A New Approach in IoT Based AI Enabled Real Time Heart Disease Prediction

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Abstract: This research paper propose a real-time Electrocardiography -based cardiac risk monitoring system using the AD8232 sensor integrated with machine learning algorithms for early detection of abnormal cardiac patterns. In this research paper also reviews the recent developments in Electrocardiography -based cardiac monitoring systems, focusing on wearable ECG sensors, signal preprocessing techniques, and machine learning methods used for detecting abnormal cardiac patterns. Nowadays cardiovascular disease is one of the leading causes of death worldwide, making early detection and continuous monitoring of heart activity is very much essential for all age groups. Electrocardiography (ECG) is widely used to detect cardiac abnormalities such as arrhythmia and other heart-related disorders. Recent advances in wearable sensors such as AD8232, the Internet of Things (IoT), and machine learning have enabled the development of intelligent ECG monitoring systems capable of providing real-time health information outside traditional clinical environments. Here we focused the role of AIoT-based systems in enabling remote patient monitoring and also discussed about the current challenges and future research directions for developing efficient and low-cost ECG monitoring systems are highlighted.

Keywords: *ECG, AD8232, Machine Learning, Cardiac Risk Monitoring, Arrhythmia Detection, IoT Healthcare, MIT-BIH Arrhythmia.*

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I. INTRODUCTION

Cardiovascular diseases (CVDs) are responsible for approximately 17.9 million deaths each year worldwide, making them the leading cause of mortality globally [5]. Early diagnosis and continuous monitoring of cardiac conditions can significantly reduce mortality rates and improve patient outcomes.

Electrocardiography (ECG) is a non-invasive diagnostic technique that records the electrical activity of the heart and provides essential information for detecting arrhythmias, myocardial ischemia, and other cardiac abnormalities [2]. Traditional ECG monitoring systems are usually confined to clinical settings and require specialized equipment and expert interpretation.

Recent advancements in embedded systems, low-cost biomedical sensors, and machine learning have enabled the development of portable and real-time ECG monitoring systems [6][7]. The AD8232 is a compact integrated signal conditioning module designed for ECG and other biopotential measurements, enabling ECG acquisition using microcontrollers and embedded platforms [4].

Machine learning techniques have shown promising results in automated ECG interpretation and arrhythmia detection [1][8]. By combining low-cost ECG sensors with intelligent algorithms, it is possible to design efficient real-time cardiac monitoring systems suitable for wearable and remote healthcare applications.

II. LITERATURE REVIEW

Electrocardiography (ECG) is widely used for monitoring cardiac activity and detecting cardiovascular abnormalities. With the increasing prevalence of cardiovascular diseases, researchers have focused on developing automated ECG analysis systems using signal processing and machine learning techniques to improve early diagnosis and monitoring.

Traditional ECG interpretation relies on manual analysis by cardiologists, which can be time-consuming and prone to human error when dealing with large volumes of ECG data.

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To address these limitations, various computational methods have been developed for automated ECG signal analysis and arrhythmia detection. Clifford et al. [2] reviewed advanced ECG signal processing techniques and highlighted the importance of preprocessing methods such as noise removal, baseline correction, and R-peak detection.

Public ECG datasets have significantly supported research in this field. Moody and Mark [3] introduced the MIT-BIH Arrhythmia Database, widely used for evaluating ECG classification algorithms. Earlier approaches mainly relied on rule-based and statistical methods, such as the QRS detection algorithm proposed by Pan and Tompkins [12].

With the advancement of machine learning, algorithms such as Support Vector Machines and Random Forest have been applied for ECG classification [8]. More recently, deep learning models have shown promising results, including the work of Rajpurkar et al. [1] and Acharya et al. [9]. Additionally, wearable sensors and IoT-based systems have enabled real-time remote cardiac monitoring [6], [10]. Low-cost ECG sensors such as AD8232 have further supported the development of portable monitoring systems [4].

