IoT Based Low Cost ECG Machine And Heart Monitoring System Using Esp32 And Ubidots Platform

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Abstract-

This project introduces an Internet of Things(IoT) based low-cost Electrocardiogram (ECG) and heart monitoring system designed around the esp32 microcontroller and integrated with the platform like ubidots. With cardiovascular diseases being a leading cause of global morbidity and mortality, the need for accessible and affordable cardiac monitoring solutions is paramount. The proposed system addresses this need by employing low-cost ECG sensors, the ESP32 microcontroller, and the Ubidots cloud platform to create a realtime, remote monitoring system. The ESP32 serves as the core component for data acquisition, processing, and transmission, ensuring the seamless integration of ECG signals into the Ubidots cloud. The Ubidots platform, known for its user-friendly interface and secure cloud environment, enables healthcare professionals to remotely access and monitor patients' ECG data in real-time. Electrocardiography (ECG) is a crucial diagnostic tool for monitoring heart health, particularly in remote or resource-limited areas where access to healthcare infrastructure is limited. However, traditional ECG machines are often expensive and require specialized expertise for operation, posing challenges for widespread adoption in such settings. This project aims to address these limitations by developing a low-cost ECG machine tailored for remote healthcare monitoring. Our system leverages affordable off-the-shelf components and innovative design to create a portable, user-friendly device suitable for use in diverse environments.Key features of our ECG machine include:- Cost-effective hardware components, ensuring affordability without compromising on performance.User-friendly interface for easy operation by healthcare professionals and patients alike.Wireless connectivity options for real-time transmission of ECG data to healthcare providers.Integration with smartphone applications for data visualization and remote monitoring.Compact and portable design for flexibility in deployment and use in various healthcare settings.The development process involves hardware design, software development, and rigorous testing to ensure accuracy, reliability, and compliance with medical standards. Additionally, the project emphasizes scalability and sustainability, with a focus on minimizing power consumption and maximizing durability to withstand challenging environmental conditions.By providing an accessible and affordable solution for ECG monitoring, our low-cost ECG machine has the potential to revolutionize healthcare delivery in underserved communities, enabling early detection and intervention for cardiovascular conditions and improving patient outcomes..

KeyWords: Internet of Things(IoT), Electrocardiogram(ECG),ESP32 microcontroller, Ubidots cloud platform, Remote Monitoring, Affordable healthcare.

INTRODUCTION

We propose an innovative approach to enhance cardiac patient diagnosis by developing a compact and cost-effective 3-Lead ECG system. Unlike traditional setups, our system is portable, user-friendly, and ideal for remote areas. By integrating IoT, we establish effective telemedicine through real-time data upload to an online database. Our study achieves 3ECG outputs for comprehensive cardiac diagnosis, addressing the limitations of existing machines. Additionally, we introduce a signal quality- aware IoT-enabled ECG telemetry system for continuous cardiac monitoring. This system includes modules for signal sensing, automated quality assessment, and real-time analysis and transmission. Tested with MIT-BIH arrhythmia

data, our framework demonstrates superior performance in classifying ECG signal quality compared to existing methods, utilizing Arduino, Android, Bluetooth, and cloud servers. Recognizing the affordability gap in developing countries this prototype aims to provide accessible cardiac observations to the masses. We employ bioelectro-potential sensors to sense and amplify signals, overcoming the cost barriers associated with conventional ECG machines.Addressing challenges in Cardiovascular Disease diagnostics, we integrate machine learning, specifically a deep convolutional neural network, and wireless bio-sensing to create an ultraportable ECG module. Training our system on MIT-BIH and PTB databases, we achieve a promising accuracy of 84%, reducing errors caused by human factors and lack of patient history. Furthermore, our report introduces a real-time ECG classification prototype utilizing an ECG sensor and Raspberry Pi. By employing Discrete Wavelet Transform for feature extraction and a trained SVM algorithm, the system detects arrhythmia onset in real time, facilitating immediate medical intervention.Considering the surge in ECG monitoring systems, we propose a taxonomy for ECG monitoring systems, conducting a systematic literature review. Our study aims to assist researchers and healthcare professionals in selecting, comparing, and assessing systems thatmeet their requirements, providing evidence- based insights into components, features, and obstacles in diagnosing various health conditions.Finally, we present a comprehensive literature survey on ECG signal analysis, emphasizing traditional signal processing methods, machine learning, and deep learning. We introduce a stages-based model for ECG signal analysis, offering a structured overview of related work in this critical domain.Certainly! A low-cost ECG machine typically utilizes innovative engineering and design principles to reduce production costs without compromising on quality or accuracy. This often involves using simplified circuitry, cost effective materials, and efficient manufacturing processes. These machines are designed to be user-friendly, portable, and easy to operate, making them suitable for use in various healthcare settings, including clinics, community health centers, and even in-home monitoring situations. By making ECG technology more affordable, these machines help healthcare providers in both developed and developing countries to diagnose and manage cardiovascular conditions more effectively. Additionally, they can facilitate early detection of heart problems, leading to timely interventions and improved patient outcomes.

