Efficient Cloud-Enabled Cardiovascular Disease Risk Prediction and Management through Optimized Machine Learning

[1]Selvaprasanth P
[1] Department of ECE, Sethu Institute of Technology, Tamilnadu, India
selvaprasanth9619@gmail.com

Abstract: The world's leading cause of morbidity and death is cardiovascular diseases (CVD), which makes early detection essential for successful treatments. This study investigates how optimization techniques can be used with machine learning (ML) algorithms to forecast cardiovascular illnesses more accurately. ML models can evaluate enormous datasets by utilizing data-driven techniques, finding trends and risk factors that conventional methods can miss. In order to increase prediction accuracy, this study focuses on adopting different machine learning algorithms, including Decision Trees, Random Forest, Support Vector Machines, and Neural Networks, that have been tuned using strategies including hyper parameter selection, cross-validation, and feature selection.

Data preparation, feature engineering, model training, and performance evaluation are all part of the study methodology. To ensure reliable and broadly applicable models, we utilize optimization techniques like Grid Search and Genetic Algorithms to precisely adjust model parameters. Features including age, blood pressure, cholesterol levels, and lifestyle choices are employed as inputs for the machine learning models in the dataset, which consists of patient medical information. The predictive capacity of the model is evaluated using evaluation measures, such as accuracy, precision, recall, F1-score, and the area under the ROC curve (AUC-ROC). Our findings show that improved machine learning models perform better than conventional methods, offering trustworthy forecasts that can help medical practitioners with early diagnosis and individualized treatment planning. In order to achieve even higher predicted accuracy, the study's conclusion discusses the significance of its findings for clinical practice as well as future improvements that might be made, like adding wearable device data in real-time or investigating deep learning techniques.

Keywords: Secure Cloud Storage, Data Encryption, Access Control, Attribute-Based Keyword Search (ABKS), Search Optimization

Corresponding Author: *Selvaprasanth P*
ECE, Sethu Institute of Technology, Tamil Nadu, India,
Mail: selvaprasanth9619@gmail.com

Introduction:

Millions of people die each year from heart-related illnesses, according to the World Health Organization, making cardiovascular diseases (CVD) one of the world's leading causes of mortality. The importance for early detection and prompt intervention is highlighted by the rising prevalence of CVD, which can greatly lower the risk of adverse consequences. Even though they work well, traditional diagnostic techniques frequently depend on a lot of clinical testing and the knowledge of medical specialists, which can take a lot of time and resources. As a result, there is increasing interest in using technology—more specifically, machine learning (ML)—to more precisely and efficiently estimate the risk of CVD.
Because it makes it possible to analyze massive and complicated information, machine learning, a type of artificial intelligence, has shown considerable promise in a number of industries, including healthcare. ML algorithms are excellent for predictive jobs because they can automatically identify patterns and relationships in data. When it comes to predicting the risk of cardiovascular disease, machine learning (ML) may evaluate patient data, including physiological measurements, lifestyle factors, and medical history, to pinpoint those who are most likely to acquire cardiovascular diseases.

This study investigates the use of machine learning (ML) methods in the prediction of CVD, with an emphasis on optimizing model performance. Machine learning relies heavily on optimization to increase models' precision, resilience, and generalizability. The models are improved and made to produce accurate predictions by using strategies including feature selection, cross-validation, and hyperparameter tweaking.

A large dataset of patient records, comprising information on blood pressure, cholesterol, age, gender, smoking status, and physical activity, is used in the study. Numerous machine learning models, such as Random Forest, Decision Trees, Support Vector Machines, and Neural Networks, employ these variables as inputs. Every model undergoes thorough optimization in order to guarantee optimal predicted performance.

The study is set up as follows: to manage missing values, outliers, and superfluous characteristics, the data is first preprocessed. The next step is to apply feature engineering to improve the relevance of the input data to the prediction objective. Following data processing, the ML models are trained using optimization approaches to enhance their performance. Lastly, the models' efficacy in predicting CVD is assessed using measures including accuracy, precision, recall, F1-score, and AUC-ROC.

The purpose of this work is to show how improved machine learning algorithms can be used to forecast cardiovascular illnesses, giving medical practitioners a useful tool. These models have the potential to facilitate early diagnosis and intervention by increasing the precision and efficacy of CVD prediction, hence lessening the toll that cardiovascular diseases take on both individuals and healthcare systems.

