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Real Time Smart System for ECG Monitoring Embedded System

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Abstract

An IoT-based real-time smart embedded system for ongoing ECG monitoring is presented in this research. Real-time body temperature and cardiac electrical activity monitoring are features of the system. It is made up of an Arduino Uno microcontroller to analyse the data gathered, a body temperature sensor to track body temperature, and an ECG sensor to record heartbeats. The severity level of the patient's condition is shown via a visual risk indication system that uses red, yellow, and green LEDs; red indicates a serious condition, yellow indicates a low risk, and green indicates no danger. For real-time monitoring, the processed data is sent to a smartphone or display. This technology ensures prompt intervention, improves patient safety, and boosts healthcare efficiency by providing timely alerts for irregularities.

Keywords: IoT-based health monitoring system, Remote patient monitoring, ECG Module, Arduino

INTRODUCTION

Global healthcare systems have faced unprecedented problems as a result of the COVID-19 pandemic, especially in managing the patient intake and minimizing the likelihood of virus transmission. Hospitals and medical facilities have been inundated by the growing need for resources, resulting in considerable pressure on medical personnel and infrastructure. This context has led to recommendations suggesting that individuals exhibiting mild COVID-19 symptoms should isolate at home instead of seeking hospital treatment. The implementation of remote patient monitoring has surfaced as a vital solution to these issues. Health monitoring systems utilizing Internet of Things (IoT) technology present an innovative method for managing patient care while lessening the strain on healthcare facilities. From the comfort of patients' homes, these devices enable continuous, real-time monitoring of vital indicators such as oxygen saturation, heart rate, and respiration rate. By delivering up-to-date health information to healthcare providers, remote monitoring solutions enhance the efficacy of patient care management. They permit early identification of health decline, which facilitates prompt medical interventions and decreases the frequency of hospital visits. Furthermore, by reducing the necessity for physical interactions between patients and healthcare professionals, these systems aid in lowering the risk of virus transmission, fostering a more secure healthcare setting. In light of the COVID-19 pandemic, this study investigates the role of Internet of Things-driven remote health monitoring systems. We will examine the technological aspects of these systems, how they affect the provision of healthcare, and any potential benefits they might offer for pandemic management.

RELATED WORK

Mehmet Taştan, 2020 ,This study offers a wearable Internet of Things (IoT)-based smart health monitoring device designed specifically for those with cardiovascular diseases. Wearable sensors are used by the system to measure vital factors such as body temperature (BT), heart rate (HR), and heart rate variability (HRV). The gathered information is monitored remotely via an Android application, allowing continuous tracking without the necessity for frequent visits to healthcare facilities. By utilizing IoT technology, the system improves patient safety, reduces healthcare expenses, and ensures timely medical responses [1].

Md. Milon Islam, Ashikur Rahaman, Md. Rashedul Islam, 2019 The article introduces a healthcare monitoring system that leverages IoT to observe patients' vital signs, such as heartbeat and body temperature, alongside environmental measurements like CO and CO2 concentrations. The system functions in real-time and promotes telemedicine by enabling remote monitoring in hospitals and healthcare centers. This innovation leads to more effective and accessible healthcare, lessening reliance on conventional face-to-face consultations [2].

Priyadharshini, B. Shunmugapriya, B. Paramasivan, J. Naskath, S. Preethi, R. Nivetha, and B. Shunmugapriya, 2020 An Internet of Things-enabled health monitoring system designed for the elderly and disabled is presented in this study. The device uses wearable sensors to track body temperature and heart rate, among other critical indications. It offers choices for remote monitoring, decreasing the frequency of hospital visits and reducing healthcare expenses. The system allows for timely medical interventions, enhancing the quality of life for those facing mobility or accessibility challenges [3].

Md. Rashedul Islam, AshikurRahaman, Md. Milon Islam, 2019 This paper showcases a smart healthcare monitoring system within an IoT framework, addressing the demand for portable healthcare solutions. The system captures essential health metrics, including heart rate and body temperature, while also assessing room conditions through sensors for CO, CO2, and temperature. Real-time data collection facilitates telemedicine applications, transitioning routine health evaluations from hospitals to home environments, thus alleviating healthcare burdens and improving patient convenience [4].

Rayan Elkhatib, Ahlam Salih, Mohamed Fadl, 2020 The study presents an interactive dashboard for tracking COVID-19 in Sudan, tackling the issues posed by conventional paper-based reporting. Developed using Tableau, the dashboard illustrates data trends and patterns for COVID-19 cases from March to September 2020. This tool equips health authorities and the public with a clear and comprehensive overview of the outbreak, supporting informed decision-making and efficient resource allocation [5].

