International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 2s, 2025
https://theaspd.com/index.php

Machine Learning-Based Classification Of Biomedical Signals

Dr. D Kalidoss[1], Ms. Priyanka Gupta[2], Ishwari Datt Suyal[3],
Associate Professor, Kalinga University, Raipur, India. dr.kalidoss@kalingauniversity.ac.in
ORCID:0000-0001-8286-9516
Associate Professor, Department of Chemistry, Kalinga University, Raipur, India.
Assistant Professor, New Delhi Institute of Management, New Delhi, India., E-mail: ishwari.suyal@ndimdelhi.org, https://orcid.org/0009-0009-8998-2154

Abstract
The effective biological signal processing technique significantly enhances researchers' ability to investigate the mechanisms of life, thereby providing deeper insights into the connection between physiological structure and function, which in turn fosters significant biological breakthroughs. Additionally, a high-precision medical signal analysis approach can alleviate some of the burdens faced by physicians in clinical diagnosis, enabling them to develop more effective strategies for disease prevention and treatment, ultimately improving society's general health and lessening the mental and physical pain of patients. EEG signals and mammary gland molybdenum target X-ray images (mammography) are two sample types of biomedical signals that are examined in this research using deep learning techniques, namely convolutional neural networks (CNNs). The development of a novel multi-layer CNN-based breast mass classification system that combines a feature choice mechanism that mimics medical diagnostic processes with a CNN feature representation network tailored for breast masses is one notable achievement.
Keywords: *Biomedical Signals, relationship, health level, network*

1. INTRODUCTION

Biomedical signals are signals from biological systems that often include information about the structural and physiological conditions of the biological systems [1]. Biological signals come in a wide variety and are mostly identified by their low strength and great degree of randomness [2]. Because digital medical and biological technologies are developing so quickly, researchers in related fields are growing increasingly interested in processing and analysing biomedical data [9]. Traditional methods of biomedical information processing, which rely on researchers or physicians to manually document, organize, and retrieve relevant research data and clinical information, are becoming inadequate to meet the escalating need for extensive, quantitative analysis of biomedical information [3].

As biomedical disciplines continue to advance rapidly, there is a growing demand among researchers and healthcare professionals for technologies that facilitate the processing and analysis of these signals [4]. Effective methods for biological signal processing can significantly enhance researchers' ability to investigate the mechanisms of life, thereby elucidating the connections between physiological structure and function, which can lead to significant biological breakthroughs [13]. By easing some of the clinical diagnosis burdens on doctors, a high-precision approach to medical signal analysis can help them create more effective disease prevention and treatment plans, which will ultimately lessen patients' mental and physical suffering and enhance society's general health. Neural networks, as a novel and effective tool for signal processing, possess unique advantages that other traditional methods cannot address [10]. Their application spans various domains, particularly in biomedical engineering. Deep learning, a branch of machine learning, uses multi-layer neural networks to extract feature representations from data. These representations are then used for data analysis. Feature selection and feature extraction make up feature engineering. The process of turning raw data into machine-learning-reliable numerical features is called feature extraction. By removing unnecessary information, feature selection helps to reduce the size of the feature set that is obtained by feature extraction [5]. An automated system is incorporated into the EEG approach to detect human emotional patterns. The following sections provide an overview of some of the major studies conducted in the past 20 years on emotion identification and related techniques.

2. MATERIALS AND METHODS

One method used to analyze and manipulate geometrical structures in photographs is mathematical morphology (MM). In 1964, Georges Matheron and Jean Serra created it at the Ecole des Mines de Paris in France [6]. In 1986, Sara went on to generalize it further. The theory gained flexibility from this generalization, which allowed it to be used to a far greater variety of structures, such as meshes, graphs, color images, and video. Set theory, lattice theory, topology, and random functions are the topics used in the picture analysis. Because of its drawbacks, this method is mostly used for analysis of digital photographs. Graphs, surface meshes, solids, and numerous other spatial structures can all be analyzed using it. Both topological and geometrical continuous-space functions on continuous and discrete variables can be analyzed using MM [11]. Morphological image analysis was made possible by all of the aforementioned functions as well as a number of operators. MM was first created to analyze binary images, but it has now been expanded to analyze grayscale functions on images as well.