III. ANALYSIS OF EXISTING METHODOLOGIES

Several research efforts have focused on the development of ECG-based cardiac monitoring systems using signal processing and machine learning techniques. Although these systems have demonstrated promising performance in detecting cardiac abnormalities, they still suffer from several limitations related to portability, computational efficiency, and real-time implementation.

Traditional ECG monitoring systems are primarily designed for hospital environments using high-cost medical equipment and require expert interpretation by trained cardiologists. While these systems provide accurate diagnostic results, they are not suitable for continuous long-term monitoring outside clinical environments. Consequently, early detection of cardiac abnormalities in daily life remains a challenge [2], [11].

Many existing research approaches rely on offline ECG analysis using publicly available datasets such as the MIT-BIH Arrhythmia Database. In these systems, ECG signals are first collected and stored, followed by offline processing using signal processing techniques and machine learning algorithms. Although such approaches achieve high classification accuracy, they do not support real-time monitoring or immediate detection of cardiac abnormalities, which limits their effectiveness in emergency healthcare scenarios [3], [8].

Earlier ECG analysis systems were mainly based on rule-based signal processing methods, such as threshold-based QRS detection and morphological feature analysis. These approaches rely heavily on manually defined rules and often fail to detect complex or subtle variations in ECG patterns. As a result, the performance of traditional signal processing methods may decrease when analyzing noisy or highly variable ECG signals [12].

Recent studies have introduced deep learning models such as convolutional neural networks (CNN) and recurrent neural networks (RNN) for automated ECG classification. These methods have shown promising results in detecting arrhythmias and other cardiac abnormalities with high accuracy [1], [9]. However, deep learning models often require large computational resources and high-performance hardware, which makes their deployment challenging in low-power embedded systems and wearable healthcare devices.

In addition, several existing ECG monitoring systems lack proper integration with Internet of Things (IoT) technologies for remote healthcare monitoring. Without efficient IoT integration, continuous patient monitoring and real-time alert generation for healthcare providers become difficult, especially in remote or resource-limited environments [10].

Therefore, there is a need for a low-cost, portable, and real-time ECG monitoring system that can efficiently analyze cardiac signals using intelligent algorithms while maintaining computational efficiency suitable for embedded platforms.

IV. RESEARCH GAP

Despite significant progress in ECG signal analysis and cardiac abnormality detection, several research gaps remain. Many existing ECG classification models rely on large datasets and computationally intensive deep learning architectures, which require high-performance hardware and are difficult to deploy on low-power wearable devices. Additionally, much of the current research focuses on offline ECG analysis, limiting real-time detection of critical cardiac abnormalities.

Although wearable ECG monitoring systems have been developed, many primarily focus on signal acquisition and transmission rather than intelligent automated analysis. Furthermore, several monitoring solutions depend on expensive medical equipment that is not accessible in rural or resource-limited environments. Limited studies have explored the integration of low-cost sensors such as the AD8232 with machine learning for real-time cardiac risk prediction. Therefore, there is a need for low-cost, portable, and real-time ECG monitoring systems that combine efficient signal processing with machine learning-based risk classification.

V. PROPOSED METHOD

To address the limitations of existing ECG monitoring systems, this study proposes a real-time cardiac risk monitoring framework using the AD8232 ECG sensor integrated with machine learning techniques. The system combines low-cost hardware, efficient signal preprocessing, and intelligent classification algorithms to enable continuous cardiac monitoring. The AD8232 module provides reliable ECG signal amplification and filtering and offers a portable

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and cost-effective alternative to traditional ECG equipment [4].

To enhance signal quality, preprocessing methods such as bandpass filtering, Gaussian filtering, and R-peak detection are applied to remove noise and artifacts [2], [12]. Machine learning models including Support Vector Machines, Random Forest, and deep learning approaches are used for automated cardiac risk classification [1], [9]. In addition, key ECG features such as RR intervals, heart rate variability, QRS duration, and ST-segment deviation are extracted to improve detection accuracy [8].

