IoT Health Monitoring System with Android App

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Abstract - ***An Internet of Things (IoT) health monitoring system that aims to revolutionize patient care by collecting, analyzing, and interpreting health data in real time, has been introduced in this manuscript. Small sensors capture data such as heart rate and oxygen levels and connect with a central hub in this novel approach. The information, which is accessible via a mobile app, enables comfortable health tracking without the need for regular doctor visits. This advanced system is advantageous since it provides a high-tech, simple, and cost-effective option, especially for people who do not have easy access to regular medical check-ups. The technology ensures that information flows seamlessly between devices, easing the task of being proactive about one's health. In essence, it offers a modern and user-friendly way for us to regain control of our health.***

Keywords - ***Healthcare, Internet of things, IoT, Health Monitoring System***

1. INTRODUCTION

A radical evolution of the current Internet into a Network of interconnected objects that not only harvests nformation from the environment (sensing) and interacts with the physical world (actuation/ command/control), but also uses existing Internet standards to provide services for information transfer, analytics, applications, and communications.

Fueled by the prevalence of devices enabled by open wireless technology such as Bluetooth, radio frequency identification (RFID), Wi-Fi, and telephonic data services as well as embedded sensor and actuator nodes, IoT has stepped out of its infancy and is the verge of transforming the current static Internet into a fully integrated Future Internet.

The internet's accessibility has fuelled its growth. IoT enhances electronic access control, enabling users to perform tasks more efficiently through smart devices and sensors communicating over the internet [1]. As technology advances swiftly, every country emphasizes IoT applications. It is a revolutionary development in internet-based computing, positively impacting various fields like smart cities, healthcare, and engineering [2]. IoT is transforming healthcare, enabling remote monitoring with wearables and smartphones. It ensures precise health assessments, facilitates continuous monitoring, and extends care beyond traditional settings, reducing costs [3]. Health providers use IoT-enabled devices with advanced sensors for remote monitoring in chronic disease management. Raspberry Pi micro-controllers offer internet connectivity, facilitating remote control and automation in healthcare systems [4]. Gondaliaa et al. (2018) proposed an IoT-based Healthcare Monitoring System for war soldiers, facilitating real-time tracking and health control, reducing the army's efforts in rescue missions [5]. Health monitoring devices have garnered substantial attention from the research community over the past decade, leading to numerous and continuously growing development efforts [6]. Health monitoring devices utilize various sensors to measure vital health parameters and display the results appropriately on different display units [7]. High demand for health monitoring devices necessitates affordable, portable, and intelligent biomedical equipment for accurate real-time monitoring through sensors with alert mechanisms [8]. Home health monitoring tracks temperature, pulse, and saturation levels, aiding those with specific conditions. For inconclusive electrocardiograms, a Holter ECG monitors and stores data 24/7, enhancing detection of unusual activity [9]. Holter ECG, strapped to the body, stores ECG data like an SD card. While lacking real-time analysis, there's a need for a system that analyses recorded data and provides ECG information at home [10]. Due to COVID-19, isolated individuals need guidance. Virtual consultations were prioritized, but they lack effectiveness, relying solely on patient statements for diagnosis [11]. For thorough patient monitoring, medical institutions rely on Niloofar's wearable band. It measures key health criteria, including oxygen level, temperature, heartbeat, and heart condition, providing critical condition notifications [12]. In 2019, Carter has designed the health monitoring system that measures SPO2 and pulse and analyses and makes estimates regarding the shift to telemedicine [13]. In 2020, a Turkish laboratory developed a stethoscope that pairs with a smartphone app, guiding users on proper positioning and collecting audio during the procedure [14]. Hu-Chang group developed a method for recognizing wheeze, addressing limitations in spectral feature discrimination for effective wheezing detection from lung sound spectrograms [15]. KE Forkheim employed neural networks to detect wheezes in lung sounds, using raw signal and Fourier transform data for training. The study aimed to assess the networks' performance in identifying wheezes [16]. Hanne-Paparo used Holter ECG to detect rhythm disturbances in athletes during late recovery after training. The study involved 32 athletes, recorded with a portable electrocardiograph cassette recorder [17]. In 2014, TC Lu designed a portable ECG monitor using the AD8232 chip for heart rate monitoring. It measured ECG signals with two chest electrode pads, displaying results on a mobile phone via Bluetooth [18].