Gathering and Preparing Data:

First, a thorough dataset comprising patient medical records with attributes like age, gender, blood pressure, cholesterol, and lifestyle habits must be gathered. Data preparation is essential because it cleans the data by eliminating outliers, addressing missing values, and normalizing the data to guarantee consistency. To verify the model's performance, this stage also involves dividing the data into training and testing sets.

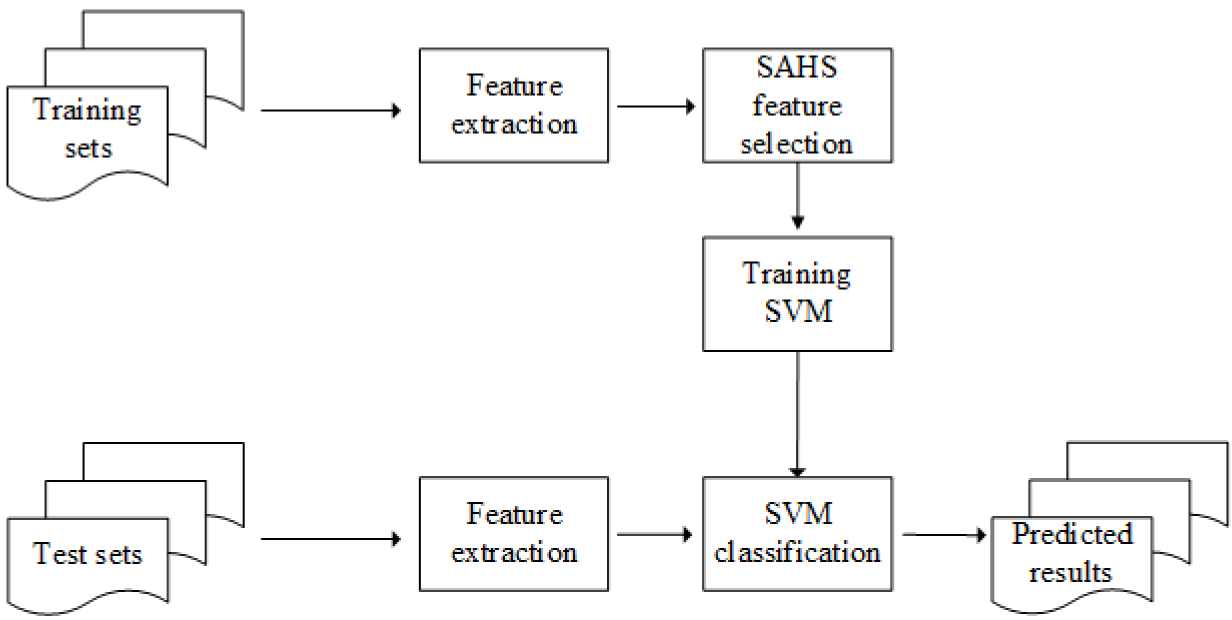

Fig.1. Framework of the proposed cardiovascular disease prediction system

ngineering Features:

By choosing and altering variables that have a significant impact on the predicting task, feature engineering improves the relevance of the data. Model accuracy and computational cost are increased by lowering dimensionality and highlighting the most useful features through the use of techniques like Principal Component Analysis (PCA) and feature scaling.
Model Selection: A variety of machine learning techniques, such as Decision Trees, Random Forests, Support Vector Machines, and Neural Networks, are chosen and compared. The selection of models is predicated on their capacity to manage high-dimensional data and non-linear interactions, both of which are prevalent in cardiovascular datasets.
Model Optimization: In this stage, the selected models are adjusted by the application of optimization methods including Bayesian Optimization, Genetic Algorithms, and Grid Search. To

improve model performance, hyperparameters like learning rate, tree depth, and regularization parameters are changed.

In order to guard against overfitting and make sure the model fits new data well, cross-validation is used.

Model Evaluation: Using metrics like accuracy, precision, recall, F1-score, and AUC-ROC, the optimized models are assessed on the test set. These measures shed light on the model's capacity for prediction and for identifying those who are at a high risk of developing cardiovascular disease. In order to achieve even higher predicted accuracy, the study's conclusion summarizes the results and discusses possible future improvements, such as integrating real-time data from wearable devices or investigating deep learning approaches.

