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INTELLIGENT IOT-DRIVEN HEALTH DIAGNOSTICS AND PATIENT MONITORING NETWORK

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ABSTRACT

Introduction of the new viruses have impacted each country to take healthcare more seriously. In this sense, the best solution for controlling such an outbreak is a remote healthcare monitoring kit. Remote patient monitoring has improved significantly with the increased usage of cellphones and wearable medical devices. IoT health monitoring aids in disease prevention and diagnosis, even though the doctoris far away. This paper demonstrates the development of such portable heath parameters checking system that can continually track a patient's pulse rate, temperature, and blood oxygen saturation. The proposed system is implemented using Node-MCU as processing unit and temperature and pulse sensors. This system can communicate the health parameters processed by the NodeMCU to the androidapplication in real time using Wi-Fi access. We describe an IoT-based system for remote health monitoring where authorized users, mostly doctors, can access health data of their patients stored on a cloud platform and diagnose illnesses remotely depending on the values obtained. Keywords: Heroku, Node-MCU, Max30102, LM-35, Android application.

I. INTRODUCTION

The increasing adoption of mobile technology and smart devices in the medical sector has profoundly impacted global critical care. These advancements are utilized by healthcare professionals and clinicians to make substantial progress in medical services within clinical environments. The significance of health research to society is immense, providing essential information on disease prevalence and risk factors, treatment outcomes, public health interventions, functional abilities, care patterns, and healthcare service expenditures and utilization. Health research involves various sensors and communication devices that are crucial tools for Internet of Things (IoT) health monitoring systems. Among the most critical applications of IoT is in the healthcare field. The primary function of a patient monitoring system (PMS) is to conduct a quantitative evaluation of patients' vital physiological parameters at critical points in their biological processes. This system continuously and automatically measures key physiological indicators in patients, such as blood pressure, temperature, oxygen saturation, and pulse rate. The detection of these numerous parameters is facilitated by biosensors. A biosensor is a device for chemical sensing that integrates a transducer with a biologically derived recognition element, enabling the systematic assessment of complex biochemical parameters. A health monitoring system's main goal is to standardize all components, including networking protocols and medical terminology, to ensure that medical records can be electronically stored and instantly transmitted to physicians. PMS monitors vital information and updates surgeons on the patient's condition. This approach has greatly reduced the risks associated with surgery by enabling early problem detection and prompt corrective action. In hospital critical care units (CCUs), patient monitors are among the most vital diagnostic tools, continuously displaying and assessing patients' vital signs. The rapid advancements in information technology and electronics have led to the development of increasingly sophisticated bedside patient monitors. These devices are equipped with specialized communication interfaces and are capable of extensive bio-signal processing and interpretation.

1.1 Problem Statement

Traditionally, healthcare systems lack continuous, real-time patient monitoring, leading to delayed detection of health issues, inefficient resource allocation, and limited access to care, especially in remote areas. This results in increased healthcare costs, reduced patient engagement, and challenges in managing chronic conditions. Current methods struggle with data fragmentation and scalability as healthcare demands grow. There's a pressing need for a solution that enables remote, real-time monitoring of vital signs such as heart rate, blood oxygen saturation, and temperature.

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An IoT-based healthcare monitoring system addresses these challenges by facilitating early detection, improving resource allocation, enhancing accessibility, reducing costs, and empowering patients in their health management valuable for managing chronic conditions and supporting aging populations.

1.2 Objective

The IoT-based healthcare monitoring system addresses critical challenges in patient care by leveraging advanced technology for real-time health tracking. Using Node-MCU as the processing unit, along with MAX30102 and LM-35 sensors, the system continuously measures vital signs such as heart rate, blood oxygen saturation, and temperature. This data is securely transmitted to a Heroku cloud server via Wi-Fi, enabling remote storage and processing. Healthcare professionals can access this information through a custom Android application, facilitating timely interventions and personalized care. The system's design prioritizes user-friendliness, reliability, and scalability, making it suitable for various healthcare settings. By enabling proactive health management, reducing the need for frequent hospital visits, and empowering patients with access to their own health data, this IoT solution has the potential to significantly improve healthcare outcomes and efficiency.

