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IoT BASED PATIENT HEALTH MONITORING SYSTEM

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Abstract : This abstract summarizes an IoT-based patient health monitoring system designed to provide continuous remote care for immobile patients. The system utilizes sensors to gather real-time data on health indicators and environmental conditions, which is stored in the cloud. Medical staff can access the data through an online portal, enabling analysis of patients' conditions. The system aims to optimize remote medical care by continuously monitoring patients' health, using SMS notifications to alert doctors or family members in critical situations. The project contributes to the field by analyzing performance metrics and optimizing the system for improved patient care. Overall, the system holds promise for revolutionizing healthcare practices and enhancing patient outcomes.

Keywords : Health monitoring, raspberry pi, ECG, IoT, Sensors, ThingSpeak, Thonny Software, Telegram.

INTRODUCTION

These days, healthcare technology is gradually making its way into our everyday lives, gradually replacing outmoded tools and procedures with more modern, innovative alternatives. It is possible for people, particularly older people, to surprise you with their reactions and readiness to adopt novel technologies, even though these innovations are designed to assist individuals. The experience of falling is one of the main factors that might substantially affect an older person's physical and emotional health. The ailments that may be brought on by falls include heart attacks, bone fractures, and general connective tissue diseases. Patients must be watched nonstop, twenty-four hours a day, which is challenging to achieve in healthcare facilities and much more challenging at home. This system tries to alleviate this issue by continuously monitoring several fundamental factors determining a patient's health status

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This project focuses on developing an intelligent Internet of Things (IoT) healthcare system for remote patient care. The motivation behind this endeavor stems from the recognition that healthcare technology has the potential to significantly improve the lives of individuals, including older adults who may initially be hesitant to embrace new technologies. Falls, a leading cause of physical and emotional health issues among older individuals, necessitate constant monitoring to prevent complications such as heart attacks, fractures, and connective tissue diseases. However, providing round-the-clock supervision in healthcare facilities and homes can be challenging.

To address these challenges, this project proposes an innovative healthcare monitoring system that continuously tracks essential health indicators and environmental conditions of patients. Through the deployment of sensors, including an electrocardiogram (ECG) sensor and a body temperature sensor, real-time data is collected from patients. The gathered information is then made available to medical staff through an online portal, allowing them to analyze and understand the patients' current condition. The efficiency of the system has been demonstrated through successful prototype development, particularly in the context of infectious disease treatment. This system has the potential to significantly improve existing healthcare practices, thereby saving more lives.

The primary objective of this project is to lay the groundwork for remote medical care by designing and implementing an intelligent IoT-based healthcare monitoring system. The specific objectives include the establishment of continuous health monitoring for immobile patients in ICU or home settings, utilizing a digital thermometer and ECG sensor to monitor temperature and heart activity in real time. By consistently updating patient data in the cloud, healthcare providers, caregivers, and family members can conveniently monitor the patient's health status and promptly intervene when necessary. The system incorporates SMS notifications, triggered when ECG signals or temperature readings exceed or fall below predetermined thresholds, ensuring effective communication with doctors or family members.

Furthermore, this project contributes to the field by conducting a thorough analysis of performance metrics, including parameters such as accuracy, reliability, real-time data retrieval speed, and the system's responsiveness to critical thresholds. The findings from this analysis will inform the optimization of the healthcare monitoring system, resulting in improved patient care and reduced mortality rates.

In conclusion, this project aims to develop an intelligent IoT-based healthcare monitoring system that addresses the challenges of remote patient care. By leveraging real-time data analysis, continuous cloud-based monitoring, and proactive alert mechanisms, this system has the potential to revolutionize healthcare practices, ultimately improving patient outcomes and saving lives.

LITERATURE SURVEY

Cristina et.al.[1] proposed an IoT as a worldwide network architecture connecting real and virtual items. The internet and network advances used in this architecture are current and developing. We provide unique item recognition, sensing, and connectivity capabilities. As a result, sensors will be noted for their extensive data collection. This research uses the Internet of Things and radio frequency identification to show how people may access healthcare service.

Hemalatha and Pavani [2] implemented a portable physiological monitoring instrument that, with an electrocardiogram, can keep track of the patient's heart rate in real-time (ECG). It's possible to use interchangeable electrodes to fasten a chest-mounted ECG sensor. The system detects and records signals created during muscle contraction. An electrical signal is created using the signals gathered from the body. This essay demonstrates how an intelligent healthcare system is used. Through early diagnosis of aberrant diseases, this innovative technology may provide patients with various advantages.

Vivek Pardeshi et al [3] the author describes the health monitoring system using raspberry pi. Any deviation from the patient's normal state of health may be discovered and communicated to the patient's relative. The instrumentation Amplifier, which is in charge of absorbing voltage discrepancies, is a fundamental part of the ECG. The approach shown is practical and straightforward to comprehend. It is a conduit between the patient and the physician.

Ashlesha [4] discussed an intelligent healthcare system based on the Internet of Things. The author provides an overview of the infrastructure required for IoT and intelligent healthcare monitoring. The improved quality and security concepts are reduced. Electrodes are positioned on the chest to collect ECG signals. ECG sensor is connected to subsequent wires (AD8232). The sensor records the electrical activity of the heart. This system offers issues and issues that could be resolved in the future. IoT apps could be improved using fresh strategies and technology. The Internet of Things uses sensors including blood pressure, temperature, heart rate, and ECG, along with the Raspberry Pi package and Wi-Fi module.

