can be saved when the handling time is diminished. Thus the



# FPGA Implementation of Modified Swarm Optimization Based Control Strategy for a Mobile Robot

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**Abstract.** In this paper the auto control strategy for a mobile robot is provided with the novel algorithm of modified particle swarm optimization algorithm (MPSO). Original taken image is preprocessed and then the features are extracted. The preprocessing involves the two important characters of resizing and RGB to gray conversion for getting the gray level image and avoid the colour image. Then the modified sobel edge detection algorithm is used to show the lines, and curves. After detecting the edges, filters are used to remove the unwanted noise. The simulation is done in MATLAB and Xilinx environment. The power, frequency, delays, and the logic utilization is measured. Then the result is compared with existing particle swarm optimization.

**Keywords:** Preprocessing · Filtering · Feature extraction · Modified sobel detection algorithm · Improved particle swarm optimization algorithm

## 1 Introduction

A field-programmable gate array (FPGA) is an integrated circuit (IC) that can be programmed in the field depending on application [1]. It contains thousands to millions of logic gates with programmable interconnection. Programmable interconnections are available for users to perform any task in the field easily. Figure 1 shows a typical architecture with available input/output. I/O blocks are designed and numbered according to the required function. FPGA consists of logic blocks such as look up tables, flip-flops and some amount of memory [2–4].



# Inverse Kinematics Analysis of an Industrial Robot Using Soft Computing

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**Abstract.** With the enormous issues in robot kinematics analysis is to streamlining the arrangement in inverse kinematics, which manages acquiring the joint factors regarding the end-effectors position and direction than the forward kinematics issue. The level of opportunity of a robot expands the inverse kinematics estimation become increasingly troublesome and costly. In mechanical and fabricating field the utilization of robot is an inescapable factor and in this manner the movement of its controller is important to express more effectively and essentially. On light about this reason kinematical approach may be viewed as here. The kinematics may be the precise examination of geometry for development of a robot arm Also may be for two kin. In this paper pseudo jacobian transfer matrix and D-H method is considered for solving the inverse kinematic problem. The solution of two analytical method optimized with ANN.

**Keywords:** Inverse kinematics · Jacobian transpose matrix · D-H method · ANN

## 1 Introduction

These days' robots are considered as an essential piece to producing field with their characteristic ability of executing perplexing and hazardous employments all the more proficiently and dependably. A mechanical controller is made out of a few connections associated jointly through joints. The kinematics manages the geometric movement of a mechanical controller and the backward kinematics are adopted as the most prevalent and proficient strategy for supervise robot manipulator. There commended methodology can be actualized to take care of the opposite kinematics issues looked in apply autonomy with most elevated DOF. Many analysts proposed a Jacobian Transpose approach to decide the inverse kinematic arrangement of automated controllers. The recommended arrangement strategy depends on utilizing neural network and genetic algorithm in a half and half framework. The blunder presented by the neural network can be limited by the utilization of genetic algorithm. The principle issues here is to find the test error though training time is bigger and also require huge numbers of shrouded neurons. Nonlinear autoregressive models with exogenous data sources rather than other intermittent neural models, have constrained criticism designs which come uniquely from the yield neurons rather than from shrouded neurons. The neural model is regularly utilized in the arrangement of recognizable proof territory. All the particular powerful systems talked about the systems, with the elements just at the information

# PSO Based Path Planning of a Six-Axis Industrial Robot



Supriya Sahu and B. B. Choudhury

**Abstract** Aristo robot is a 6-axis articulated robot widely used in industries to lift small parts with greater accuracy. The use of robot in production sector depends upon the efficiency with which it performs a given task with shortest possible time. This research presents a proposal, to optimize the path for a particular task by adopting Particle Swarm Optimization (PSO) algorithm. For the analysis of optimal path, total ten numbers of objects have been defined and the robot has to cover up all objects with all possible paths with minimum cycle time. The optimal solution is obtained using robomaster simulation software and the global best solution is obtained using PSO. The program for optimization of path length is written in MATLAB software. The global best result obtained using PSO is a simple method for solving path planning problems for any industrial applications.

