E-Healthcare Monitoring system using IoT and Machine Learning

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***Abstract*—: The Internet of Things (IoT) is a new technology that is rapidly advancing in the health arena with numerous new developments. IoT devices are evolving with cutting-edge resources and technology to meet new problems. The health status of in- and out-patients can be routinely and periodically monitored with IoT devices. The field of machine learning is rapidly advancing and has the potential to completely transform the healthcare system in several ways, including patient care, treatment, and diagnosis. In order to create an advanced automation system, we concentrate on developing an IoT application framework for the Healthcare Monitoring System that is coupled with machine learning (ML) approaches to handle healthcare problems. This system will link, monitor, and make decisions for an accurate patient diagnosis. To validate and authenticate our proposed work, we obtained patient data from IoT devices and applied Machine Learning for analyse and prediction. We developed User Interface for patient and doctor communication The Internet of Things (IoT) is a new technology that is rapidly advancing in the health arena with numerous new developments. IoT devices are evolving with cutting-edge resources and technology to meet new problems. The health status of in- and out-patients can be routinely and periodically monitored with IoT devices. The field of machine learning is rapidly advancing and has the potential to completely transform the healthcare system in several ways, including patient care, treatment, and diagnosis. In order to create an advanced automation system, we concentrate on developing an IoT application framework for the Healthcare Monitoring System that is coupled with machine learning (ML) approaches to handle healthcare problems. This system will link, monitor, and make decisions for an accurate patient diagnosis. To validate and authenticate our proposed work, we obtained patient data from IoT devices and applied Machine Learning for analyse and prediction. We developed User Interface for patient and doctor communication.**

***Keywords*—: *I*nternet of Things, Machine Learning, Healthcare.**

I. INTRODUCTION

The healthcare industry is undergoing a profound transformation with the integration of cutting-edge technologies, such as the Internet of Things (IoT) and Machine Learning, combined with the power of cloud computing. This convergence has opened up new avenues for healthcare monitoring, diagnosis, and treatment, leading to improved patient care, reduced costs, and more efficient healthcare systems. The Internet of Things (IoT) has emerged as a disruptive force in healthcare by enabling the interconnection of medical devices, wearables, and sensors, allowing real-time data collection and communication. This interconnected ecosystem offers a wealth of health-related data, from vital signs to medication adherence, which can be collected, processed, and analyzed to monitor patient health and inform medical decision-making. Machine Learning, a subset of artificial intelligence (AI), plays a pivotal role in healthcare monitoring. It can analyze vast volumes of healthcare data, detect patterns, make predictions, and assist medical professionals in diagnosing diseases, predicting patient outcomes, and recommending personalized treatment plans. Machine Learning models are continuously learning from new data, which leads to improved accuracy and effectiveness over time. The cloud has become the backbone of this technological revolution. It provides the infrastructure, storage, and computational power required to process and store the massive amounts of healthcare data generated by IoT devices and applications. Cloud-based solutions offer scalability, flexibility, and security, allowing healthcare providers to access and share information securely and cost-effectively. This integration of IoT, Machine Learning, and cloud computing has far-reaching implications for healthcare monitoring. It enhances patient care by enabling continuous remote

monitoring, early disease detection, and timely interventions. It reduces the burden on healthcare professionals, automating routine tasks and providing decision support. It also improves patient engagement and empowers individuals to take control of their health, ultimately leading to better health outcomes. This paper will delve into the various aspects of healthcare monitoring using IoT and Machine Learning with a focus on cloud-based solutions.

Internet-of Things (IoT)-driven health and wellness monitoring systems enable remote and continuous monitoring of individuals, with applications in chronic conditions such as obesity, hypertension, diabetes, hyperlipidemia, heart failure, asthma, depression, elderly care support, preventive care and wellness .The IOT paradigms can play a significant role in improving the health and wellness of subjects by increasing the availability and quality of care, and dramatically lowering the treatment costs and frequent travel.

The IOT-driven healthcare system employs networked biosensors to simultaneously collect multiple physiological signals and wireless connectivity to share/transmit gathered signals directly to the cloud diagnostic server and the caregivers for further analysis and clinical review. Further, the IoT-enabled remote monitoring applications can significantly reduce travel, cost and time in long-term monitoring applications.

II. LITERATURE SURVEY

Mohammed, B. G (2023): Author developed an IoT-based smart healthcare monitoring system that tracks and monitors crucial health parameters, including body temperature, heart rate, and SPO2 (oxygen saturation), and provides real-time data to both doctors and patients through a cross-platform mobile application. Their system uses a Raspberry Pi 4B microcontroller, DS18B20 temperature sensor, MAX30100 pulse oximeter, and a 4G GSM, GPRS, and GNSS HAT module for communication. Abnormal parameter values trigger SMS alerts to doctors and patient's relatives, facilitating remote healthcare management and lifesaving decisions. They tested system on a group of individuals, demonstrating its effectiveness in real-time health monitoring and alerting.