MOTIVATION

The motivation behind this project stems from the urgent need to address the significant burden of cardiovascular diseases worldwide, which continue to be a leading cause of morbidity and mortality. Recognizing the challenges posed by the high cost and limited accessibility of traditional ECG monitoring systems, especially in remote or resource-limited areas, our goal is to develop an Internet of Things (IoT) based low-cost Electrocardiogram (ECG) and heart monitoring system. By leveraging affordable off-the-shelf components, such as low-cost ECG sensors and the ESP32 microcontroller, and integrating with platforms like Ubidots for real-time data transmission, we aim to create a solution that is accessible, affordable, and user-friendly. Our system not only addresses the affordability gap but also emphasizes scalability, sustainability, and compliance with medical standards. Through the development of a portable, easy-to-use device with wireless connectivity options and integration with smartphone applications, we strive to revolutionize healthcare delivery by enabling early detection and intervention for cardiovascular conditions, particularly in underserved communities where access to healthcare infrastructure is limited. Ultimately, our motivation lies in improving patient outcomes and enhancing the overall quality of cardiac care on a global scale.

PROBLEM DEFINATION

The problem addressed by this project revolves around the limitations and challenges associated with traditional Electrocardiogram (ECG) monitoring systems, particularly in the context of remote or resource-limited areas where access to healthcare infrastructure is scarce. Cardiovascular diseases remain a leading cause of morbidity and mortality globally, yet the high cost and complexity of traditional ECG machines hinder their widespread adoption, especially in underserved communities. These machines often require specialized expertise for operation and are not easily portable, making remote monitoring and timely intervention difficult. Additionally, the lack of affordable solutions exacerbates the disparity in access to cardiac care. Therefore, the problem definition focuses on developing a low-cost, portable ECG monitoring system that leverages Internet of Things (IoT) technology to enable real-time data transmission and remote

monitoring, thus overcoming the barriers of cost, accessibility, and usability associated with traditional ECG machines.

OBJECTIVE

1. Develop an Internet of Things (IoT) based low-cost Electrocardiogram (ECG) and heart monitoring system.
2. Utilize affordable off-the-shelf components, including low-cost ECG sensors and the ESP32 microcontroller, to ensure affordability without compromising performance.
3. Integrate the ECG monitoring system with the Ubidots cloud platform for real-time data transmission and remote monitoring by healthcare professionals.
4. Design a user-friendly interface for easy operation by both healthcare professionals and patients, enhancing accessibility and usability.
5. Implement wireless connectivity options to enable real-time transmission of ECG data to healthcare providers, facilitating prompt intervention when necessary.
6. Enable integration with smartphone applications for data visualization and remote monitoring, enhancing flexibility and accessibility.
7. Develop a compact and portable design to ensure flexibility in deployment and use in various healthcare settings.
8. Ensure accuracy, reliability, and compliance with medical standards through rigorous testing and validation during the hardware design and software development phases.
9. Emphasize scalability and sustainability in the development process, with a focus on minimizing power consumption and maximizing durability to withstand challenging environmental conditions.
10. Revolutionize healthcare delivery in underserved communities by providing an accessible and affordable solution for ECG monitoring, enabling early detection and intervention for cardiovascular conditions and improving patient outcomes.