Conclusions: This study's results demonstrate the potential of machine learning algorithms that have been refined using cutting-edge methods to precisely estimate the risk of cardiovascular disease. These refined models show notable increases in prediction accuracy, providing medical practitioners with an invaluable aid in early diagnosis and individualized therapy planning. Subsequent investigations may examine the assimilation of instantaneous data obtained via wearable technology, thereby furnishing ongoing observation and forecasting. Deep learning approaches might also be looked into to improve model performance and possibly provide predictions that are even more accurate and trustworthy.

Reference:

1. Patidar, M., Kumar, D. A., William, P., Loganathan, G. B., Billah, A. M., & Manikandan, G. (2024). Optimized design and investigation of novel reversible toffoli and peres gates using QCA techniques. Measurement: Sensors, 32, 101036.
2. Kumar, R., Keshamma, E., Kumari, B., Kumar, A., Kumar, V., Janjua, D., & Billah, A. M. (2022). Burn injury management, pathophysiology and its future prospectives. Journal for Research in Applied Sciences and Biotechnology, 1(4), 78-89.
3. Thimmaraju, M. K., Trivedi, R., Hemalatha, G., Thirupathy, B., & Billah, A. M. (2023). Microfluidic revolution and its impact on pharmaceutical materials: A review. Materials Today: Proceedings.
4. Islam, F., Dehbia, Z., Zehravi, M., Das, R., Sivakumar, M., Krishnan, K., ... & Emran, T. B. (2023). Indole alkaloids from marine resources: Understandings from therapeutic point of view to treat cancers. Chemico-Biological Interactions, 110682.
5. Billah, A. M., & Venkatesan, P. (2017). A self-limited survey on community pharmacies in India, the services offered, facilities available to make ease of compliance for the medication prescribed and over the counter medication in view of pharmacists. Journal

of Pharmaceutical Sciences and Research, 9(3), 314.

6. Taqui, M., Swamivelmanickam, M., & Billah, M. A. (2021). Adverse drug reactions associated with drugs inducing osteoporosis. National Journal of Physiology, Pharmacy and Pharmacology, 11(4), 356-359.

7. Thimmaraju, M. K., Meher, V. K., Arjun, G., Boddeda, B., Thirupathy, B., Garige, A. K., ... & Billah, A. M. (2022). Dengue fever occurrence in India, Brazil, Paraguay, Philippines and Singapore using Google trends. International Journal of Health Sciences, 6, 1715-1726.

8. Thimmaraju, M. K., Boddeda, B., Arjun, G., Garige, A. K., Chandupatla, V., Kumar, K. R., & Billah, A. M. (2022). Design and invitro evaluation of gastro retentive oral matrix tablet formulations of ketorolac tromethamine. International Journal of Health Sciences, 6, 1945-1952.

9. Thimmaraju, M. K., Boddeda, B., Laskar, S. A., Vanamala, M., Uzma, U., Laskar, K. H., ... & Billah, A. M. (2022). Antibodies and antibody fragments are therapeutic tools in the treatment of type-II diabetes mellitus. International Journal of Health Sciences, (II), 1953-1961.

10. Sobti, R., Garg, R., Srivastava, A. K., & Shahi, G. S. (Eds.). (2024). Computer Science Engineering and Emerging Technologies: Proceedings of ICCS 2022.

11. Thimmaraju, M. K., Hussain, M. A., Garige, A. K., Chandupatla, V., & Billah, A. M. (2024). Automation and Robotics in Healthcare Industry for Monitoring Patients in Critical Care Unit. In Computer Science Engineering and Emerging Technologies (pp. 624-629). CRC Press.

12. Sankar, K., Billah, A. A. M., Sankar, V., Singaram, V., & Viswanathan, S. (2024). Impact of Vortioxetine and Fluoxetine on Cognition and Health Related Quality of Life among Major Depressive Disorder Patients with and without Metabolic Syndrome. Journal of Young Pharmacists, 16(1), 72-80.