1.3 Need of Smart Health System

The need for a smart healthcare system has become increasingly critical in today's rapidly evolving medical landscape. Traditional healthcare models often struggle with inefficiencies, delayed diagnoses, and limited patient engagement. A smart healthcare system addresses these challenges by leveraging IoT technology, real-time monitoring, and data analytics. It enables continuous tracking of vital signs, early detection of health issues, and remote patient care, particularly beneficial for chronic disease management and elderly care. This approach reduces the burden on healthcare facilities, minimizes unnecessary hospital visits, and allows for more personalized treatment plans. Furthermore, it empowers patients to take an active role in their health management through easy access to their medical data. In an era of growing healthcare demands and limited resources, smart healthcare systems offer a promising solution for improving care quality, accessibility, and cost-effectiveness.

II. LITERATURE SURVEY

Patient health monitoring systems heavily rely on the Internet of Things (IoT) to track patients' wellbeing. Although still in its early stages, IoT has the potential to significantly impact the healthcare sector and related industries. Researchers are continuously discovering various technological advancements in the healthcare system. While IoT is applied in every area of medical science, there is always scope for further research and development. Early identification of any health issue can enable patients to take necessary emergency actions, potentially saving their lives. The primary goal is to design and implement a smart patient health tracking system that provides an overview of the proposed system. Sensors embedded in the patient's body can measure heart rate and temperature, with the control unit determining the values of all connected sensors. Health monitoring and adaptive settings are currently active research areas. These sensors transmit information to a personal server or portable devices via wireless network technology, such as access points or ground stations. Consistent fitness monitoring has the potential to increase human lifespan by up to 60% through early detection. Additionally, the system is specifically designed for continuous monitoring of coma patients' vital signs. Numerous studies and approaches are being developed by experts to analyze and build systems for monitoring diabetic patients' data using IPV6 connectivity. This involves taking non-invasive metrics of patient data related to specific diseases, providing a better alternative to current data measurement and health record systems. A cloud environment is established to ensure patient safety, where every transferred data is stored in the patient's profile, separate from sensitive government records. Short- and long-term outcome categories are offered using two analytical methodologies to assist individuals. By leveraging technology, professionals can monitor patients with minimal healthcare resources. Future work will focus on improving the use of sensors by incorporating softer materials and coordinating information sharing between specialists, patients, and their families through a networking paradigm. The system uses WBAN to alert caretakers and medical professionals in case of irregularities. Integrating digital health records with historical and physical records provides a basis for making informed decisions and conducting further research on

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potential explanations. The architecture suggested by ADR is based on smart health monitoring and drug therapies with decision-making support. Using mobile technology, doctors and patients can communicate and access patient monitoring data. The hardware is designed to be simple for comfortable domestic use. Real-time data allows physicians to identify patients' current high blood pressure. The proposed system's effectiveness and design have been proven. When measurement values are wirelessly transmitted to Android applications via the IoT platform, high-sensitivity sensors produce more accurate results. For people with cardiovascular conditions, an IoT-based ECG system can be developed. Doctors can use smartphones to check patients' heart information using the Blynk IoT system, a free app. Building a cloud database is an essential step that will enable the maintenance of healthcare information, including a patient's medical history. Each new ECG reading obtained by a physician is immediately entered into the patient's data file for later examination. A demonstration system showed that the proposed system is feasible, capable of consistently and reliably managing up to sixteen bedsides in real-time. Smart sensors can lead to significant improvements in the healthcare industry. Combining multiple embedded technologies into an application-specific solution is a promising approach to combating diseases, but it will require research from different perspectives to address several innovative and challenging issues. As wireless sensor nodes are developed for biomedical applications, the knowledge gained from their adoption and implementation should be used to create smart sensors for new applications. Implanted smart sensors, which are rapidly advancing in their ability to treat medical conditions, offer clear benefits for both individuals and society. Those suffering from debilitating illnesses and their families will see the most significant improvements in their quality of life

III. PROPOSED SYSTEM

The proposed system is an IoT-based remote health monitoring solution using Node-MCU as the processing unit. It continuously tracks vital signs such as pulse rate, temperature, and blood oxygen saturation. The system transmits this data in real-time to an Android application via Wi-Fi, allowing doctors to remotely monitor and diagnose patients. This setup includes sensors for measuring health parameters and ensures data is accessible on a cloud platform, enhancing remote healthcare capabilities and improving patient outcomes.