LITERATURE SURVEY

1. Varad Choudhari, Vaishnav Dandge, Natasha Choudhary (1):- A Portable and Low-cost 12-Lead ECG device for sustainable remote healthcare:- The diagnosis of cardiac patients is commonly done using Electrocardiogram (ECG). But in the frequently used 3 Lead ECG device, all the cardiac diseases are not covered in the diagnosis. This paper illustrates an approach towards developing a 12-Lead ECG system. The existing 12-Lead ECG systems are costlier and require a large setup size. Also, these machines are not that user-friendly to be operated in rural areas. The proposed system is compact which makes it portable and shows effective results in ambulatory systems.
2. Niyatha Malepati1, Rubia Fatima2, Swarnima Gupta3, Vaishnavi Ramsali4, Dr. Shobha K. R5:- Portable ECG Device for Remote Monitoring and Detection of Onset of Arrhythmia:- The classification of ECG at an early stage of abnormality is vital, since failure to do so increases the risk of a cardiac arrest in real time. The detection of anomalies in the ECG signal helps with the diagnosis of the patient's cardiac status. In this paper a prototype is proposed which obtains the patient's ECG data and classifies it into various classes of arrhythmia in real time. The prototype consists of ECG sensor and Raspberry Pi. The ECG sensor collects patient's data in real time and the collected data is processed on the Raspberry Pi using DWT for ECG feature extraction.
3. Md. Hafizul Islam Chowdhuryy, Dept. of EEE, Chittagong University, Chittagong, AI Assisted Portable ECG for Fast and Patient Specific Diagnosis :- Human errors, unavailability of patient history, lack of demographic data, lack of expert supervisors for time sensitive diagnosis etc. often lead to fatal errors in Cardiovascular Disease diagnostics (CVD). In our current work, we incorporated machine learning through deep convolutional neural network and wireless bio-sensing to make an ultraportable ECG (Electro Cardiogram) module that will help reduce these errors. We've verified our system and algorithm using MIT-BIH and PTB database of 40 patients with an accuracy of 84%. As we trained our system with more patients, our accuracy improved from 58% for 10 patients to 84% for 80 patients. The preliminary system showed 92.3% accuracy with 7.69% false positives. Our wireless sensor nodes utilized low power/ low bandwidth MQTT protocol to mimic a very low latency wired equivalent real-time system with ultra-portability.
4. Devendra R Sanghavi, 2 S V. Athawale An IoT based Low-Cost ECG Monitoring System for Remote Patient :- In this era Internet of Things (IoT) had been proven a lot more helpful and smart in various

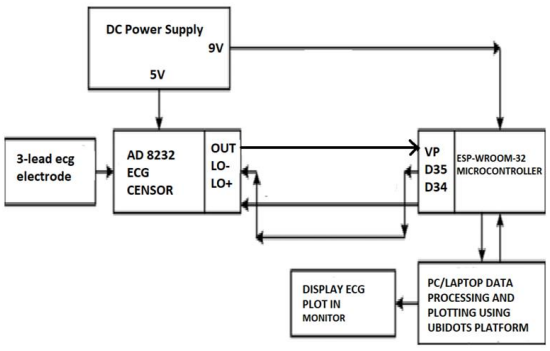
applications and still continues to be useful. The most promising application of IoT is in the field of health care sector. In some countries, people still do not have access to quality health facilities owing to different barriers. The physical distance between patient and clinic is one of the foremost reasons. This paper studies the application of IoT in health care domain and a system is proposed to monitor the ECG of the distant patient. This system comprises of Raspberry Pi, Arduino Uno, ECG Sensor and IoT Cloud for storing and plotting ECG data in real time..

PROJECT SCOPE

The scope of this project encompasses the development of an Internet of Things (IoT) based low-cost Electrocardiogram (ECG) and heart monitoring system tailored for remote healthcare monitoring. The project includes the design and integration of affordable off-the-shelf components, such as low-cost ECG sensors and the ESP32 microcontroller, along with the implementation of the Ubidots cloud platform for real-time data transmission and remote monitoring by healthcare professionals. The system will feature a user-friendly interface for easy operation by both healthcare professionals and patients, with wireless connectivity options enabling real-time transmission of ECG data to healthcare providers and integration with smartphone applications for data visualization and remote monitoring. A compact and portable design will ensure flexibility in deployment across various healthcare settings. Rigorous testing and validation will be conducted to ensure accuracy, reliability, and compliance with medical standards. Emphasis will be placed on scalability and sustainability, with efforts to minimize power consumption and maximize durability to withstand challenging environmental conditions. Ultimately, the project aims to revolutionize healthcare delivery in underserved communities by providing an accessible and affordable solution for ECG monitoring, facilitating early detection and intervention for cardiovascular conditions, and improving patient outcomes.

BLOCK DIAGRAM

Low-cost ECG machines typically work by measuring the electrical activity of the heart through electrodes attached to the body. These electrodes detect the tiny electrical signals generated by the heart's activity and transmit them to the machine with the help of ESP 32 Microcontroller. The machine then amplifies and processes these signals to produce an ECG waveform, which represents the heart's rhythm and Function.For a heart monitoring system, the ECG data collected from the machine can be transmitted wirelessly to a monitoring device such as a smartphone or a computer. This allows for real-time monitoring of the heart's activity, enabling early detection of abnormalities or irregularities. The monitoring system may also include software algorithms to analyze the ECG data and provide insights into the patient's cardiac health. Additionally, This systems Also offer features like remote monitoring and alerts for healthcare professionals or caregivers.