Esrat Jahan et al [5] presented an overview of heart rate monitoring and pulse oximeter sensor. The patient's heart rate is measured using sensors attached to the patient's fingertips in this study, and the results are afterward shown on an LCD. Unqualified users may use the system as it is intended. A graph on a graphical LCD may show the change in heart rate. The technology that was built can show the highest and lowest heart rates throughout time. Abnormalities are signaled by a buzzer and shown on an LCD. The output should be hooked to convey the heart rate to the computer.

Buruncuk *[6] implemented an idea on* IoT has many different applications. Wireless sensor networks have been created for IoT. (WSN). Designs for health monitoring are given using IOT. Several issues are connected to IOT and health monitoring. Modern technologies reduce improved quality and security concepts. New methods and techniques are applied. In the Internet of Things, sensors for temperature, pulse oximetry, blood pressure, and heart rate are employed.

Ibrahim et al [7] introduced the "Heart rate Monitoring System." In this research, a unique method for identifying each component of an IOT healthcare system is presented. An IOT-based healthcare monitor may be employed using a broad model described. It is impossible to stress the importance of having a recognized end-to-end system for remote health monitoring. In this case, the sensors that track the patient's vitals take center stage. The contribution is made by focusing on Low Power Wide Area Networks (LPWANs), emphasizing its particular applicability for using Internet of Things (IoT) devices.

Rakshith et al. [8] suggested an intelligent healthcare system that consists of a server, the internet, and smart identification tags. Based on the patient's medical report, which the doctor diagnoses through WLAN, the smart identification tag provides information about the patient's physiological circumstances. This article aims to monitor the patient often. The innovative technology being provided here might benefit patients in several different ways. The author has shown a mobile physiological monitoring system that can track a patient's body parameters while being treated at a hospital. Intelligent systems can sense and manage their environment and make choices based on the available data.

Lahamge et al [9] This paper described the health monitoring system is used to detect numerous bodily indicators. Later, this information is made accessible online to clinicians. The warnings will be created automatically and delivered to the doctor in an emergency while the patient is unaware. Here, it is possible to utilize health parameter data right away. People focus on illness prevention and early detection. The author has looked at an Arduino-based health monitoring device. Through sensors connected to the internet, a person with a disability may be identified and informed.

Sowmya et al [10] explained how an Arduino board and a distributed ubiquitous environment may be used to create a "Remote Health Care Monitoring System." The IoT-based Smart Healthcare System is the author's main emphasis here. The transmission of the patient's health indicators is the main objective of this system. A practical approach for monitoring a patient's temperature and pulse rate is suggested in this study. The technology employs a pulse sensor to monitor the patient's heart rate. We can access the different bodily characteristics by using sensors. These inputs are sent to the computer for usage by loved ones and medical professionals. IoT technology has greatly benefited patients in the current healthcare system.

METHODOLOGY

The proposed IoT-based health monitoring system follows a methodology consisting of several key steps. Firstly, there is a recognition of the need for a remote health monitoring system, specifically targeting older individuals who require continuous monitoring due to their vulnerability to falls and associated health risks. Falls can lead to serious medical conditions such as heart attacks, fractures, and connective tissue diseases. Monitoring patients continuously is challenging, both in healthcare facilities and at home**.**

The primary objective of the system is to establish a foundation for remote medical care. This involves the development of an intelligent IoT healthcare system that monitors a patient's health indicators and the conditions within their confined space. Real-time data is collected from sensors integrated into the system, including an ECG sensor and a body temperature sensor, which provide essential inputs for monitoring the patient's health status. To enable medical staff to access and analyse the collected data, an online portal is developed. This portal allows for real-time monitoring of patients and provides valuable insights into their current health condition. The efficiency and performance of the prototype system are evaluated, with a focus on its suitability for healthcare monitoring, particularly in infectious disease treatment scenarios. The system aims to demonstrate its potential to enhance the current healthcare system and save lives. Expanding the system's functionality, control parameters are implemented to monitor and control additional aspects such as onion storage slots to prevent spoilage. This is achieved using the Node MCU and Cayenne software platform, enabling spoilage detection and notification to the user through SMS or email.

The collected data, including body temperature, ECG, heart rate, and other vital parameters, undergoes thorough processing and analysis. Appropriate algorithms are applied to process the data, and the results are presented in a visual format that can be interpreted by medical professionals or remote specialists. The system emphasizes preventive measures based on the collected data. Timely intervention is facilitated by alerting medical staff or caregivers when abnormal readings or conditions are detected. This proactive approach aims to address health issues before they escalate. To ensure the system's accuracy, reliability, and usability, thorough testing and validation are conducted. The system is tested under different scenarios to assess its performance and identify any potential issues or areas for improvement.

Overall, by following this methodology, the proposed IoT-based health monitoring system aims to provide continuous monitoring, efficient data analysis, and timely intervention to enhance patient care, particularly for older individuals. The integration of sensors, online portals, control parameters, and preventive measures offers a comprehensive approach to remote medical care.