EXISTING SYSTEM

The existing Arduino-based system for monitoring the health of Covid-19 patients has several limitations, including inadequate connectivity due to the absence of integrated Wi-Fi or Bluetooth modules, as well as restricted processing and memory capabilities that hinder the management and storage of real-time data. Scalability poses a challenge, as traditional configurations struggle to monitor multiple patients simultaneously. Additionally, integrating data into current electronic health record (EHR) systems presents difficulties, and ensuring patient privacy and security with robust protective

measures is complex. Other concerns include maintaining the accuracy of sensors amid environmental variability and creating a user-friendly interface.

Disadvantages

Monitoring and transmitting data in real-time can pose difficulties because of processing constraints and possible latency problems, which can impact the system's responsiveness. Furthermore, these configurations lack scalability, making it challenging to observe numerous patients at once in larger healthcare environments.

REQUIREMENT ANALYSIS

Evaluation of the Rationale and Feasibility of the Proposed System

To reduce the risk of infection and improve patient care management, the objective is to develop an Internet of Things (IoT)-based health monitoring system that enables healthcare professionals to remotely monitor the vital signs of Covid-19 patients, including blood saturation, heart rate, pulse rate, and body temperature. The proposed IoT health monitoring solution is designed to facilitate continuous and accurate remote monitoring of Covid-19 patients' vital signsit makes use of a MAX3100 biosensor module to track blood saturation and heart rate, and a DS18B20 sensor to assess body temperature. A humidity sensor is also used to measure the humidity and room temperature. The system is powered by an ESP8266Arduino microcontroller, which handles the encoding and decoding of all incoming data before execution. Sensors are placed on the patients' fingers, and the collected data is transmitted to a smartphone for real-time visualization and remote monitoring by healthcare workers. This innovation allows healthcare professionals to oversee multiple patients concurrently, ensuring quick reactions and reducing the risk of infection through fewer physical interactions.

PROPOSED SYSTEM

The proposed Internet of Things (IoT)-based health monitoring system is intended to provide remote vital sign tracking for COVID-19 patients, guaranteeing accurate and ongoing health monitoring. It features a DS18B20 sensor for measuring body temperature and a MAX3100 biosensor module for monitoring heart rate and blood oxygen saturation. A humidity sensor is also included to gauge the room's temperature and humidity levels. The core of the system is an ESP8266Arduino microcontroller, which processes and manages all incoming data prior to execution. The sensors are affixed to the patients' fingers, and the collected data is transmitted to a smartphone for real-time visualization and oversight by medical personnel. This technology allows healthcare providers to monitor multiple patients simultaneously, ensuring prompt interventions and minimizing the risk of infection by reducing the need for physical contact.

Advantages:

The suggested health monitoring system utilizing IoT technology provides notable benefits, such as enabling remote observation, which allows healthcare providers to monitor numerous patients at once without the need for in-person contact, thereby minimizing the risk of infection.

SELECTED METHODODLOGIES

To gather vital health data for effective patient monitoring, the proposed system integrates a number of sensors, including the DHT11 for recording room temperature and humidity, the DS18B20 for tracking body temperature, and the MAX30100 biosensor for measuring blood saturation and heart rate. The ESP32 Arduino is at the heart of this system; it processes sensor data and controls encoding and decoding to ensure accurate transmission.

With its web server functionality, the ESP32 utilizes the HTTP protocol to send live data to a web interface, allowing healthcare professionals to view patient information remotely on smartphones or computers. This capability for remote monitoring enables medical personnel to oversee multiple patients at once, reducing the need for physical contact and lowering the risk of infections, all while presenting data in a clear and user-friendly format.

SYSTEM ARCHITECTURE

The ESP8266Arduino microcontroller is at the centre of the design of the suggested Internet of Things-based health monitoring system, as seen in Figure 1, which acts as the central processing and communication unit. The system incorporates various sensors, such as the DS18B20 for measuring body temperature, the MAX3100 biosensor for tracking heart rate and oxygen levels, as well as a humidity sensor for monitoring environmental conditions.

The microcontroller encodes and processes the data gathered by the sensors before wirelessly sending it to a paired smartphone. A user-friendly application on the smartphone provides real-time health metrics for remote observation by healthcare professionals.