**Keywords** Aristo robot · PSO · Path planning · Path length · Robomaster simulation

## 1 Introduction

The requirement of high efficiency and performance with greater accuracy and precision with minimum machining time has introduced the use of robots in different production industries. In order to decrease the machining time while using the robot in industries the path through which it performs the given task with minimum time is required to be defined. The selection of path with minimum path length can be achieved by use of different optimization techniques and PSO is one of the best techniques that has been adopted to solve different path planning problems. Multi

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© Springer Nature Singapore Pte Ltd. 2020  
H. S. Behera et al. (eds.), *Computational Intelligence*  
in *Data Mining*, Advances in Intelligent Systems and Computing 990,  
[https://doi.org/10.1007/978-981-13-8676-3\\_19](https://doi.org/10.1007/978-981-13-8676-3_19)

# Selection of Industrial Robot Using Fuzzy Logic Approach



Swagat Nayak, S. Pattanayak, B. B. Choudhury and N. Kumar

**Abstract** This paper introduces a modified fuzzy technique (FUZZY TOPSIS) for the selection of best Industrial robot according to the assigned performance rating. Both conflicting quantitative and qualitative evaluation criteria are considered during the selection process. A collective index is prepared using weighted average method for preparing the ranking of rule base. Triangular and Gaussian membership function is used to describe the weight of each criterion (input parameters) and rating of each alternatives (ranking of robots). From comparison study, it is found that the Gaussian membership function is most effective for closeness measurement as its surface plot shows a good agreement with the output result. This approach confirms that the fuzzy membership function is a suitable decision making tool for the Manufacturing decisions with an object lesson in the robot selection process.

**Keywords** Industrial robots · Attributes · Selection · Fuzzy membership functions

## 1 Introduction

Industrial requirement of precision in repetitive works, reduction of man power and their associated cost, reduction of lead and idle time and working in hazardous situation, demands automation. Industrial robotics is the most flexible and fully automated technique used to fulfill such demands. Selection of industrial robot is a significant problem to the designer/manufacturer. Selection of robot is always task specific. Controlling a robot in varying operational environment like production work is always laborious. The environment “where subjective is not accurate and uncertain information available about the source”, then Fuzzy logic controller will be

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© Springer Nature Singapore Pte Ltd. 2020  
H. S. Behera et al. (eds.), *Computational Intelligence in Data Mining*, Advances in Intelligent Systems and Computing 990,  
[https://doi.org/10.1007/978-981-13-8676-3\\_20](https://doi.org/10.1007/978-981-13-8676-3_20)



2nd International Conference on Structural Integrity and Exhibition 2018  
Assessment of creep deformation and rupture behaviour of  
304HCu austenitic stainless steel

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### Abstract

Reduction in CO<sub>2</sub> gas emission and decrease in fuel consumption can result in increase in efficiency of the thermal power plants. Increase in efficiency is directly linked to the steam temperature and pressure which requires materials having high creep strength. This resulted in development of Advanced Ultra Super Critical (AUSC) power plant which aims to increase efficiency to more than 45 % and significant decrease in CO<sub>2</sub> emission. The 304HCu stainless steel is one of the candidate materials to be used in AUSC power plant. It contains around 3 wt. % of copper, certain amounts of niobium and nitrogen and increased carbon content for enhancing creep strength. Creep tests are conducted for 304HCu stainless steel at 923K, 973K and 1023K over a stress range of 100-240MPa. The creep curve exhibited shorter primary regimes followed by marginal secondary regimes and extended tertiary regime. The variation of steady state creep rate with applied stress exhibited Norton's power law relationship ( $\dot{\epsilon}_s = A\sigma^n$ ). The value of  $n$  (stress exponent) decreased with increase in temperature but decrease was more pronounced at 923K. The product of steady state creep rate and rupture life obeyed Monkman-Grant relation. The contribution of tertiary creep was found to increase with temperature. Microstructural degradation in the form of coarsened precipitates, dislocation cell formation and deformation bands was the primary reason for increase in tertiary regime of creep curve and increase in the value of damage tolerance factor ( $\lambda$ ). A mathematical model based on finite element analysis coupled with continuum damage mechanics has been used to predict the creep deformation and rupture life of 304HCu SS. The prediction of creep curve based on this model was found to be in good agreement with experimental results.