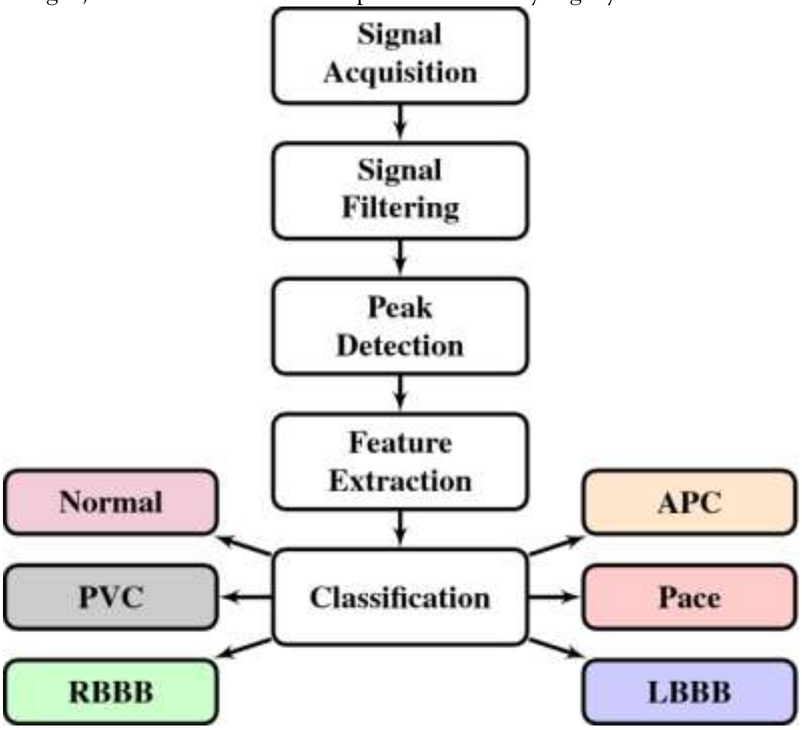

Figure 1: Proposed flow

Back propagation is used in multilayer perception algorithms to facilitate learning. Inputs, outputs, and a hidden layer of nodes that learn during background propagation are all part of MLP. The data item is then processed by transferring weight. Last but not least, the final MLP performance with mistake cost in comparison to the anticipated result. Every neuron tracks each weighted input for each neuron's output since all neurons are linearly enabled. The weight improvement ascertained by gradient descent change of the loss function. In order to guarantee weight quick exposure to the answer without any modifications, the results of previous neurons and the rate of learning were evaluated. A perceptron is a binary category that is a basic set of rules that were suggested with the help of scientist Frank Rosenblatt. It can mutilate a series of enter signals into portions. Evaluation of too many category algorithms, however, models the neuron, the basic building block of the human brain, and has a remarkable capacity for complicated problem analysis and resolution. To handle complicated issues, a multilayer perceptron combines with other perceptrons layered in multiple layers. Every perceptron in the input layer, which is the first layer on the left, sends outputs to every other perceptron in the hidden layer, which is the second layer, and every perceptron in the second layer gives outputs to the output layer, which is the last layer on the right [7]. The multilayer perceptron's fundamental characteristics are: Every neuron in the network has a differentiable nonlinear activation function. The network is made up of input nodes, output nodes, and one or more hidden layers. The network is highly interconnected[14]. According to Sambasivam et al. (2020), there are two phases of multi-layer perceptron training: Before the performance is attained, the network's weight is established in the forward process and the input signal is sent layer by layer throughout the network. Layer after layer, the error signal generated by the reverse procedure of comparing the network output with the intended response is once more dispersed across the network.

3. RESULT

It is similar to adding fresh training data to the neural network when the surroundings change [8]. In order to provide the desired output for particular inputs, the network can independently modify the mapping relationships and its structural parameters [15]. As a result, the neural network is more flexible than expert systems that employ rigid reasoning techniques, more in line with the principles of how the human brain functions[12].

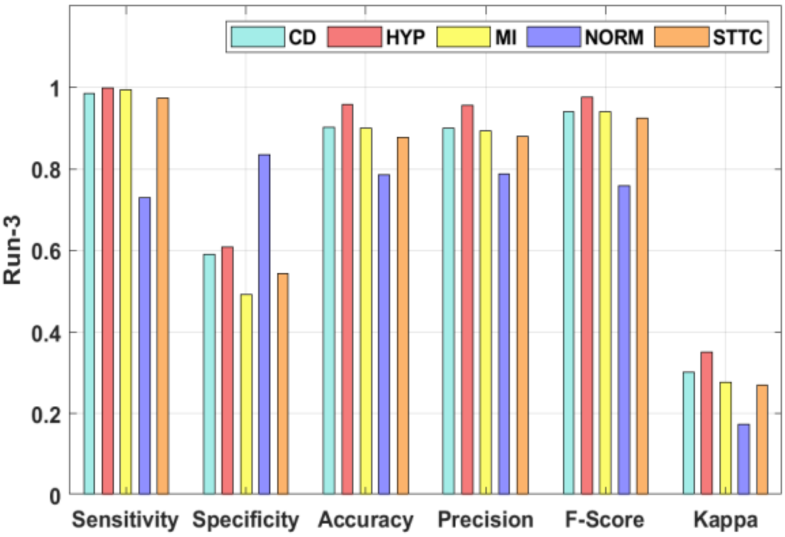

Figure 2: Result Analysis

As digital medical technology and biological technology advance rapidly, there is an increasing demand among scholars in related fields for the processing and analysis of biomedical data.