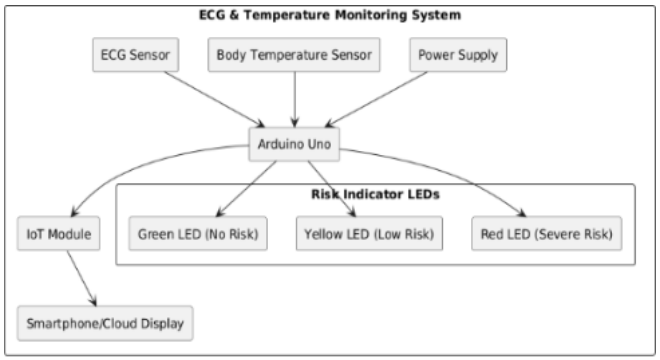


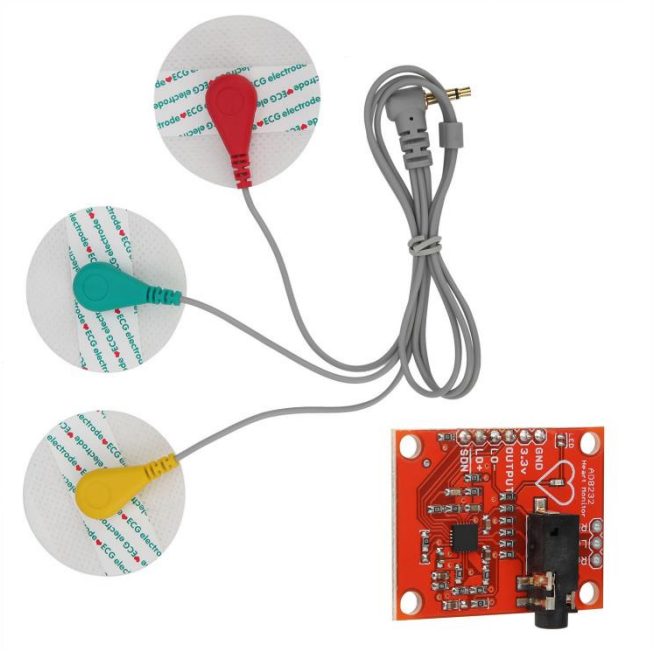
Fig 1: System Architecture

SYSTEM MODULES

ECG Sensor:

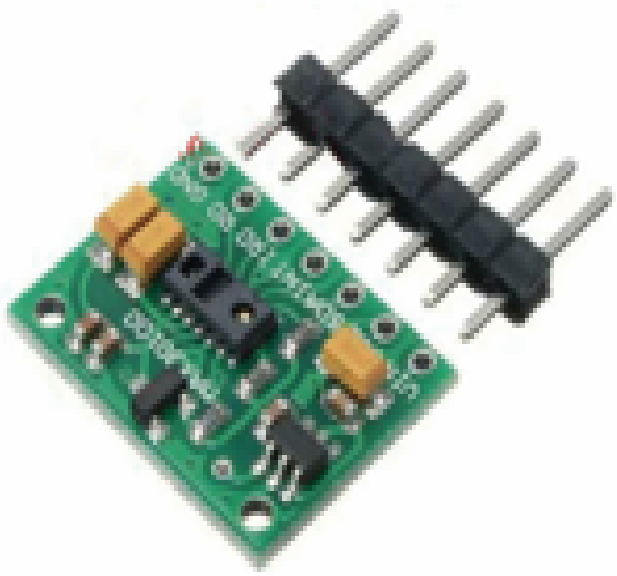
Cardiologists frequently use an electrocardiogram (ECG) sensor to swiftly and non-invasively check for irregular heart rhythms and possible heart disease symptoms.An ECG can assist in identifying: Arrhythmias are conditions in which the heart beats abnormally fast, too slowly, or irregularly. Coronary heart disease, in which an accumulation of fatty materials blocks or disrupts the heart's blood flow. Heart attacks occur when the heart's blood supply is abruptly cut off.Certain locations on the arms, legs, and chest are equipped with electrodes, which are tiny, skin-sticking plastic patches. Lead wires are used to

connect the electrodes to an ECG equipment. After that, the heart's electrical activity is measured, deciphered, and printed. The body does not get any electrical energy.



MAX30100 Biosensor Module:

The MAX30100 module tracks blood oxygen saturation (SpO2) and heart rate by employing red and infrared LEDs along with a photodetector. The LEDs project light through the skin, and the photodetector detects the reflected light, which changes according to variations in blood volume. This information is analyzed to determine the levels of oxygen and heart rate.

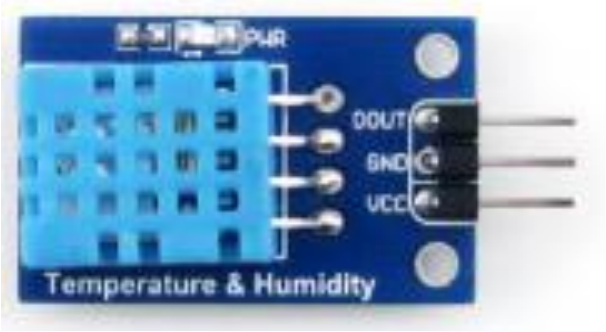


DS18B20 Temperature Sensor:

The DS18B20 sensor accurately measures body temperature and utilizes a 1-Wire interface. It delivers digital temperature readings, functions effectively across a broad range (-55°C to +125°C), and relays data directly to the ESP8266 microcontroller.