13. Sankar, K., Billah, A. A. M., Shanmugasundram, N., Veintramuthu, S., & Viswanathan, S. (2024). Effect of Vortioxetine in Comparison to Fluoxetine on Metabolic Parameters in Patients With Depressive Disorder: A Randomized Controlled Trial. Cureus, 16(1).

14. Mohammed, T., Swamivelmanickam, M., & Billah, A. M. (2023). A pharmacovigilance study on steroid induced osteoporosis. Research Journal of Pharmacy and Technology, 16(11), 5285-5288.

15. Thimmaraju, M. K., Thirupathy, B., Garige, A. K., Chandupatla, V., Billah, A. M., & Thakar, C. M. (2022). Selenium-containing bodipy dyes as photosensitizers. Materials Today: Proceedings.

16. Thimmaraju, M. K., Immadi, S., Gandla, K., Billah, A. M., & Hussain, M. A. (2022). ComprehensiveReview On Role Of CD27Cells In T-Cell Immunity. NeuroQuantology, 20(9), 4963.

17. Mohathasim Billah, A., Raja, D. I., & Venkatesan, P. Department of Pharmacy, Annamalai University, Annamalai Nagar, Tamil Nadu, India.

18. Thelly, M. T., laxman Pol, S., Suresh, S. N., Nisha, K. B., & Ajeed, A. PHYTOCHEMISTRY, PHARMACOLOGICAL ACTIVITIES AND TRADITIONAL USES OF MUSA ACUMINATA.

19. Suriyakala, P., Mohathasim Billah, A., Rajamohamed, H., Mohamed Akram Ali, S., Sathya, A., & Vijayalakshmi, K. Journal Homepage:-www. journalijar. com. Reviews of studies on hypertension epidemiology in India have shown a high prevalence in both urban and rural areas, 7, 8.

20. Šiša, M., Pla, D., Altuna, M., Francesch, A., Cuevas, C., Albericio, F., & Álvarez, M. Total Synthesis and Antiproliferative Activity Screening of (()-Aplicyanins A, B and E and Related Analogues.

21. Singh, G., Rishi, M. S., Herojeet, R., Kaur, L., & Sharma, K. (2020). Evaluation of groundwater quality and human health risks from fluoride and nitrate in semi-arid region of northern India. Environmental geochemistry and health, 42(7), 1833-1862.

22. Singh, H., Singh, N., Kaur, L., & Saxena, S. K. (2001). Effect of sprouting conditions on functional and dynamic rheological properties of wheat. Journal of Food Engineering, 47(1), 23-29.

23. Afreen, S. S., & Lokeshappa, B. (2014). Production of bacterial cellulose from Acetobacter Xylinum using fruits wastes as substrate. The International Journal of Science and Technoledge, 2(8), 57.

24. KAUR, L., SINGH, N., KAUR, K., & SINGH, B. (2000). Effect of mustard oil and process variables on extrusion behaviour of rice grits. Journal of food science and technology (Mysore), 37(6), 656-660.

25. Sneha, M., & Thapar, L. (2019). Estimation of Protein Intake on the Basis of Urinary Urea Nitrogen in Patients with Non-Alcoholic Fatty Liver. International Journal for Research in Applied Science and Engineering Technology, 7, 2321-9653.

26. Kaur, L., & Shah, S. (2022). Screening and characterization of cellulose-producing bacterial strains from decaying fruit waste. International Journal of Food and Nutritional Science, 11, 8-14.

27. Verma, S., & Kaur, L. (2018). Identification Of Waste Utilizing Bacteria From Fruit Waste. Global Journal for Research Analysis, 7(6).

28. Kaur, L. (2017). Bulk And Nano-Zinc Oxide Particles Affecting Physio-Morphological Properties Of Pisum Sativum.

29. Rajesh, J., Ashraf, M. S., Kaur, L., Rout, S., Nayak, S. K., Kaur, G., & Saikanth, D. R. K. (2022). Application of Fuzzy Logic in Smart Agriculture to Recognise Tomato Fruit Ripeness. IJFANS International Journal of Food and Nutritional Sciences, 11(1), 2360-2367.

30. Ratra, S. H. R. E. Y. A., Kaur, L. A. K. H. V. I. N. D. E. R., & Thukral, B. H. A. W. A. N. A. (2016). Effect of Aloe vera and wheat grass juice as an edible coating to prolong the shelf life of bananas. Int. J. Eng. Res. Technol, 3, 2648-2655.