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Selection and peer-review under responsibility of Peer-review under responsibility of the SICE 2018 organizers.

**Keywords:** 304HCu SS; Creep; Continuum damage mechanics; FE analysis.

## 1.0 INTRODUCTION

To achieve higher plant efficiency and reduction in CO<sub>2</sub> emission, there is a necessity of increase in temperature and pressure of boiler tube in the modern power plants. Advanced Ultra super critical power plant aims to increase the efficiency by increasing the temperature more than 923K and pressure more than 30MPa [Weitzel P.S., 2011]. However, the elevated temperature resistance and creep resistance of the material (300grades of austenitic SS) used in conventional power plant is not adequate. 304grades of stainless steel has been modified by adding 3wt pct. of Cu, increased carbon content and certain amounts of niobium and nitrogen which has good elevated temperature resistance and creep resistance, material named as 304HCu SS.

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Selection and peer-review under responsibility of Peer-review under responsibility of the SICE 2018 organizers.

10.1016/j.prostr.2019.05.009

# Study on Microstructure and Tribological Properties of Plasma Processed LM6 Alloy

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**Abstract.** In the research work, LM6 alloy prepared by plasma processed technique is studied for wear behavior. The wear behavior of the plasma processed LM6 alloy sample is study at room conditions at four different loads ,i.e. 10N, 20N, 30N, 40N and with different sliding speeds, i.e. 200, 300, 400, 600 rpm's for about 2 min,5 min,10min,15 min respectively, using a pin-on-disk wear testing instrument. From the pin-on-disk experiment, cumulative mass loss varying with the sliding speed, applied load and time was studied. The existence of eutectic silicon is sensed by the microstructure. The wear of plasma processed LM6 alloy sample increased as applied load, sliding speed and time increased.

**Key words:** LM6 Alloy, Dry Sliding wear, sliding speed, Wear resistance, Tribological Properties.

## 1. Introduction

Aluminium-silicon alloys are widely and favorably implemented in automobile engineering applications like pistons, clutch housing, and liners, in which tribological and mechanical properties of the material are significant, due to the metallurgical feature, like more strength to weight fraction and high thermal conductivity [1]. The tribological wear behavior of Al-Si alloys depend on different parameters, such as composition, size, shape, and distribution of micro components. All the while, it also relies upon service conditions and mechanical properties for example, interface condition, applied load, temperature and sliding speed [2-3]. Many research studies are worked out for investigation of analyzing the wear quality of these alloys under different testing conditions. For simulated wear testing in the laboratory, pin-on-disc testing equipment is one of the most commonly implemented. It is attached with a continuously rotating disc, in which the effect of sliding speed, normal load, alloy composition and the presence of interface film etc. can be effortlessly investigated [4]. Torabian et al. have considered the impacts of normal load, alloy composition, sliding speed and distance on the wear of Al-Si alloys. The wear rate is strictly depending upon the applied load. It increments straightly with load [5].