DHT11 Temperature and Humidity Sensor:

The DHT11 sensor provides digital output after measuring temperature and humidity. It functions between 0 and 50°C in temperature and between 20 and 90% in humidity. In order to monitor the surrounding environment, it transmits data to the ESP8266.



Arduino UNO:

One of Arduino's standard boards is the Arduino UNO. 'One' is what UNO means in Italian. The Arduino software's initial release was dubbed UNO. Additionally, it was Arduino's first USB board. It is regarded as a strong board that is utilized in many different tasks. The Arduino UNO board was created by Arduino.cc. The ATmega328P microprocessor serves as the foundation for the Arduino UNO. In contrast to other boards, like the Arduino Mega board, etc., it is simple to use. Shields, additional circuits, and digital and analog input/output (I/O) pins make up the board.

Web Server:

The web server serves as the host for the user interface, enabling remote access to health information. It utilizes HTTP for data transmission to a smartphone or PC interface, allowing healthcare providers to observe patient vital signs in real-time.

LED:

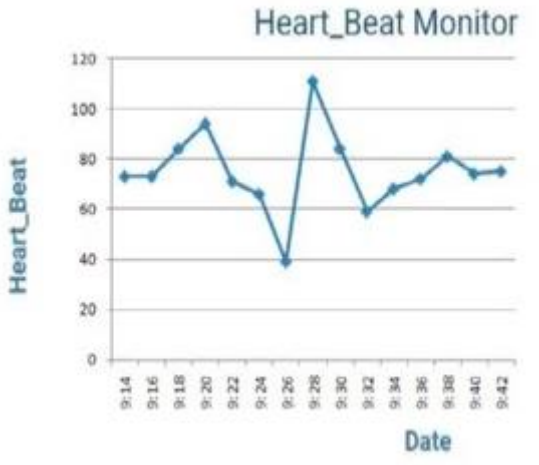
A semiconductor device known as a light-emitting diode (LED) releases light when electricity flows through it. This is caused by a process known as electroluminescence, in which electrons and electron holes in the semiconductor recombine to release energy in the form of photons. The energy band gap of the semiconductor material determines the color of the light that is emitted; white light can be produced by combining semiconductors or by applying a phosphor coating. Since their introduction in 1962, LEDs—which emit low-intensity infrared light—have been utilized in devices such as indication lamps and remote controls. LEDs have become widely used in lights, displays, and sensors as a result of their gradual evolution to emit visible, ultraviolet, and infrared light at different brightness levels. Although they are constrained by their low voltage requirements and temperature sensitivity, their benefits include energy efficiency, extended life, compact size, and fast switching. Although Oleg Losev invented the first LED in 1927, commercial LEDs came into being following major breakthroughs in the 1960s, with the creation of blue LEDs in the 1990s garnering a Nobel Prize.

RESULT & DISCUSSION

The significance of the research is examined in this analysis section, particularly in light of the COVID-19 epidemic, which has placed an unprecedented strain on healthcare systems globally. Hospitals are severely overcrowded as a result of the pandemic because of the influx of virus-infected patients. In addition to overburdening healthcare facilities, this circumstance has made it extremely difficult to provide other patients with varying medical needs with the proper care. The demand for creative solutions that might assist hospitals in better managing their patient load has been brought to light by the strain on resources, including medical personnel, equipment, and space. The implementation of the proposed Internet of Things-based healthcare and health monitoring system is one possible solution to these problems. By using IoT technology, the solution can significantly reduce the strain for medical staff, allowing them to focus on other crucial responsibilities.

GRAPH

Graph of Heart beat monitor a



Graph of Heart beat monitor b

CONCLUSION

An excellent option for ongoing health monitoring is offered by the real-time smart ECG monitoring embedded system, which efficiently measures body temperature and heart activity. The system uses the Arduino Uno, body temperature sensor, and ECG sensor to evaluate data in real-time and classify patient situations into three risk levels, which are represented by red, yellow, and green LEDs. By ensuring prompt alarms and early intervention, this straightforward visual indicator system enhances patient safety and lessens the need for ongoing human monitoring. The system is a viable choice for both clinical and home-based healthcare settings due to its affordability and user-friendliness. To further

improve its capabilities and dependability, future developments might incorporate cloud integration, mobile alerts, and sophisticated data analytics.

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