Malathi, M (2023) [2]: The Authors Malathi, M., Muniappan, A., Misra, P. K., Rajagopal, B. R., & Borah, P. focuses on developing a health monitoring system using an Arduino Mega 2560 microcontroller, various sensors (such as blood pressure, body temperature, and heart rate sensors), and IoT technology. Their system continuously monitors patients' health parameters and send notifications to caretakers, nurses, and doctors. It is useful in the pandemic like covid-19 to reduce the need for in-person doctor visits and maintain social distancing. They include ECG sensors for heart-related monitoring

Raju, K (2023) [3]: Authors developed health sensor network system for Internet of Things (IoT) applications, for monitoring the safety and health of ICU patients in a hospital setting. They incorporate various wearable sensors to monitor environmental and physiological parameters, such as heart rate, temperature, and motion. Data from these sensors is processed by an Arduino module and displayed on an LCD screen. Additionally, the data is transmitted to an IoT-based server for storage and visualization. Their proposed system aims to provide real-time monitoring and alerts for critical health parameters.

G. Saranya (2022) [4]: In their Research, authors G. Saranya, N. Dineshkumar, A. S. Hariprasath and G. Jeevanantham designed and developed Contactless IoT-enabled cloud-assisted health monitoring system to monitor and detect the severity of Covid-19 in patients. They uses unobtrusive sensors to measure vital parameters such as heart rate, temperature, oxygen level, and pulse rate, which are critical for Covid-19 monitoring. The data collected by the sensors is transmitted to a cloud server via a microcontroller and Wi-Fi module in real-time. The data is then processed using Convolutional Neural Network (CNN) algorithms to predict the severity of the patient's condition, and healthcare providers are alerted to any abnormalities. Their system is cost-effective, scalable, and efficient, enabling timely responses to critical situations. Their Experimental results show the accuracy and effectiveness of the proposed architecture in monitoring Covid-19 patients.

M. N. Bhuiyan et al (2022) [5]: Authors discusses the context and significance of healthcare monitoring systems in the face of the COVID-19 pandemic and the challenges faced by healthcare providers. they highlights the system's integration of IoT technology

and cloud-based storage to monitor critical health parameters and enable remote patient care, especially in rural and urban areas. They used hardware components, including Arduino Uno, Node MCU ESP8266, and various sensors, as well as the implementation of the Google Firebase platform for data storage. They developed mobile application 'HSMART' as a user-friendly interface for accessing patient data and monitoring health.

M. I. Abdullah (2022) [6]: Author introduces a Covid-19 Patient Health Monitoring System based on IoT technology. Their system allows medical staff to remotely monitor crucial health parameters, including blood saturation, heart rate, pulse rate, body temperature, humidity, and room temperature. They utilizes sensors such as MAX30100 for heart rate and blood saturation, DS18B20 for body temperature, and DHT11 for humidity, all processed by an ESP32 Arduino. They developed a web server to acess data on smartphones or PCs, making it an efficient tool for monitoring multiple patients simultaneously while reducing the risk of infection among healthcare workers.

H. K. Bharadwaj (2021) [7]: In their work they provide a comprehensive overview of the intersection between machine learning and Internet of Things (IoT) in the context of healthcare. Their paper explores the utilization of machine learning techniques to enhance IoT-based healthcare applications.

III. METHODOLOGY

Raspberry Pi:

Raspberry Pi,developed by the Raspberry Pi Foundation, encompasses a series of affordable single-board computersaimed at fostering computer science education and facilitating a myriad of DIY projects. These compact devices feature ARM-based processors, RAM, HDMI output, GPIO pins, and various ports for connectivity. Compatible with multiple operating systems like Raspberry Pi OS (formerly Raspbian), Ubuntu, and Windows 10 IoT Core, Raspberry Pi serves as a versatile platform for endeavors ranging from home automation and media centers to robotics and IoT applications. Supported by a vibrant community, Raspberry Pi encourages experimentation and learning, making it an invaluable tool for both beginners and seasoned enthusiasts in exploring the realms of programming, electronics, and computer science.

ECG sensor :

The AD8232 Single Lead Heart Rate Monitor is a cost-effective board used to measure the electrical activity of the heart. This electrical activity can be charted as an ECG or Electrocardiogram and output as an analog reading. ECGs can be extreme noisy, the AD8232 Single Lead Heart Rate Monitor acts as an op amp to help obtain a clear signal fromthe PR and QT Intervals easily. It is designed to extract amplify, and filter small bio potential signals in the presenceof noisy conditions, such as those created by motion or remote electrode placement. The AD8232 Heart Rate Monitor breaks out nine connections from the IC that you can solder pins, wires, or other connectors to.SDN, LO+, LO-, OUTPUT, 3.3V, GND provide essential pins for operating this monitor with an Arduino or other development board. Also provided on this board are RA (Right Arm), LA (Left Arm), and RL (Right Leg) pins to attach and use your own custom sensors. Additionally, there is an LED indicator light that will pulsate to the rhythm of a heartbeat. Biomedical Sensor Pads and Sensor Cable are required to use the heart monitor.