The proposed system can be integrated with IoT-based healthcare platforms to enable remote patient monitoring. ECG data can be transmitted to cloud servers, allowing healthcare professionals to monitor patients and respond quickly to potential cardiac risks. Such IoT-enabled systems are important for modern telemedicine applications [10]. The proposed approach provides low-cost, portable, and real-time cardiac monitoring with machine learning-based risk classification, supporting early detection of cardiovascular abnormalities.

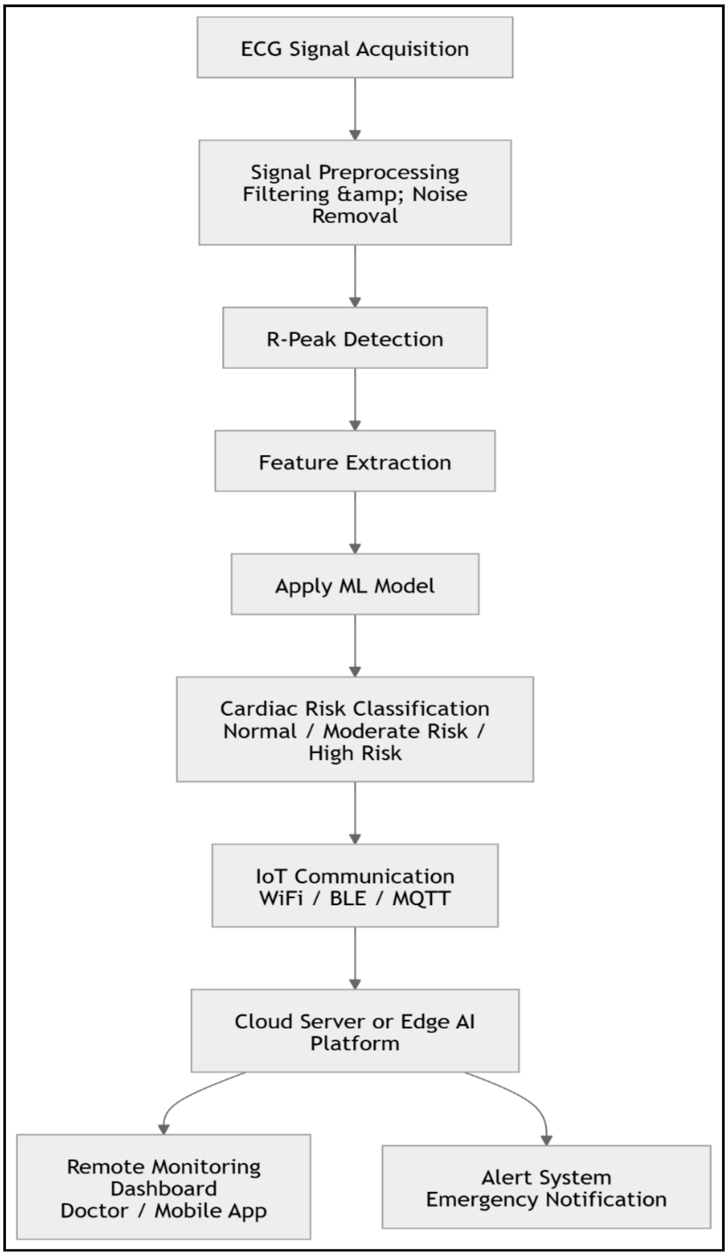

Fig 1: AIOT based Health Monitoring System Architecture

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VI. CONCLUTION

This paper reviewed recent advancements in ECG-based cardiac monitoring systems, emphasizing wearable sensors, signal processing, machine learning, and AIoT integration. ECG remains essential for detecting cardiac abnormalities, and modern techniques have improved real-time monitoring and automated analysis.

While traditional systems rely on clinical settings, wearable and IoT-based solutions enable continuous remote monitoring. Machine learning models further enhance accurate detection of abnormal patterns.

However, challenges such as computational complexity, limited real-time deployment, and integration with low-cost hardware still exist. Future work should focus on lightweight, scalable solutions. AIoT-based ECG systems offer strong potential for improving early detection and remote healthcare services.

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