PARAMETERS AND SIGNIFICANCE OF THE PROJECT

- Data Security: Ensuring the security and privacy of patient data is of paramount importance in any healthcare-related system. In this project, measures were taken to protect sensitive patient information. The data stored in the website database and IoT cloud was encrypted to prevent unauthorized access. Access controls and authentication mechanisms were implemented to restrict data access to authorized personnel only.

- Scalability and Flexibility: The patient monitoring system was designed to be scalable and adaptable to different healthcare settings. The modular architecture of the system allowed for easy expansion and integration of additional sensors or devices as needed. This flexibility enables healthcare providers to tailor the system according to specific patient requirements and healthcare environments.

- Real-Time Monitoring and Alerts: One of the key features of the patient monitoring system was its ability to provide real-time monitoring and alerts. By continuously collecting and analyzing data from the ECG sensor and temperature sensor, the system could promptly detect any abnormalities or critical situations. Immediate alerts via SMS notifications to the concerned individuals or healthcare professionals ensured timely interventions and improved patient care.

- Remote Monitoring: The use of IoT technologies and cloud-based storage enabled remote monitoring capabilities. Authorized healthcare providers could access the patient's monitoring data from anywhere using a secure login. This remote monitoring feature proved particularly beneficial for patients who were bedridden at home or those in remote healthcare facilities. It allowed healthcare professionals to monitor multiple patients simultaneously and provide timely support and interventions.

- Cost-Effectiveness: A significant focus of the project was to develop a patient monitoring system that offered a cost-effective alternative to existing healthcare monitoring solutions. By leveraging affordable hardware components, open-source software tools like Thonny, and utilizing cloud-based storage, the overall cost of the system was significantly reduced. This cost-effectiveness makes the system more accessible and affordable, especially in resource-constrained healthcare settings.

- User-Friendly Interface: The user interface of the patient monitoring system was designed with simplicity and ease of use in mind. The graphical representation of data on the website and cloud platform provided a user-friendly experience for healthcare professionals to interpret and analyze patient trends. The system's intuitive interface minimized the learning curve and enabled efficient utilization of the monitoring system.

- Potential for Future Enhancements: The project opens up possibilities for future enhancements and advancements in patient monitoring. As technology progresses, the system can be further improved by integrating additional sensors, implementing machine learning algorithms for predictive analysis, or integrating with electronic health record (EHR) systems for seamless data integration and analysis.

PROPOSE METHOD

- Accuracy of ECG Signal: Assess the accuracy of the ECG signal obtained from the single-lead cardiac monitor. This can be done by comparing the ECG waveforms captured by the system with standard ECG waveforms. Calculate metrics such as sensitivity, specificity, and positive predictive value to evaluate the system's ability to accurately detect and represent the patient's cardiac activity.
- Heart Rate Measurement Accuracy: Evaluate the accuracy of the heart rate measurements derived from the ECG signal. Compare the system's heart rate calculations with reference measurements from other reliable sources or medical devices. Calculate metrics such as mean absolute error or percentage error to quantify the level of accuracy.
- Temperature Measurement Accuracy: Assess the accuracy of the temperature measurements obtained from the digital temperature sensor. Compare the system's temperature readings with reference measurements from a calibrated thermometer. Calculate metrics such as mean error or mean absolute deviation to evaluate the accuracy of the temperature monitoring component.
- Response Time: Measure the system's response time, which refers to the time it takes for the system to detect a change in the patient's vital signs and generate an appropriate notification or alert. This can be done by simulating various scenarios where vital signs change abruptly and measuring the time taken for the system to respond.
- Reliability and Availability: Evaluate the system's reliability and availability by monitoring its uptime and tracking any system failures or downtime incidents. Measure metrics such as mean time between failures (MTBF) and mean time to repair (MTTR) to assess the system's reliability and downtime resolution efficiency.
- Data Storage and Retrieval: Analyze the performance of data storage and retrieval processes in the website database and IoT cloud. Measure metrics such as data transfer rate, storage capacity utilization, and response time for data retrieval queries.
- Cost-effectiveness: Compare the overall cost of implementing and maintaining the proposed system with existing patient monitoring systems. Consider factors such as the cost of hardware components, software development, data storage, and communication infrastructure. Evaluate the cost-effectiveness of the proposed system by considering the benefits it offers in terms of functionality and reduced expenses compared to alternative solutions.

BLOCK DIAGRAM

In the block diagram, the Raspberry Pi Pico acts as the main controller for the system. It is responsible for collecting data from the ECG sensor and the temperature sensor. The ECG sensor measures the electrical activity of the heart, while the temperature sensor measures the patient's body temperature.

The ECG sensor and the temperature sensor are connected to the Raspberry Pi Pico. These sensors capture the respective signals and send them to the Raspberry Pi Pico for processing and analysis. The system also includes a buzzer that is connected to the Raspberry Pi Pico. The buzzer serves as an alert mechanism to notify the patient or the patient's nearest person in case the sensor values exceed the threshold level set by the user. When the threshold is exceeded, the Raspberry Pi Pico triggers the buzzer to generate an audible alarm.