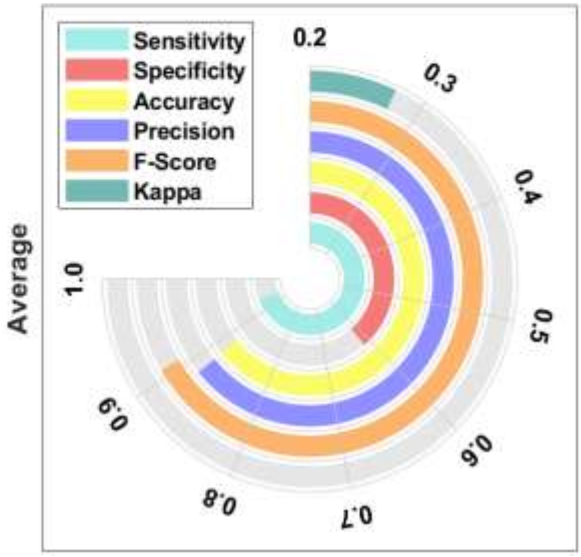

Figure 3: Average Analysis

Traditional biomedical information processing methods, which rely entirely on researchers or physicians to manually record, organize, and retrieve relevant clinical and research data, are unable to meet the increasing demand for comprehensive, quantitative analysis of biological data. As a result, biomedical informatics has developed, emphasizing the convergence of cognitive science, computer science, information science, and brain-machine interface, especially in the fields of clinical medicine and biology.

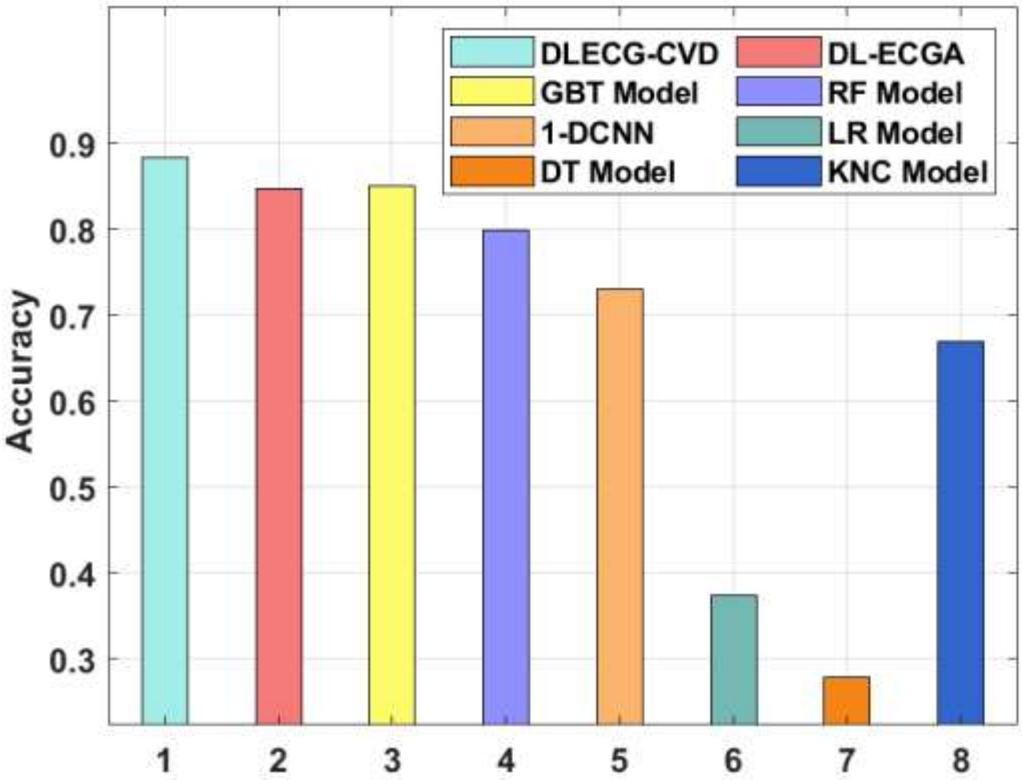

Figure 4: Average Analysis

Determining the system's status (normal or diseased) from the properties of the signals under analysis is the main goal of biomedical signal processing, which eventually helps with precise medical decision-making.