IV. DATA AND METHODOLOGY

4.1 Hardware Components

4.1.1. Node-MCU (ESP8266)

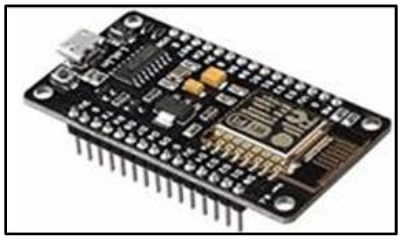

Figure 1. Node-MCU

The ESP8266 Wi-Fi module is a standalone SOC with it possess TCP/IP convention stack, permitting any microcontroller to get to Wi-Fi systems. The ESP8266 can run applications or offload all Wi-Fi organize movement to another CPU.

4.1.2. Max30102

Figure 2. Max30102

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The MAX30102 incorporates a double sensor beat oximetry module and a heart rate estimation module. It contains inside LEDs, light sensors, optics and low-noise hardware with surrounding light concealment. Utilized to calculate heart rate and blood oxygen levels.

4.1.3. Temperature Sensor LM35

The output voltage of the precession integrated circuit temperature sensor LM35 fluctuates according to the ambient temperature. It is a small, inexpensive IC that can sense temperatures between -55°C and 150°C.

Figure.3-LM35

4.2 Software Components

4.2.1. Heroku

Figure.4 Heroku

Heroku is a platform that helps developers to build, run, and function applications entirely in the cloud. In this project flask server developed on Python is deployed on free version of Heroku serverwith which we can handle http request from any device connected to internet.

4.2.2. Python flask server

Flask is a python framework for web development which helps you develop web applications easily.

Its helps in easy development of restful API's. Here in our project, we have created a restful API to handle GET and POST requests from the clients. Through post request client will be able to post data to the server and through GET request client can retrieve data from the server. Data is current stored database.

4.2.3. Custom mobile application

Mobile application is a doctor's side client which will be used to retrieve data from the server. The Volley library is used here for sending HTTP GET request to the server to retrieve the data from the server and display it in the recycler view in the mobile application. For Android apps, Volley is an HTTP library that facilitates quick and simple networking. Google created it, and it was unveiled at Google I/O 2013

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Figure 5-custom Android application

4.2.4. Arduino IDE

Here we are using Node-MCU which has in built ESP8266 which helps use connect to internet and using its libraries, send HTTP request to the server.

4.3 Block Diagram

The block diagram explains that the sensors are used to measure the health parameters like MAX30102is used to measure heart rate and blood oxygen saturation and LM-35 is used to calculate the temperature. This data is sent to the Node-MCU. With the help of inbuilt ESP82266 this data is sent to the Heroku server via HTTP POST request. Furthermore, this data is retrieved on the Android application using the HTTP GET request to the server using the android retrofit library