Additionally, the system incorporates a cloud platform for data storage and remote access. The Raspberry Pi Pico is connected to the cloud platform, allowing the recorded sensor values to be uploaded and stored securely. The cloud platform provides a user-friendly interface for viewing and monitoring the sensor data from anywhere.

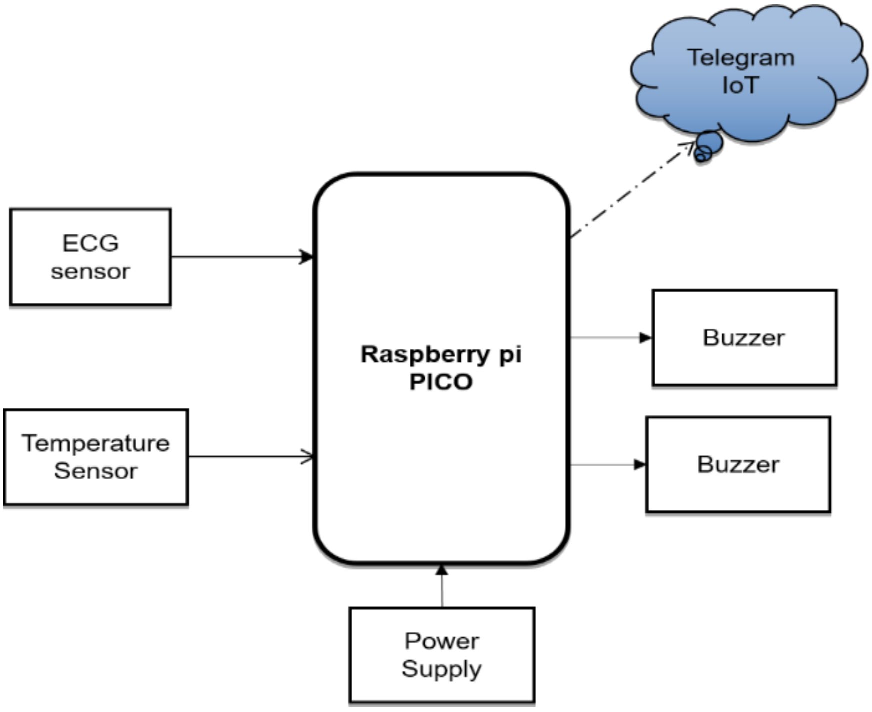

Fig.1. Block Diagram of the proposed System

By integrating the ECG sensor, temperature sensor, buzzer, and cloud platform, the proposed system enables continuous monitoring of the patient's ECG and temperature values. It provides real-time notifications and remote access to the sensor data, facilitating prompt action and ensuring effective patient care.

CIRCUIT DIAGRAM

- Single-Lead Cardiac Monitor:
  - Attach three electrodes to the patient's right arm, left arm, and right leg.
  - Connect the electrodes to the input terminals of the cardiac monitor.

- Temperature Sensor:
  - Connect the digital temperature sensor to the appropriate pins of the Raspberry Pi.
  - Ensure the sensor is properly calibrated and positioned to measure the patient's axillary temperature accurately.

- Amplification and Filtering:
  - Connect the output of the cardiac monitor and temperature sensor to appropriate amplification and filtering circuits.
  - These circuits will amplify and condition the electrical signals to ensure accurate measurement and reliable data transmission.
  - The output of the amplification and filtering circuits should be connected to the input pins of the Raspberry pi.

- Grounding and Safety:
  - Properly ground all components of the circuit to prevent electrical interference and ensure patient safety.
  - Connect the ground terminals of the cardiac monitor, temperature sensor, Raspberry Pi, and Raspberry Pi to a common ground point.

- Raspberry Pi:
  - Connect the output pins of the Raspberry Pi to the appropriate input pins of the Raspberry Pi. Program the Raspberry Pi to receive the ECG and temperature data.
  - Use the data to create real-time graphs of the ECG signals.
  - Calculate the heart rate based on the ECG data and display it on the screen. Store the ECG and temperature data in the website database and IoT cloud for long-term storage and analysis.

- ECG Sensor Connections:
  - Connect the ECG sensor's output to an analog input pin.
  - Connect the ECG sensor's ground (GND) pin.

- Connect the ECG sensor's power supply pin to the boards 5V pin.

➢ LCD Connections:
- Connect the LCD's VCC pin to the Raspberry Pi's 5V pin.
- Connect the LCD's GND pin to the Raspberry Pi's ground pin.
- Connect the LCD's SDA pin to the Raspberry Pi's SDA pin (for I2C communication).
- Connect the LCD's SCL pin to the Raspberry Pi's SCL pin (for I2C communication).

➢ Buzzer Connections:
- Connect the buzzer's positive terminal to a digital output pin of the Raspberry Pi.
- Connect the buzzer's negative terminal to the Raspberry Pi's ground pin

➢ Pulse Sensor Connections:
- Connect the pulse sensor's output to an analog input pin of the Raspberry Pi.
- Connect the pulse sensor's power supply pin to the Raspberry Pi's 5V pin.
- Connect the pulse sensor's ground (GND) pin to the Raspberry Pi's ground pin.