Temperature sensor:

The **DS18B20** is a 1-wire programmable Temperature sensor from maxim integrated. It is widely used to measure temperature in hard environments like in chemical solutions, mines or soil etc. The constriction of the sensor is rugged and also can be purchased with a waterproof option making the mounting process easy. It can measure a wide range of temperature from **-55°C to +125°** with a decent accuracy of **±5°C**.

The sensor works with the method of 1-Wire communication. It requires only the data pin connected to the microcontroller with a pull up resistor and the other two pins are used for power.

Heart Monitor sensor:

The MAX30102 is an integrated pulse oximeter and heart rate monitor biosensor module. It integrates a red LED and an infrared LED, a photodetector, optical components, and low-noise electronic circuitry with ambient light suppression.

It features a 1.8V power supply and a separate 5.0V power supply for internal LEDs for heart rate and blood oxygen acquisition in wearable devices, worn on the

fingers, earlobe, and wrist. The standard I2C-compatible communication interface can transmit the collected values to the KL25Z and other microcontrollers for heart rate and blood oxygen calculation.

Web server:

Cloud computing the one demand delivery of compute power, database storage, applications and other IT resources through a cloud service platform via the internet with pay has you go pricing. Cloud computing provides a simple way to access server storage, data bases and a broad set of application service over the internet. A cloud service platform such as a amazon web services owns and maintains the networkconnected hardware required for these application services. Suggestion taken by the specialized doctors are stored in this web serve

IV. RESULT & DISCUSSION

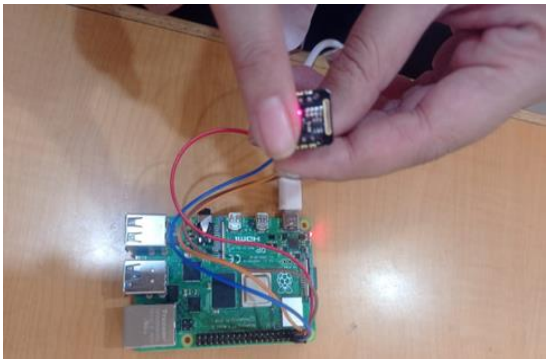

Figure 1: Experimentally checking Heart Rate

The figure 1 shows the checking of heart rate from Heart Moitor sensor that is connected to patient hand, heart rate and oxygen level of the patient is displayed on the webserver and then message will be sent to the register mobile number.

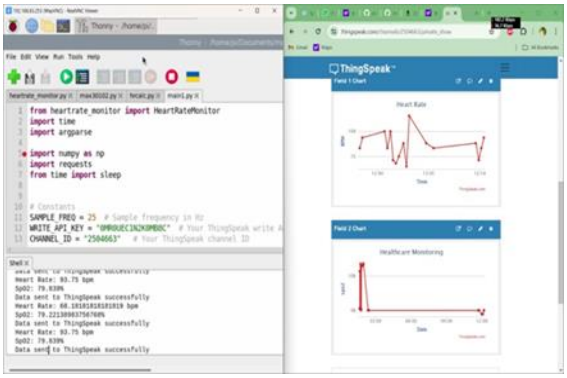

Figure 2: Experimentally checking heart rate

Figure 2 shows the Experiment output of Heart Monitor sensor on raspberry pi and ThingSpeaks.

```
Patient Health Alert
Patient ID: P061
Patient Age: 21
Timestamp: 28-10-2023 07:00
Body Temperature: 37.0
Blood Pressure: 125
Oxygen Level: 75
Condition: critical
Contact No: +919579329840
```

Figure 3: Message from the server to registered mobile number

Figure 3 shows the message send from server to the registered mobile number.

ADVANTAGES

- Early Disease Detection.
- Improved Patient Outcomes.
- Remote Monitoring and Telehealth.
- Disease Prediction and Prevention.
- Behavioral Health Monitoring.

APPLICATIONS

Medical application

V. CONCLUSION

In this work we designed and implemented an ECG monitoring system based on cutting-edge cypress WICED IoT technology. The architecture of the IoT based ECG monitoringsystem was presented at the beginning. Various ECG sensing networks including Wi-Fi, Bluetooth, Zig-bee and BLE were introduced and compared. Based on the proposed architecture, an IoT-based ECG monitoring system was implemented. Through a wearable monitoring node with three electrodes, real-time ECG signals can be collected with satisfactory accuracy. The gathered data were transmitted to the IoT cloud using Wi-Fi, which supports high data rates and wide coverage areas. The IoT cloud is responsible for visualizing the ECG data to users and storing these valuable data for further analysis, which is implemented on the basis of three servers, i.e., the HTTP server, MQTT server, and storage server. Eliminating the

need of mobile applications, the web-based GUI provides a versatile means independent of any mobile OSplatform for users to access to the ECG data. Further studies on ECG monitoring are still needed in the future. AWS IoT is a new managed service that enables Internet-connected THINGS.

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