# Glass/jute/sisal fiber reinforced hybrid polypropylene polymer composites: Fabrication and analysis of mechanical and water absorption properties

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## ARTICLE INFO

### Article history:

Received 2 January 2020

Received in revised form 26 February 2020

Accepted 28 February 2020

Available online 26 March 2020

### Keywords:

Polypropylene

Glass fiber

Jute fiber

Sisal fiber

Maleic anhydride

NaOH pellets

## ABSTRACT

The main objective of the present work is to prepare a glass/jute/sisal fiber (GF/JF/SF) reinforced polypropylene (PP) hybrid composites and analyse the influence of different fiber loadings on its mechanical and water absorption behaviour. The polymer composites of various compositions with different fiber loadings such as 70 wt% PP + 30 wt% GF, 70 wt% PP + 30 wt% JF, 70 wt% PP + 30 wt% SF, 70 wt% PP + 15 wt% GF + 15 wt% JF, 70 wt% PP + 15 wt% GF + 15 wt% SF, 70 wt% PP + 10 wt% GF + 10 wt% JF + 10 wt% SF have been fabricated using compression moulding technique. The fiber loading of different fibers is found to have a significant positive effect on the performance of glass/jute/sisal fiber reinforced polypropylene hybrid composites. Among the hybrid composites one with the composition of 70% PP + 10% GF + 10% JF + 10% SF shows a maximum flexural modulus of 3119.81 MPa which is almost 130% higher than the value obtained for virgin PP. It also shows a maximum hardness value of 100.1 in R/Scale reading. The same composition shows highest impact strength of 44.15 J/m, which is almost 40% higher than the value obtained for virgin sample. Water absorption is also found to be less in all these polymer composites and hybrid composites below 0.3% (by weight).

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Selection and Peer-review under responsibility of the scientific committee of the 2nd International Conference on Processing and Characterization of Materials.

## 1. Introduction

The polymer composite materials play a significant role in numerous plastic and polymer industries because of its low cost, light weight, higher mechanical properties, low corrosion resistance, environmentally friendly nature, design flexibility, lower thermal conductivity, durability, etc. [1,2]. Due to their high strength to weight ratio and excellent mechanical properties, synthetic fibre reinforced polymer composites find a greater application in various sectors such as automobile, marine, aerospace, etc. [3]. Literature survey suggests that the glass [4] and carbon [5] are the commonly used synthetic fibers so far. But in comparison to other available synthetic fibers, GF is a desirable reinforcing agent for many polymer products as it is smooth, much cheaper, and significantly less brittle when used in composites. However,

the synthetic fibers in general do have their own disadvantages of higher manufacturing cost and important environmental issues such as renewability and disposal [6].

Recently, due to the growing global energy crisis and ecological risks natural fiber reinforced polymer composites have attracted more research interests. Natural fibre reinforced polymer composites have a great impact on research sectors due to their availability, biodegradable behaviour, renewability, environmental friendly character, low cost and density, high specific properties, good thermal and acoustic properties and improved energy recovery property, low energy consumption, non-abrasive nature etc. [3,6,7]. A great deal of work has been carried out and reported to measure the potential of natural fibre as reinforcement in polymer such as jute [8], coir [9,10], bamboo [11], sisal [12,13], banana [14,15], hemp [16], sugar palm [17], etc. Plant based natural fibers justify their use as reinforcement for polymer composites but they suffer from the disadvantages like low mechanical properties, poor adhesion properties due to their hydrophilic character, durability factor,

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# Nutrient (sulphate) removal from wastewater in inverse fluidized bed biofilm reactor