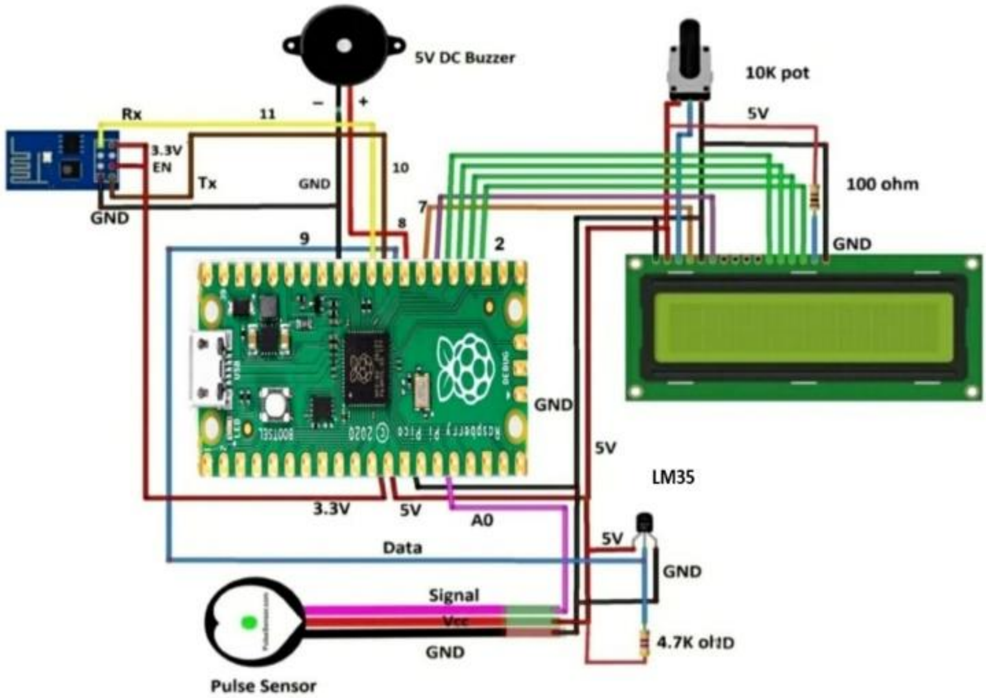

Fig. 2. Circuit Diagram

The circuit designed to ensure the accuracy and safety of the patient monitoring system. The electrical signals from the cardiac monitor and temperature sensor need to be properly amplified and filtered before being sent to the Raspberry Pi and Raspberry Pi. Additionally, the circuit would need to be properly grounded to prevent electrical interference and ensure patient safety. The Raspberry Pi would be programmed to create the ECG graph, calculate the heart rate, and store the data in the website database and IoT cloud. The SMS notification system would be set up to send alerts if the patient's body temperature reaches a dangerous level. The display screen would show real-time monitoring data and trends over time, allowing healthcare professionals to make informed decisions about the patient's care.

SOFTWARE DESIGN

In this project, the Thonny software was utilized for implementing the code, and ThingSpeak was employed as a platform for receiving notifications on Telegram. Thonny is an Integrated Development Environment (IDE) that offers a user-friendly interface for programming and debugging Python code. It provides a range of features and tools that simplify the development process.