31. Eshita, L. K. (2018). Influence of height and weight on physical fitness index of amateur gymers of age 17 years. J Eng Technol, 5(06), 3236-40.

32. Puri, D., & Kaur, L. (2018). Evaluation of the sensory characterstics of namkeen prepared from composite papaya seed flour. International Journal of Engineering, Science and Mathematics, 7(4), 614-623.

33. Bajaj, G., Kaur, L., & Mishra, P. (2017). GREEN TEA BASED EDIBLE BIO PACKAGING FILM: DEVELOPMENT OF EDIBLE PACKAGING FILM AND ITS EVALUATION. International Journal of Research in Economics and Social Sciences (IJRESS), 7(5).

34. Singh, G., Bala, S., Katoch, S., Kumar, A., Kumar, A., Bharadwaj, A., & Kurniullah, A. Z. (2022). Liver cirrhosis: The struggling liver. International Journal of Health Sciences, (I), 5547-5559.

35. Ravichandra, T., Radha Krishna Murthy, G., Verma, A., & Kaur, L. (2022). A Study on Work-Life Balance of a Female Employee in Indian Industry.

36. Pathania, S., Kaur, L., & Mishra, D. (2016). EFFECT OF BULK AND NANO-ZINC OXIDE ON MORPHOLOGICAL CHANGES IN CICER ARIETRIUM (CHICKPEAS).

37. Rahman, M. M., Kaur, L., Shahminajada, M. I., Rahman, T., Bapan, P. S., & Syrmos, N. FROM BOWELS TO AIRWAYS: UNDERSTANDING THE ASSOCIATION BETWEEN IRRITABLE BOWEL SYNDROME AND ALLERGIC DISEASES.

38. Chand, K., Shahi, N. C., Lohani, U. C., & Garg, S. K. (2011). Effect of storage conditions on keeping qualities of jaggery. Sugar Tech, 13(1), 81-85.

39. Siddiqui, A., Chand, K., & Shahi, N. C. (2021). Effect of process parameters on extraction of pectin from sweet lime peels. Journal of The Institution of Engineers (India): Series A, 102, 469-478.

40. Shahi, N. C., Lohani, U. C., Chand, K., & Singh, A. (2012). Effect of pre-cooling treatments on shelf life of tomato in ambient condition. International Journal of Food, Agriculture

and Veterinary Sciences, 2(3), 50-56.

41. Thakur, R. R., Shahi, N. C., Mangaraj, S., Lohani, U. C., & Chand, K. (2021). Development of an organic coating powder and optimization of process parameters for shelf life enhancement of button mushrooms (Agaricus bisporus). Journal of Food Processing and Preservation, 45(3), e15306.

42. Chand, K., Singh, A., & Kulshrestha, M. (2012). Jaggery quality effected by hilly climatic conditions.

43. Chand, K., Verma, A. K., Kumar, A., & Shahi, N. C. (2014). Effect of edible coating on quality parameters of jaggery during storage. Sugar Tech, 16, 80-85.

44. Khamgaonkar, S. G., Singh, A., Chand, K., Shahi, N. C., & Lohani, U. C. (2013). Processing technologies of Uttarakhand for lesser known crops: An overview. Journal of Academic Industry Research, 1(8), 447-452.

45. Chand, K., Pandey, R. K., Shahi, N. C., & Lohani, U. C. (2013). Pedal operated integrated potato peeler and slicer. Agricultural Mechanization in Asia, Africa, and Latin America, 44(1), 65-68.

46. Nasir, G., Chand, K., Azaz Ahmad Azad, Z. R., & Nazir, S. (2020). Optimization of Finger Millet and Carrot Pomace based fiber enriched biscuits using response surface methodology. Journal of Food Science and Technology, 57, 4613-4626.

47. Thakur, R. R., Shahi, N. C., Mangaraj, S., Lohani, U. C., & Chand, K. (2020). Effect of apple peel based edible coating material on physicochemical properties of button mushrooms (Agaricus bisporus) under ambient condition. International Journal of Chemical Studies, 8(1), 2362-2370.

48. Kumar, A., Chand, K., Shahi, N. C., Kumar, A., & Verma, A. K. (2017). Optimization of coating materials on jaggery for augmentation of storage quality. Indian Journal of Agricultural Sciences, 87(10), 1391-1397.