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## ARTICLE INFO

### Article history:

Received 30 December 2019

Received in revised form 11 March 2020

Accepted 13 March 2020

Available online 6 April 2020

### Keywords:

Industrial wastewater treatment

Sulphate

Inverse fluidized bed

Biomass

Superficial gas velocity

## ABSTRACT

Sulphate is one of the inorganic nutrient pollutants present in wastewater which needs to be treated due to present day global stringent emission norms. Among the several available biological means to treat industrial wastewaters, the use of inverse fluidized bed biofilm reactors (IFBBRs) has gained much attention in recent years over other fluidized bed reactors. In this work, the feasibility of removal of sulphate from synthetic wastewater having initial concentrations of 13.096, 32.74, and 65.48 mg/l was studied using mixed bacterial culture. Spherical polypropylene balls were taken as biomass support particles having density of 920 kg/m<sup>3</sup> and diameter of 5.63 mm. Three different bed-volume to reactor-volume ( $V_b/V_r$ ) ratios i.e., 0.304, 0.380, & 0.445 and three different superficial air velocities i.e., 0.0065, 0.0085, & 0.0106 m/s were considered for experimental runs. The reactor inoculum was prepared from the sludge collected from local steel industry's wastewater treatment plant. The effects of different input parameters such as  $V_b/V_r$  ratio, superficial air velocities, and initial concentration of sulphate in synthetic wastewater on the output sulphate concentration were studied. Temperature of 30–32 °C and pH of 8.3–8.8 were maintained throughout the degradation studies. The reactor was operated in semi-batch recirculation mode with superficial water velocity of 0.0021 m/s. Sulphate concentration was measured by turbidity method using UV spectrophotometer at 420 nm which is as per APHA standards. The maximum removal efficiency of sulphate was found to be 72–75% which was achieved at a  $V_b/V_r$  ratio of 0.380 and the superficial gas velocity of 0.0085 m/s observed at a time of 40 h. Higher sulphate reduction was not achieved due to presence of more inorganic salts in the synthetic wastewater. At higher initial sulphate concentration, reactor operational difficulties were observed.

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Selection and Peer-review under responsibility of the scientific committee of the 2nd International Conference on Processing and Characterization of Materials.

## 1. Introduction

Wastewaters containing high concentration of sulphate are generally produced from various industrial sources like pulp and paper industries, detergent manufacturing units, construction, waste leachate, and food processing units [1]. Sulphate can also be released naturally from acid mine drainage (AMD) wastewater which also contain high concentration of heavy metals [2]. This higher concentration of sulphate and heavy metals causes serious environmental problem like acid rain and corrosion in the drain pipes or public water supply lines. Also, when sulphate wastewater

effluent discharged to the environment they can increase the acidity nature of the soil and water bodies. The maximum limit of sulphate concentration in water for human consumption is not to exceed by 250 mg/l as per U.S. EPA 2001. So, sulphate laden wastewater required proper treatment before it can be discharged to the environment.

There are many methods available for the treatment of these wastewaters like precipitation, membrane separation, ion-exchange [3], electrochemical reduction [4], activated carbon treatment [5], and bio-sorption [6]. The removal efficiencies of these methods depend on the concentration of sulphate in wastewater, pH, and the acceptable limit set by the government agencies. These methods are generally expensive and less efficient in degradation of high concentration of sulphate. So, various

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## Plasma Sprayed Red Mud-Fly Ash Composite Coatings on Mild Steel: A Comprehensive Outline

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DOI:10.9734/bpi/atpsr/v2

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### ABSTRACT

The present investigation aims at evaluating the effect of fly ash addition on coating characteristics of pure red mud. Plasma sprayed coatings composed of red mud and a varying percentage of fly ash on mild steel were considered for the study. Coating technologies have already gained a promising momentum for the creation of emerging materials in the last few decades. Plasma spraying technique was used with varying levels of power namely 6, 9, 12 and 15 kW. Plasma spray is one of the most widely used techniques involved in surface modification by improvement of wear resistance, which may affirm the great versatility and its application to a wide spectrum of materials. Investigations of the coatings focused on tribological properties like sliding wear behaviour, wear morphology, wear mechanism and frictional force. Different coating characteristics like surface morphology, hardness, porosity, thickness and new phase formation are studied. The sustainability of these coatings towards high temperature at air environment up to 1000°C is evaluated by finding their adhesion strength. DSC and TGA techniques are implemented to observe the coating behaviour to heat. The coatings show remarkable resistance towards high temperature by virtue of adhesion strength compensation. It is feasible to use these coatings limiting < 800°C otherwise dislodging of coating from metal. Fly ash with 10, 20 and 50% by weight was mixed with red mud and sliding wear test performed using a pin on disc wear test machine. The wear test was performed for sliding distance up to 942 m with track diameter of 100 mm and at a sliding speed of 100 rpm (0.523 m/s); applying a normal load of 10 N for a maximum duration of 30 minutes. The variation of wear rate and frictional force with that of sliding distance and time has been presented. The addition of fly ash with red mud reduces the wear rate by enhancing the coating property. But the optimum percentages of fly ash required for better coating material still impact a question mark for the researchers. It is observed that for the early stage the wear rate increases slowly and then rises drastically with sliding distance for all coating type and finally becomes stagnant. Operating power level proved to be the remarkable variable for different coating property. In our observation the coatings wear resistance (reverse of wear rate) decreases until an optimum value at 12 kW, afterwards indicating some other dominating parameters. Significant wear resistance was visible with the addition of fly ash due to an increase in bond strength and dense film at the interface. Wear rate decreases with operating power up to 12 kW, thereafter increases with initiating other dominating parameters. The present study concludes that, red mud coatings possess acceptable thermal properties. Fly ash is a beneficiary reinforcing agent for red mud, and the composite can be coat able with favoring surface properties. These coatings can be operated at high temperature. It is observed that, these composite coatings can also be employed for suitable tribological applications. Plasma generating power, adversely affect the coating morphology. Our work is a portfolio for researcher to discover many other aspects of red mud and its composite coatings. Study of corrosion wear behaviour may be implemented by future investigators to find its distinct application areas.