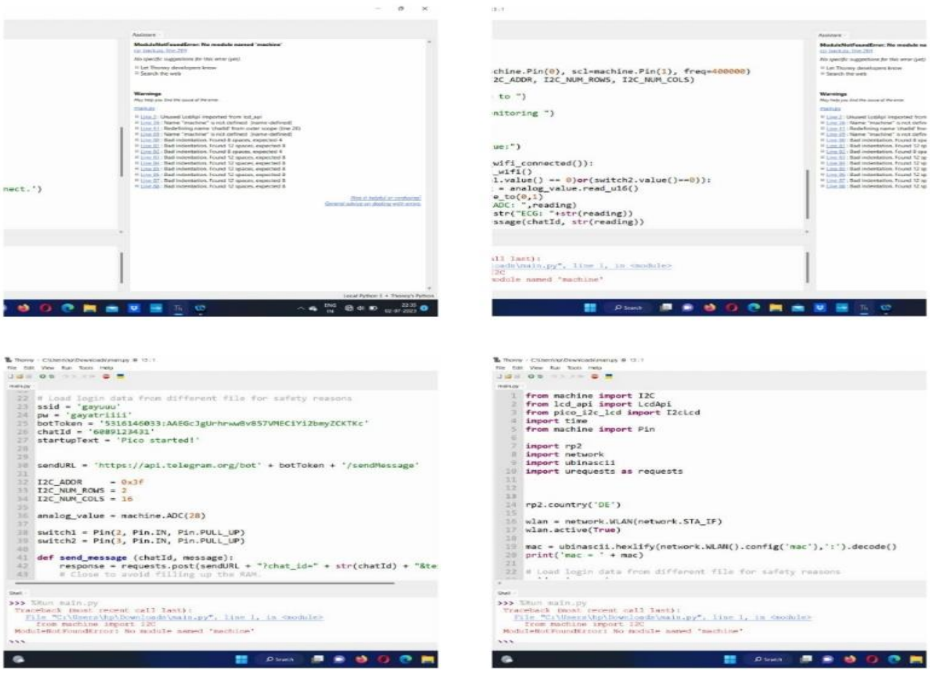

Fig. 3. Thonny Software Implemented

Using Thonny, the code for the patient monitoring system was written and executed on the Raspberry Pi. Thonny allowed for easy integration of the necessary libraries and modules required for interacting with the hardware components such as the single-lead cardiac monitor, Raspberry Pi, and digital temperature sensor. The code implemented in Thonny facilitated the collection of data from these devices and the processing of that data for further analysis. For sending notifications, the project leveraged ThingSpeak, an IoT platform that allows for real-time data collection and analysis. ThingSpeak offers various integration options, including the ability to send notifications to Telegram, a popular messaging platform. By utilizing ThingSpeak's functionality, the system was able to send alerts and updates to a designated user or group on Telegram.
The system collected data from the single-lead cardiac monitor, which assessed the patient's ECG signal by attaching electrodes to specific body locations. The Raspberry Pi received this data and transmitted it to the Raspberry Pi. The Raspberry Pi, running the code implemented in Thonny, processed the data and created a graph for visualization purposes. Additionally, the ECG data was used to determine the patient's heart rate in beats per minute.

Moreover, the system employed a digital temperature sensor to measure the axillary temperature while the patient was being supported under the arm. The temperature readings were also gathered using the Raspberry Pi and displayed on a screen.
To ensure data persistence and backup, the Raspberry Pi stored the continuous monitoring data in both a website database and an IoT cloud. This redundancy allowed for backup in case one of the storage systems failed. The system also incorporated a mechanism to trigger a signal if the body temperature reached a critical threshold, such as 36°C or increased beyond 38°C. Instead of using a GSM module, which can be costly, the system employed a bulk SMS API provider to send SMS notifications through the website. This approach helped keep the overall cost of the patient monitoring system lower.

The data collected from the patient monitoring system was visualized on the cloud and website, allowing for trend analysis and monitoring of individual patient data over time. This comprehensive representation of the data facilitated healthcare professionals in observing and understanding patient trends and deviations from normal ranges. To summarize, Thonny software was used for code implementation and execution, providing an accessible development environment. ThingSpeak was employed as a platform to receive notifications on Telegram, enabling real-time alerts and updates. These tools, in conjunction with the hardware components and data storage systems, contributed to the successful implementation of the proposed patient monitoring system.

MONITORING STRUCTURE OF THE SYSTEM

Procedure:

Informed participants will be connected to a Raspberry Pi, which will monitor their health using an ECG sensor and temperature sensor. A push switch will be available for patients to alert their doctor when assistance is required. Collected sensor data will be sent to an IoT cloud platform for visualization by medical professionals. The system will be configured to send alert messages via Telegram Notification in critical health situations. The experiment will span two weeks, and collected data will undergo statistical analysis for evaluation.

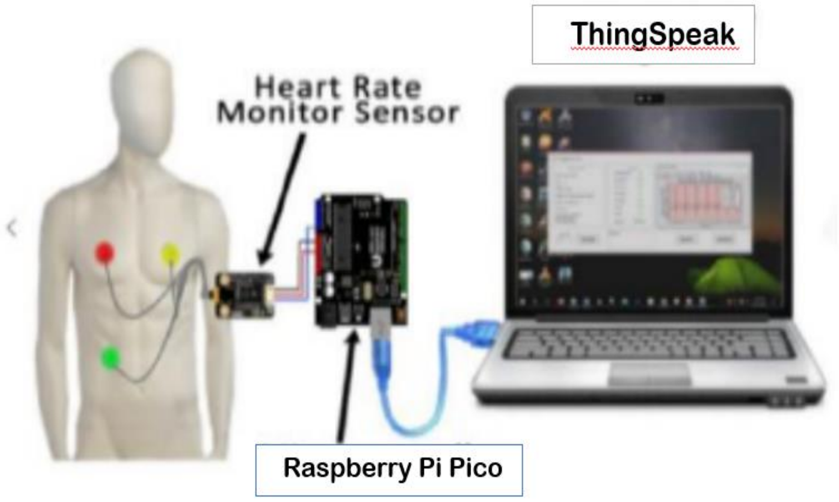

Fig.4 Monitoring Structure

Data Analysis:

The data collected from the sensors will be analysed to evaluate the effectiveness of the system in monitoring the health conditions of patients. The frequency of alerts sent to the doctor via Telegram Notification will be recorded and analysed to evaluate the effectiveness of the push switch in alerting the doctor in case of any critical health conditions.

The findings of this experiment will offer valuable insights into the efficiency of a Raspberry Pi and IoT cloud-based system for monitoring the health status of patients. The findings could have important implications for the development of similar systems in the future.

RESULTS

The patient monitoring system described in this project utilizes a Raspberry Pi as the central hub for connecting various input and output devices. One of the key components is the single-lead cardiac monitor, which is used to assess the patient's ECG signal. Electrodes are attached to the patient's right arm, left arm, and right leg to capture the electrical activity of the heart. The data from the cardiac monitor is received by an Raspberry Pi, which then sends it to the Raspberry Pi for further processing.