49. Singh, A., Rana, I., Sahi, N. C., Lohani, U. C., & Chand, K. (2012). Optimization of process variables for preparation of apple pomace-black soyflour based biscuits. International Journal of Food, Agriculture and Veterinary Science, 2(1), 101-106.

50. Umesh Kumar, P. K., & Chand, K. (2015). Application of response surface method as an experimental design to optimize clarification process parameters for sugarcane juice. J Food Process Technol, 6(422), 2.

51. Pandey, R. K., Chand, K., & Tewari, L. (2018). Solid state fermentation and crude cellulase based bioconversion of potential bamboo biomass to reducing sugar for bioenergy production. Journal of the Science of Food and Agriculture, 98(12), 4411-

4419.

52. Kumar, S., Singh, A., Shahi, N. C., Chand, K., & Gupta, K. (2015). Optimization of substrate ratio for beer production from finger millet and barley. International Journal of Agricultural and Biological Engineering, 8(2), 110-120.

53. Singh, S. K., Lal, C., Shahi, N. C., & Chand, K. (2013). Estimation of canal seepage under shallow water table conditions. Journal of Academic and Industrial Research, 1(9), 571-575.

54. Chand, K., & Pandey, R. K. (2012). Optimization of foam mat drying process variables for malta powder. International Journal of Food, Agriculture and Veterinary Sciences, 2(2), 67-73.

55. Omar, A., Saxena, A., Chand, K., Paswan, A., Röttgering, H. J. A., Duncan, K. J., ... & Pant, J. (2019). Optical detection of a GMRT-detected candidate high-redshift radio galaxy with 3.6-m Devasthal optical telescope. Journal of Astrophysics and Astronomy, 40, 1-6.

56. Surwade, S. A., & Chand, K. (2017). Antimicrobial food packaging: An overview. European Journal of Biotechnology and Bioscience, 5(5), 85-90.

57. Singh, A., Santosh, S., Kulshrestha, M., Chand, K., Lohani, U. C., & Shahi, N. C. (2013). Quality characteristics of Ohmic heated Aonla (Emblica officinalis Gaertn.) pulp.

58. Tongkachok, K., Garg, S., Balakrishnan, S., & Vijayalakshmi, N. S. (2022). Impact of transformational leadership on organizational performance through employee motivation. ECS Transactions, 107(1), 12873.

59. Sakthimala, B., & Deepalakshmi, G. (2023). EMPLOYMENT ENGAGEMENT A REVIEW OF CURRENT RESEARCH AND ITS IMPLICATIONS. A THEORETICAL FRAMEWORK. Multidisciplinary Handbook of Social Exclusion Research, 126.

60. Sakthimala, B., & Deepalakshmi, G. (2024, March). Work Satisfaction and Green HRM Mediate the Effect of Corporate Ecological Culture on Employee Performance. In Advancements in Business for Integrating Diversity, and Sustainability: International Analytics Conference 2023| IAC 2023 February 2& 3, 2023| Virtual Conference (p. 110). Taylor & Francis.

61. Kandi, V., Balakrishnan, S., Sivakumar, G., & Vijayalakshmi, N. S. (2022). Impact of Social Media Marketing on Organizational Performance: A Case Study of Amazon India. ECS Transactions, 107(1), 12749.

62. Choudhary, N., Sakthimala, B., & Dhanalakshmi, D. HRM PRACTICE IN BANKING SECTOR: AN ANALYSIS OF EMPLOYEE TRAINING IN PRIVATE BANKS. MULTI DISCIPLINARY STUDIES: PROSPECTS AND PROBLEMS IN MODERN ERA, 139.

63. Bhuvana Suganth, D., & Manjunath, R. (2017). Fault tolerance communication in mobile distributed networks. In Proceedings of the International Conference on Data Engineering and Communication Technology: ICDECT 2016, Volume 1 (pp. 77-87). Springer Singapore.

64. Varsha, A., & Karnika, S. (2024, January). Smart Waste Segregation System. In 2024 International Conference on Intelligent and Innovative Technologies in Computing, Electrical and Electronics (IITCEE) (pp. 1-4). IEEE.