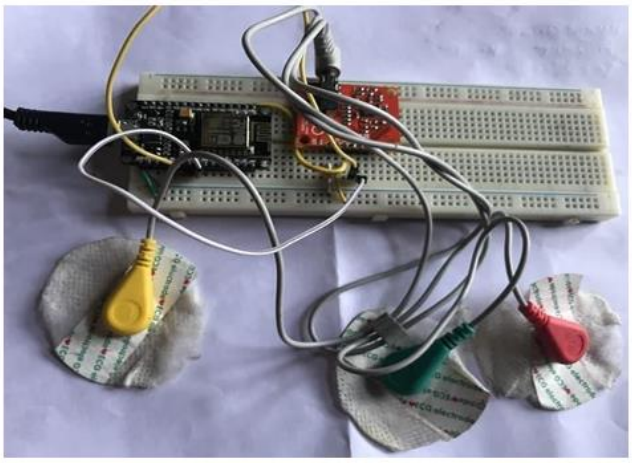


ADVANTAGES

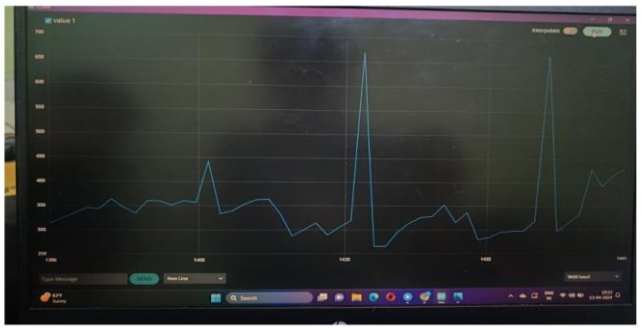
1. Accessibility: The low-cost nature of the ECG monitoring system makes it accessible to a wider population, including those in remote or resource-limited areas where traditional healthcare infrastructure is lacking.
2. Affordability: By utilizing affordable off-the-shelf components and innovative design principles, the system offers a cost-effective alternative to traditional ECG machines, reducing financial barriers to healthcare access.
3. User-friendly Interface: The system features a user-friendly interface that simplifies operation for both healthcare professionals and patients, enhancing usability and facilitating widespread adoption.

4. Real-time Monitoring: With wireless connectivity options and integration with smartphone applications, the system enables real-time transmission of ECG data to healthcare providers, allowing for prompt monitoring and intervention when necessary.
5. Portability: The compact and portable design of the system enhances flexibility in deployment across various healthcare settings, including clinics, community health centers, and even in-home monitoring situations.
6. Integration with Cloud Platform: Integration with the Ubidots cloud platform facilitates remote access and monitoring of patients' ECG data in real-time, enabling healthcare professionals to monitor multiple patients simultaneously and make informed decisions promptly.
7. Early Detection and Intervention: By providing continuous monitoring and real-time transmission of ECG data, the system facilitates early detection of cardiovascular conditions, allowing for timely interventions and improved patient outcomes.
8. Scalability and Sustainability: Emphasis on scalability and sustainability in the development process ensures that the system can be deployed and maintained in diverse healthcare environments while minimizing power consumption and maximizing durability.
9. Compliance with Medical Standards: Rigorous testing and validation ensure that the system meets medical standards for accuracy, reliability, and safety, providing healthcare professionals with reliable diagnostic information.
10. Potential for Revolutionizing Healthcare Delivery: The combination of accessibility, affordability, real-time monitoring, and user-friendly design has the potential to revolutionize healthcare delivery, particularly in underserved communities, by enabling early detection and intervention for cardiovascular conditions and improving overall patient outcomes.

HARDWARE CONNECTION



RESULT



CONCLUSION

The development of a low-cost ECG machine and heart monitoring system holds promise for improving access to cardiac care, especially in resource-constrained settings. By making these technologies more affordable and portable, more people can benefit from early detection and management of cardiac conditions, potentially saving lives and reducing healthcare costs in the long run.Certainly! A low-cost ECG machine typically refers to a device designed to perform electrocardiography, a vital diagnostic tool used to measure the electrical activity of the heart. Traditional ECG machines can be expensive and require specialized training to operate, limiting their availability, especially in low-resource settings or rural areas. However, advances in technology have led to the development of more affordable and portable ECG devices that offer reliable cardiac monitoring.These low-cost ECG machines often come in compact, handheld designs, making them suitable for use in various healthcare settings, including clinics, ambulances, and even home environments. They may incorporate wireless connectivity features, allowing healthcare providers to transmit ECG data remotely for interpretation or consultation with specialists. In addition to standalone ECG machines, there has been a growing interest in developing integrated heart monitoring systems that combine ECG monitoring with other health metrics, such as heart rate variability, blood pressure, and activity levels. These systems provide a comprehensive view of cardiovascular health and enable continuous monitoring, which is particularly valuable for patients with chronic conditions or those at risk of cardiac events.Overall, the development of low-cost ECG machines and heart monitoring systems represents a significant advancement in healthcare technology, with the potential to democratize access to cardiac care, improve early detection of heart

conditions, and empower individuals to take proactive steps towards managing their cardiovascular health..

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