The Raspberry Pi plays a crucial role in the system by creating graphs using the ECG data. These graphs provide visual representations of the patient's heart activity over time. Additionally, the ECG signal is analyzed to determine the heart rate in beats per minute (BPM), which provides valuable information about the patient's cardiac health.

Another important aspect of the system is the measurement of the patient's body temperature. A digital temperature sensor is utilized to measure the axillary temperature while the patient is supported under the arm. The Raspberry Pi gathers the temperature data and displays it on a screen, allowing healthcare providers to monitor any fluctuations in body temperature.

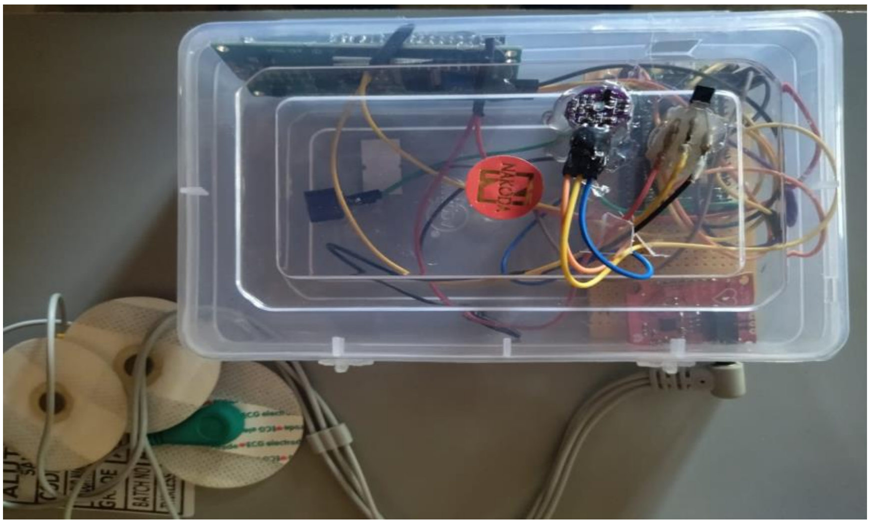

Fig.5. Hardware Overview

The continuous monitoring data from both the ECG and temperature sensors is stored in a website database and an IoT cloud. This redundancy ensures that the data is securely backed up and can be accessed from either source in case of a failure. The system is designed to send a signal if the patient's body temperature reaches 36°C or increases over 38°C, indicating a potential fever. Instead of using a GSM module, the system leverages a bulk SMS API provider to send SMS notifications through the website. This approach helps reduce costs associated with traditional GSM modules used in patient monitoring systems.

To provide an effective visualization and analysis of the patient's trends, the system displays all variables over time on the cloud platform and website. This allows healthcare professionals to monitor and identify any patterns or changes in the patient's ECG and temperature readings. The system also includes a 5V micro-USB-powered 2.5A power supply to ensure a reliable and continuous energy source for the monitoring system.

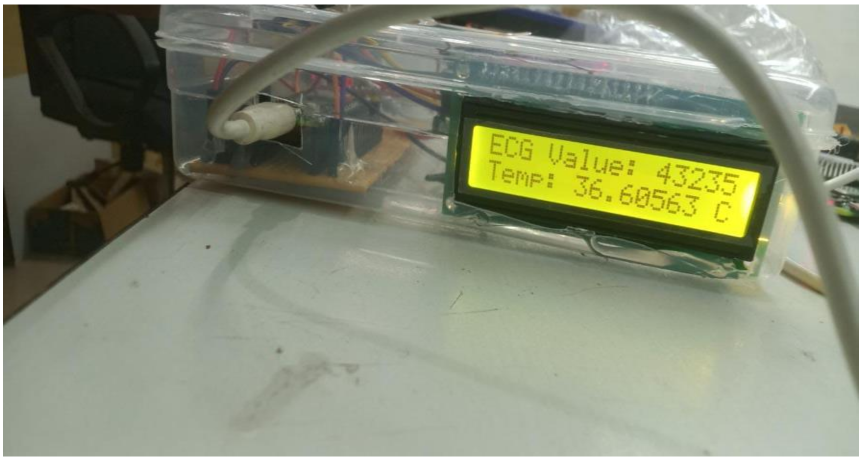

Fig.6. Experimental Setup

This study aims to develop a patient monitoring system that can be implemented with less expense and complexity than current methods. Such a system is usable by patients in healthcare facilities and those who are bedridden at home.