65. Jaichandran, R., Bharathi, P. S., Meenakshi, B., Anushya, A., & Devi, V. B. (2021). The Defense Against Jamming Attack in Cognitive Radio Networks: Energy Efficiency Management Perspective. Microprocessors and Microsystems, 82, 103816.

66. Suganthi, D. B., Manjuath, R., & Aravindan, A. (2016, May). Reliable security policy in mobile distributed network. In 2016 IEEE International Conference on Recent Trends in Electronics, Information & Communication Technology (RTEICT) (pp. 1782-1786). IEEE.

67. Mishra, N., Rajkumar, M., & Mishra, R. (2019). Micromanagement: an employers' perspective. International Journal of Scientific & Technology Research, 8(10), 2949-2952.

68. Mishra, N., Mishra, R., & Singh, M. K. (2019). The impact of transformational leadership on team performance: The mediating role of emotional intelligence among leaders of hospitality and tourism sector. International Journal of Scientific & Technology Research, 8(11), 3111-3117.

69. Mishra, R., Sharma, M. P., Seth, K., & Singh, V. (2023). A study on consumers' travel purchase intention through travel apps. Prabandhan: Indian Journal of Management, 16(7), 25-42.

70. Mishra, R., & Singh, V. (2022). A study on destination loyalty of tourists at the UNESCO world heritage site: A case study of old Goa in India.

71. Mishra, N., Rajkumar, M., & Mishra, R. (2022). Emotional intelligence as a moderator between micromanagement leadership and employee performance. Prabandhan: Indian Journal of Management, 15(10), 63-70.

72. Rana, V. (2017). Trends, issues and women in hospitality and tourism industry. RET International Academic Publishing ISBN, 978-93.

73. Saravanan, V., Rajakumar, S., Banerjee, N., & Amuthakkannan, R. (2016). Effect of shoulder diameter to pin diameter ratio on microstructure and mechanical properties of dissimilar friction stir welded AA2024-T6 and AA7075-T6 aluminum alloy joints. The International Journal of Advanced Manufacturing Technology, 87, 3637-3645.

74. Abdulkarem, W., Amuthakkannan, R., & Al-Raheem, K. F. (2014, March). Centrifugal pump impeller crack detection using vibration analysis. In 2nd International Conference on Research in Science, Engineering and Technology (pp. 206-211).

75. Saravanan, V., Banerjee, N., Amuthakkannan, R., & Rajakumar, S. (2015). Microstructural evolution and mechanical properties of friction stir welded dissimilar AA2014-T6 and AA7075-T6 aluminum alloy joints. Metallography, Microstructure, and Analysis, 4, 178-187.

76. Amuthakkannan, R., Kannan, S. M., Selladurai, V., & Vijayalakshmi, K. (2008). Software quality measurement and improvement for real-time systems using quality tools and techniques: a case study. International Journal of Industrial and Systems Engineering, 3(2), 229-256.

77. Vijayalakshmi, K., Ramaraj, N., & Amuthakkannan, R. (2008). Improvement of component selection process using genetic algorithm for component-based software development. International Journal of Information Systems and Change Management, 3(1), 63-80.

78. Amuthakkannan, R. (2012). Parameters design and performance analysis of a software-based mechatronics system using Taguchi robust design–a case study. International Journal of Productivity and Quality Management, 10(1), 1-24.

79. Amuthakkannan, R., Kannan, S. M., Vijayalakshmi, K., & Ramaraj, N. (2009). Reliability analysis of programmable mechatronics system using Bayesian approach. International Journal of Industrial and Systems Engineering, 4(3), 303-325.

80. Madhan, E. S., Kannan, K. S., Rani, P. S., Rani, J. V., & Anguraj, D. K. (2021). A distributed submerged object detection and classification enhancement with deep learning. Distrib. Parallel Databases, 1-17.

81. Sakthivela, M., Balakrishnab, N., Kannanc, K. S., & Devabaland, P. (2021). An Analysis of Load Balancing Algorithm Using Software-Defined Network. Turkish Journal of Computer and Mathematics Education Vol, 12(9), 578-586.

82. Padmanaban, K. (2021). A Novel Groundwater Resource Forecasting Technique for Cultivation Utilizing Wireless Sensor Network (WSN) and Machine Learning (ML) Model. Turkish Journal of Computer and Mathematics Education (TURCOMAT), 12(2), 2186-2192.