4. CONCLUSION

Biomedical informatics is a new and multidisciplinary field of study that depends on the cooperation of clinical medicine, computer science, and classical biology. Research in biomedical informatics benefits greatly from the theoretical, practical, and technical assistance provided by each of these disciplines. Additionally, biomedical informatics provides useful theoretical frameworks and procedures that support multidisciplinary collaboration and communication across different disciplines. It facilitates the advancement of interdisciplinary research in linked domains, which in turn promotes the thorough and well-coordinated development of several disciplines. The fields of biomedical informatics and other fields intersect frequently. Because breast magnetic resonance imaging (MRI) technology is radiation-free and has a superior soft tissue resolution, it provides obvious advantages for breast inspections. The invention and application of rapid imaging sequences and bespoke breast coils has significantly raised the quality and standards of breast MRI. Although breast cancer is the most frequent malignant tumor in women worldwide, it is sometimes assumed that it is a common disease in developed nations; however, less developed nations are responsible for more than 50% of breast cancer cases and 58% of related fatalities.

REFERENCES

1. Aayesha, Muhammad Bilal Qureshi, Muhammad Afzaal, Muhammad Shuaib Qureshi, and Muhammad Fayaz. "Machine learning-based EEG signals classification model for epileptic seizure detection." Multimedia Tools and Applications 80, no. 12 (2021): 17849-17877.
2. Krithika, R., & Jayanthi, A. N. (2023). A Comprehensive Literature Review on High Resolution Radar Target Recognition Techniques. International Journal of Advances in Engineering and Emerging Technology, 14(2), 32–41.
3. Qaisar, Saeed Mian, Humaira Nisar, and Abdulhamit Subasi, eds. Advances in non-invasive biomedical signal sensing and processing with machine learning. Springer, 2023.
4. Ramachandran, K., & Naik, R. (2024). Decolonizing Development: Equity and Justice in Global South SDG Frameworks. International Journal of SDG's Prospects and Breakthroughs, 2(2), 1-3.

5. Bahador, Nooshin, and Jukka Kortelainen. "Deep learning-based classification of multichannel bio-signals using directedness transfer learning." Biomedical Signal Processing and Control 72 (2022): 103300.

6. Patil, A., & Reddy, S. (2024). Electrical Safety in Urban Infrastructure: Insights from the Periodic Series on Public Policy and Engineering. In Smart Grid Integration (pp. 6-12). Periodic Series in Multidisciplinary Studies.

7. Patel, Vandana, and Ankit K. Shah. "Machine learning for biomedical signal processing." In Machine Learning and the Internet of Medical Things in Healthcare, pp. 47-66. Academic Press, 2021.

8. Zhang, J., & Song, X. (2024). The AI-assisted Traditional Design Methods for the Construction Sustainability: A Case Study of the Lisu Ethnic Minority Village. Natural and Engineering Sciences, 9(2), 213-233. https://doi.org/10.28978/nesciences.1569562

9. Kumar, Aditya, Niharika Koch, Sk Imran, and Jainath Yadav. "Artificial intelligence and machine learning in biomedical signal processing." In Evolution of Machine Learning and Internet of Things Applications in Biomedical Engineering, pp. 145-168. CRC Press, 2024.

10. Tahmasebi, M., Ehya, F., & Paydar, G. R. (2025). Geochemical and Geological Studies of Oil Shales in Ab Kaseh Section, Kouhrang County, Chaharmahal and Bakhtiari Province, Iran. Archives for Technical Sciences, 1(32), 75–92. https://doi.org/10.70102/afts.2025.1732.075

11. Subasi, Abdulhamit. Practical guide for biomedical signals analysis using machine learning techniques: A MATLAB based approach. Academic Press, 2019.

12. Kafle, V.P., & Inoue, M. (2010). Locator ID Separation for Mobility Management in the New Generation Network. Journal of Wireless Mobile Networks, Ubiquitous Computing and Dependable Applications, 1(2/3), 3-15.

13. Park, Cheolsoo, Clive Cheong Took, and Joon-Kyung Seong. "Machine learning in biomedical engineering." Biomedical Engineering Letters 8 (2018): 1-3.

14. Basanta Kumar, R., & Sunil, K. (2024). Biotechnological Approaches to Develop Personalized Medicines for Rare Genetic Disorders. Clinical Journal for Medicine, Health and Pharmacy, 2(2), 20-28.

15. Sakai, Asuka, Yuki Minoda, and Koji Morikawa. "Data augmentation methods for machine-learning-based classification of bio-signals." In 2017 10th Biomedical Engineering International Conference (BMEiCON), pp. 1-4. IEEE, 2017.