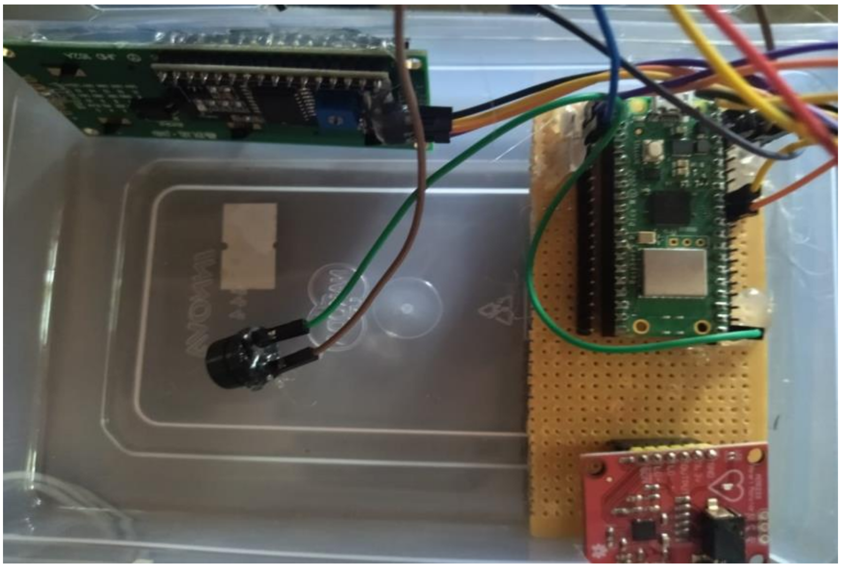

Fig. 7 Hardware Design

In terms of the results, the patient monitoring system demonstrates flawless functionality. By continuously recording data from the ECG and temperature sensors, the system provides real-time monitoring capabilities. The collected sensor data is sent to the cloud, where graphs are generated based on the ECG readings. These graphs provide a visual representation of the patient's heart activity and allow for better analysis and interpretation of the data.

Furthermore, the system analyzes the temperature and ECG readings to determine whether to adjust the notification parameter's value to 0 or 1. If the predefined threshold values are exceeded or fall below, the system triggers automatic alerts. These alerts are sent via Telegram to notify doctors or relatives about the abnormal ECG signals or temperature readings. The real-time SMS notifications inform the user regularly about the sensing values, ensuring timely intervention and improved patient care.
Fig.8 is the proposed system's real-time SMS notification. It informs the user of the sensing values regularly.

The proposed patient monitoring system offers several additional features and benefits. It includes an alarm system that activates a buzzer if the patient's body temperature exceeds 50°C or if the heartbeat goes above 80 BPM. This helps alert healthcare providers to critical situations requiring immediate attention. The system also enables remote monitoring of the patient's ECG signals, allowing doctors to monitor the patient's cardiac health from a remote location.

Fig. 8. Temp and ECG values received on Telegram

Overall, the system provides an affordable and less complex solution for patient monitoring, making it suitable for healthcare facilities and home-based care for bedridden patients. With its scalability, data security measures, real-time monitoring capabilities, and user-friendly interface, the system holds potential for further enhancements and advancements in the field of patient monitoring.

CONCLUSION AND FUTURE SCOPE

In conclusion, this project presents a comprehensive and cost-effective patient monitoring system that utilizes a Raspberry Pi as the central hub for data collection, processing, and analysis. The system incorporates a single-lead cardiac monitor and a digital temperature sensor to continuously monitor the patient's electrocardiogram (ECG) signals and body temperature, respectively. By attaching electrodes to the patient's right arm, left arm, and right leg, the cardiac monitor captures the electrical activity of the heart, enabling the assessment of the patient's ECG signal. The Raspberry Pi receives the ECG data and sends it to the Raspberry Pi, which processes the information and creates graphs to visualize the heart activity over time. The system also calculates the patient's heart rate in beats per minute (BPM), providing valuable insights into their cardiac health. Simultaneously, the digital temperature sensor measures the axillary temperature while the patient is supported under the arm. The Raspberry Pi gathers the temperature data and displays it on a screen, allowing healthcare providers to monitor any changes or abnormalities in body temperature. The collected data from both the ECG and temperature sensors is stored in a website database and an IoT cloud, ensuring secure storage and providing a backup option in case of a failure. The system is designed to send an SMS notification if the patient's body temperature exceeds predefined threshold values, indicating a potential fever. By utilizing a bulk SMS API provider, the system eliminates the need for a GSM module, reducing costs associated with traditional patient monitoring systems.

The monitoring system presents the data in real-time through the cloud platform and website, enabling healthcare professionals to monitor each patient's trends and patterns. The system's ability to generate graphs based on the ECG readings allows for a visual representation of the patient's heart activity, facilitating better analysis and interpretation of the data.The project also incorporates additional features for enhanced patient care. An alarm system is implemented to activate a buzzer if the patient's body temperature exceeds 50°C or if the heartbeat goes above 80 BPM, alerting healthcare providers to critical situations requiring immediate attention. Remote monitoring of the patient's ECG signals enables doctors to assess their cardiac health from a remote location, enhancing the level of care provided. the proposed patient monitoring system offers a cost-effective and practical solution for continuous patient monitoring. By leveraging the capabilities of the Raspberry Pi and integrating various sensors, the system provides real-time monitoring, data storage, and analysis functionalities. Its user-friendly interface, scalability, and ability to generate automatic alerts make it suitable for deployment in both healthcare facilities and home-based care for bedridden patients.This project not only fulfills the objective of developing a more affordable alternative to existing patient monitoring systems but also addresses the complexity associated with such systems. By incorporating cloud storage and utilizing readily available technology, the proposed system offers an accessible and efficient solution for healthcare providers and patients alike.

Future enhancements to the system could include the integration of additional sensors and the development of more advanced analytics algorithms to provide more comprehensive health insights. With continuous advancements in technology, this patient monitoring system holds great potential to revolutionize the field of healthcare, facilitating improved patient care, remote monitoring, and early detection of health anomalies.

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