83. Kanna, D. K., Devabalan, D. P., Hariharasitaraman, S., & Deepa, P. (2018). Some Insights on Grid Computing-A Study Perspective. International Journal of Pure and Applied Mathematics, 118(8), 47-50.

84. Kumar, V. S., & Naganathan, E. R. (2015). Segmentation of Hyperspectral image using

JSEG based on unsupervised clustering algorithms. ICTACT Journal on Image and Video Processing, 6(2), 1152-1158.

85. Jasper Gnana Chandran, J., Karthick, R., Rajagopal, R., & Meenalochini, P. (2023). Dualchannel capsule generative adversarial network optimized with golden eagle optimization for pediatric bone age assessment from hand X-ray image. International Journal of Pattern Recognition and Artificial Intelligence, 37(02), 2354001.

86. Sabarish, P., Karthick, R., Sindhu, A., & Sathiyanathan, N. (2021). Investigation on performance of solar photovoltaic fed hybrid semi impedance source converters. Materials Today: Proceedings, 45, 1597-1602.

87. Nagarani, N., Karthick, R., Sophia, M. S. C., & Binda, M. B. (2024). Self-attention based progressive generative adversarial network optimized with momentum search optimization algorithm for classification of brain tumor on MRI image. Biomedical Signal Processing and Control, 88, 105597.

88. Suresh, H. R., Vinitha, V., Girinath, N., & Karthick, R. (2021). Suppression of four wave mixing effect in DWDM system. Materials Today: Proceedings, 45, 2707-2712.

89. Sabarish, P., Raj, L. H. T., Ramprakash, G., & Karthick, R. (2020, September). An Energy Efficient Microwave Based Wireless Solar Power Transmission System. In IOP Conference Series: Materials Science and Engineering (Vol. 937, No. 1, p. 012013). IOP Publishing.

90. Karthick, R., Prabaharan, A. M., & Selvaprasanth, P. (2019). Internet of things based high security border surveillance strategy. Asian Journal of Applied Science and Technology (AJAST) Volume, 3, 94-100.

91. Rajagopal, R. K. P. M. T. K. R., Karthick, R., Meenalochini, P., & Kalaichelvi, T. (2023). Deep Convolutional Spiking Neural Network optimized with Arithmetic optimization algorithm for lung disease detection using chest X-ray images. Biomedical Signal Processing and Control, 79, 104197.

92. Karthick, R., & Sundararajan, M. (2021). SPIDER-based out-of-order execution scheme for Ht-MPSOC. International Journal of Advanced Intelligence paradigms, 19(1), 28-41.

93. Karthick, R., & Meenalochini, P. (2020). Implementation of data cache block (DCB) in shared processor using field-programmable gate array (FPGA). Journal of the National Science Foundation of Sri Lanka, 48(4), 475.

94. Karthick, R., & Sundararajan, M. (2017). Design and implementation of low power testing using advanced razor based processor. International Journal of Applied Engineering Research, 12(17), 6384-6390.

95. Meenalochini, P., Karthick, R., & Sakthivel, E. (2023). An Efficient Control Strategy for an Extended Switched Coupled Inductor Quasi-Z-Source Inverter for 3Φ Grid Connected System. Journal of Circuits, Systems & Computers, 32(11).

96. Karthick, R., Senthilselvi, A., Meenalochini, P., & Senthil Pandi, S. (2023). An optimal partitioning and floor planning for VLSI circuit design based on a hybrid bio-inspired whale optimization and adaptive bird swarm optimization (WO-ABSO) algorithm. Journal of Circuits, Systems and Computers, 32(08), 2350273.

97. Reka, R., Karthick, R., Ram, R. S., & Singh, G. (2024). Multi head self-attention gated graph convolutional network based multi-attack intrusion detection in MANET. Computers & Security, 136, 103526.

98. Vijayalakshmi, S., Sivaraman, P. R., Karthick, R., & Ali, A. N. (2020, September). Implementation of a new Bi-Directional Switch multilevel Inverter for the reduction of harmonics. In IOP Conference Series: Materials Science and Engineering (Vol. 937, No. 1, p. 012026). IOP Publishing.