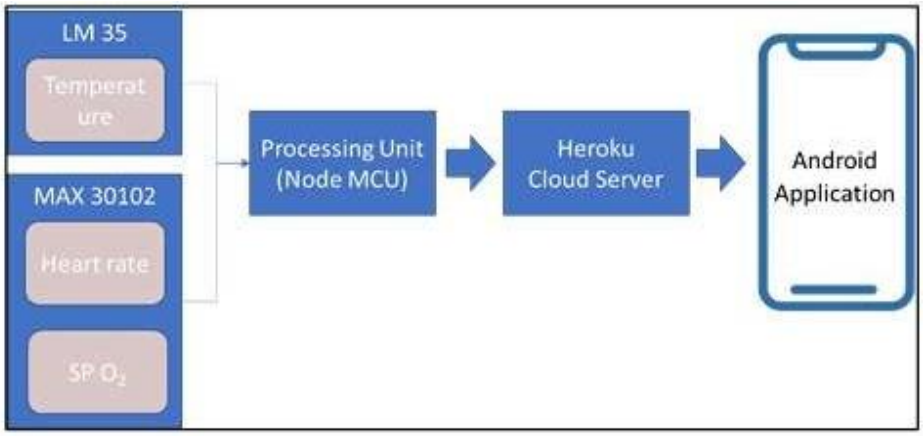

Figure 6-Project block diagram

4.4 Algorithm

Client 1: Sensor Module:

STEP 1: Start

STEP 2: Initialize all pins and the Max3012 sensor

STEP 3: Connect to internet using Wi-Fi module.

STEP 4: Serial.read() for key '1' pressed to start taking reading (switch to start taking readings).

STEP 5: Take 4 heartrate readings and average them out.

STEP 6: Take 10 temperature reading and average them out.

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STEP 7: Send HTTP post request to the Heroku deployed server.

STEP 8: Repeat from STEP - 4

STEP 9: Stop.

Client 2: Android App

STEP 1: Start

STEP 2: Initialize the recycler view

STEP 3: On 'Fetch Data' button click, send get request to the server to retrieve all the data

STEP 4: Display data

STEP 5: Stop.

V. APPLICATIONS

- **Home Healthcare Monitoring**: Patients can use the system at home to continuously monitor vital signs, reducing the need for frequent hospital visits and allowing for early detection of health issues.
- **Telemedicine:** Doctors can remotely access patients' health data in real-time, enabling remote consultations, timely diagnosis, and management of chronic conditions.
- **Elderly Care:** The system can be used in assisted living facilities to monitor the health of elderly residents, providing alerts for any abnormal vital signs and ensuring prompt medical attention.
- **Postoperative Monitoring**: Patients recovering from surgery can be monitored remotely, ensuring that any complications are detected early, thereby reducing the risk of readmission and enhancing recovery outcomes.

VI. RESULT ANALYSIS

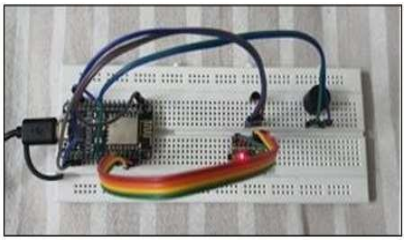

Figure 7-Circuit

This project aims to enhance the healthcare sector by providing a system for monitoring patients' health. It enables physicians to remotely track essential parameters such as temperature and heart rate ofpatients within the hospital as well as those offsite. By using this patient monitoring system, time is saved,contributing to more efficient healthcare delivery. Initially, patient data is gathered through sensors: temperature is measured using an LM35 sensor, and heart rate is monitored with a heartbeat sensor. Thisdata is then transmitted to a Heroku server for further processing.

Figure 8-Android Application

This data can be fetched from the server and displayed on an android application to the end user which is doctor's end. We can also operate this system as per users' convenience where if the user hasall the sensors and internet connectivity which can help them monitor the health of users from any location. By using the system, it reduces time and hence the patient monitoring system is designed.

VII. CONCLUSION

For future development, we can implement separate authentication and login features for doctors and patients. Additionally, more sensors could be integrated to measure various health parameters such as blood pressure and blood sugar levels, enhancing the system's health monitoring capabilities. Patients could also schedule online consultations for immediate medical attention based on their measured health parameters, saving time and ensuring timely care. Patient data will be sent to the corresponding doctor, who can then create individual patient reports and add personal comments directly within the app. The app will also notify patients to take their daily medications and perform their exercises. By incorporating machine learning models, this IoT-based health monitoring system can provide more accurate disease predictions, making it more compact, user-friendly, and accessible to everyone.

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