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IoMT-Driven Ensemble Learning Framework for Cardiovascular Disease Prediction

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***Abstract*—Cardiovascular disease remains one of the leading causes of death worldwide and encompasses a wide range of conditions. Accurate diagnosis can be challenging in the medical field due to the overlap of cardiovascular symptoms with those of other diseases or with signs of natural aging. However, machine learning (ML) and its algorithms have proven effective in performing prediction and classification tasks on the vast amounts of healthcare data now available. In this research, the proposed work introduced an efficient hybrid recommender system for cardiovascular disease, leveraging the Internet of Medical Things (IoMT). This system offers personalized medical recommendations based on clinical test results, utilizing wireless sensor networks. To enhance feature selection, the system employs the Sequential Forward Selection (SFS) technique, that follows a greedy selection strategy. The dataset used for this study includes information from one hundred cardiac patients, each exhibiting varying levels of heart disease. Simulation results demonstrate that the proposed model delivers high accuracy in predicting heart disease cases. Moreover, the simulation not only identifies the condition but also suggests appropriate medical treatments for the patient.**

Keywords—component, Cardiovascular Disease, Prediction, Machine Learning, IoMT

I. Introduction

Several factors can increase an individual's risk of developing cardiovascular disease. These include conditions such as obesity, high blood sugar, elevated blood pressure, and abnormal cholesterol levels. According to the American Heart Association, additional warning signs include rapid weight gain (1–2 kg per day), sleep disturbances, swelling in the limbs, persistent coughing, and an elevated heart rate. Accurately diagnosing cardiovascular disease can be challenging for healthcare professionals, as these symptoms often overlap with those of other medical conditions or are commonly associated with the natural aging process [1].

Today, artificial intelligence (AI) and machine learning (ML) have numerous applications in the field of cardiovascular care. AI has the potential to empower cardiologists by enabling the effective use of precision medicine and large-scale patient data through advanced analytical tools. This advancement allows for more informed and personalized clinical decision-making. Both AI and ML algorithms are highly effective in performing prediction and classification tasks using the diverse and complex healthcare data currently available. [2].

In the past five years, remarkable progress has been made in the fields of machine learning and artificial intelligence (AI). Interest in AI systems among clinical researchers has grown substantially during this period. According to a recent survey of healthcare professionals, more than half of the respondents indicated that they currently use or intend to implement AI-enhanced imaging in their clinical practice. [3].

Developing machine learning algorithms typically requires substantial effort and a solid understanding of the underlying techniques. For example, training and refining deep neural networks can be a time-consuming process, often taking several months. Many of the most advanced deep learning models have been created by individuals with extensive education in computer science and strong expertise in artificial intelligence. This presents a significant challenge for clinical researchers who wish to apply AI technologies to address critical biomedical issues, as meeting these technical requirements can be difficult without specialized training. [4].

Early AI research primarily focused on creating more mechanical, rule-based procedures. Ensemble Machine Learning (EML) encompasses a range of techniques aimed at enhancing model performance by combining multiple learning algorithms. The objective of this project is to design a system capable of automatically constructing high-performing AI models across various datasets, with the primary aim of improving prediction accuracy. Data can be effectively represented through vectors for processing. With the advancement of EML, the fields of medicine and healthcare are poised to experience significant benefits in the near future [5].

Ensemble Machine Learning (EML) has the potential to greatly enhance the adoption of AI techniques in the medical field by reducing the high technical barriers that once limited their implementation. This advancement could lead to a substantial increase in the number of patients who benefit from AI-driven healthcare solutions. As a result, the application of AI may positively impact a much broader patient population.

II. Related Works

In recent years, a growing body of research has investigated the feasibility of applying machine learning techniques to the detection of cardiac abnormalities and the prediction of cardiovascular conditions. These advanced computational methods are increasingly being recognized for their potential to support clinical decision-making by identifying patterns in complex medical data. One notable study conducted by Melillo et al. [6] focused on the development of an automated system for risk stratification in patients diagnosed with congestive heart failure (CHF). The system was designed to classify patients into two distinct risk categories low risk and high risk based on various clinical indicators. To achieve this, the researchers employed the Classification and Regression Tree (CART) algorithm, a widely used decision tree method in medical data analysis. The results of the study demonstrated that the model achieved a sensitivity of 93.3%, indicating a high rate of correctly identifying patients at risk. However, the specificity was found to be 63.5%, suggesting that there is still room for improvement in correctly identifying patients who are not at risk. Overall, the study highlights the promise of machine

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The study presents a detailed comparison between the actual classification labels provided by experienced cardiologists and the predictions generated by the proposed algorithm, as depicted in Figures 2 to 6. Although the expert insights from cardiologists serve as the clinical benchmark, the system's overall performance closely aligns with these expert judgments, demonstrating high reliability. Most existing classification models primarily focus on identifying diseases or generating rule-based recommendations. In contrast, the technology introduced in this study not only detects potential cardiovascular conditions but also offers personalized medical recommendations for treatment and follow-up care.

One of the key strengths of the proposed system lies in its scalability. As more patient data becomes available and is incorporated into the system, its accuracy and performance continue to improve. This makes the system highly adaptable and effective for real-world healthcare applications. During system evaluation, the model was tested with a diverse set of 100 unique patient records at a time. Successful implementation of such a system also requires a deep learning inputs from various medical professionals, ensuring that its recommendations are both clinically sound and contextually relevant.

V. Conclusion

After a patient is diagnosed with a cardiovascular condition, they receive modified advice regarding necessary changes to their diet and physical activity, customized according to their age and gender. Unlike most existing research, which concentrates solely on predicting the presence or absence of heart disease, the proposed approach introduces a multiclass classification model capable of identifying eight different types of cardiovascular disorders. To boost classification accuracy and reduce false positives, this method incorporates a feature selection process that filters out less significant attributes. The retained features were evaluated for their relevance, and a similarity score was calculated to compare each patient undergoing treatment with the broader patient population. The integration of this system into existing diagnostic and recommendation frameworks has the potential to significantly improve operational efficiency. Moreover, this approach is particularly beneficial for individuals residing in underserved or remote regions who may lack access to specialized cardiology care. By offering precise detection and actionable treatment suggestions, the system bridges gap in healthcare accessibility and enhances the quality of patient outcomes.

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