*Keywords: Red mud; fly ash; plasma coating; bond strength; thermal stability; sliding wear; wear mechanism.*

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# High Density Polyethylene (HDPE) and Polypropylene (PP) Polyblend: An Experimental Approach

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DOI: 10.9734/bpi/namse/v1

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## ABSTRACT

The present research focuses to evaluate a complete outlook of virgin high density polyethylene (HDPE) and polypropylene (PP) polyblends. Virgin PP of 10, 20, 30, 40 and 50 weight % is compounded with virgin HDPE. Tensile, Flexural and impact test specimens of virgin HDPE, Virgin PP and HDPE-PP composites are prepared via twin screw extruder and injection moulding methods as per ASTM D638-02a (Type-I), ASTM D790 and ASTM D256-A standards respectively. The mechanical properties like tensile strength, flexural strength, Izod impact strength are examined. Polymer sheets are fabricated using a two roll milling machine and compression moulding; and its electrical properties like dielectric strength, surface resistivity, volume resistivity are examined according to ASTM-D 257 standard. The study also includes effect of strain rate on tensile properties of the prepared composite at a cross head speed of 30, 40, 50, 60 and 70 mm/min. Design of experiment is conducted to find parameters dominating the tensile strength. All experiments are carried out at room temperature of 23°C and absolute humidity of 54%. Scanning electron microscopy (SEM), Atomic force microscopy (AFM) and polarised light microscopy (PLM) are used to observe the surface and crystal morphology. X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR) tests verify the non compatibility of both polymers. Differential scanning calorimetry (DSC) and thermogravimetric analysis (TGA) techniques are used to study the thermal behaviour of composites. The results manifest dielectric strength and volume resistivity decreases with addition of PP to HDPE; whereas surface resistivity increases. Co-occurring spherulites are seen for polyblends; indicating the composite to be a physical blend of continuous and dispersed phases, but on the other hand PP improves the tensile and flexural properties of HDPE.

*Keywords: High density poly ethylene (HDPE); Polypropylene (PP); polyblends; mechanical; thermal; crystallization; electrical properties; strain rate.*

## 1. INTRODUCTION

Polymer composite is material of research in modern days. Thermoplastic polymers are of great interest due to their technical and commercial importance [1]. In general two or more polymers are melt blended to form a product as polyblends [2-5]. The component percentages are the primary factor influencing their physical properties [6]. The manufacturing technique and operating conditions are second governing factor.

Among the thermoplastic polymers; PP possess good mechanical strength. In addition it has high chemical resistance, low cost and easy to manufacture. PP has wide application in automobile spare parts and as well as container [7]. HDPE is known for its large strength to density ratio due to its little branching. HDPE unlike PP cannot withstand normally required autoclaving conditions [8-13].

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