E-health, within the realm of the Internet of Things (IoT), represents a paradigm shift in healthcare delivery, harnessing the power of interconnected devices and advanced technologies to revolutionize patient care. In this transformative landscape, this paper presents a health monitoring system using IoT with the temperature sensor and pulse rate sensor. In the proposed circuit Arduino is used as a microcontroller. A mobile app has also developed and interface with the circuit to transfer the data with the help of wi-fi or Bluetooth module. This circuit can be implement into the wearable devices such as wrist bands, rings, and watches. E-health devices will be helpful at the time of such any pandemic such as covid-19.

The objective of this paper to design a system efficiently collects real-time and exact health data, including vital signs, physical activity, and other essential indicators, enabling for early detection of deviations from typical health patterns and prompt intervention and preventive measures. It delivers ongoing insights into health state without physical presence, assisting healthcare practitioners in proactive treatment of chronic diseases and informed decision-making. It reduces the likelihood of problems by applying predictive analytics and trend analysis, hence improving overall health outcomes. Furthermore, it promotes better communication between patients and healthcare providers by providing a platform for collaborative decision-making based on shared health information.

This paper is presented in four sections in which section I shows the introduction and literature about the health monitoring devices. Section II describes the methodology of proposed circuit and Section III presents the simulation result and appearance of mobile application. In the last, Section IV conclude the paper with the future scope in the area of E-health.

2. METHODOLOGY

This paper presents a simple structure of health monitoring system which is based on Arduino. This health monitoring system, which consists of sensors and a microcontroller, uses the Arduino Uno as its microcontroller, as well as MAX30100 sensors for pulse rate and SPo2 measurements, as well as LM35 sensors for body temperature readings. An HC-05 Bluetooth module, which allows the Arduino to communicate with the mobile application, and an LCD display are also included.

The design runs on a 5V power source and includes an Arduino Uno microcontroller, two sensors (MAX30100 and LM35), a 16 2 I2C LCD display, and a Bluetooth module. The microcontroller (Arduino Uno) connects to the computer via USB (Universal Serial Bus), allowing commands to be transmitted to the device. The circuit design was carried out using circuito.io, an online circuit design application. A block diagram and wiring diagram for the proposed methodology is shown in Figure 1 and Figure 2 respectively.

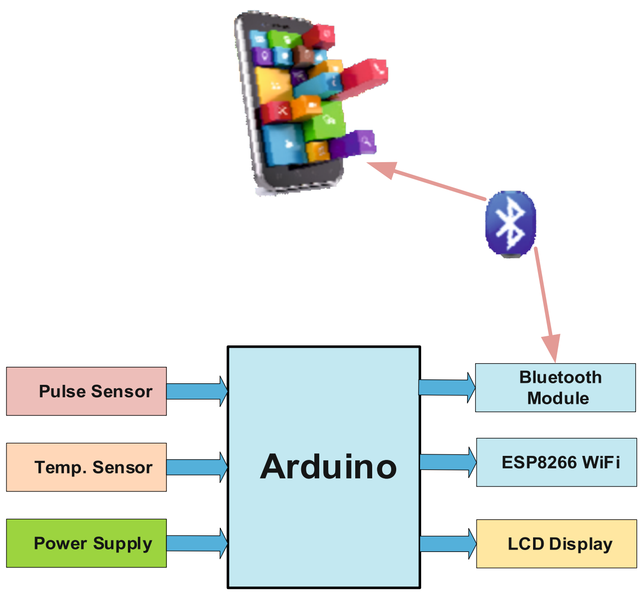

Fig. 1. Block Diagram of Proposed Health Monitoring System

The MIT Inventor App was used to design the mobile application. Following the development of the program, it is easily loaded onto the mobile device and a download link is issued. A confirmation of the connection is displayed after connecting the Bluetooth device to the application via mobile scanning. Following that, by carrying out the relevant steps, the collected findings can be displayed on the screen. Users build applications using a visual block language, dragging and dropping components into the design view. This application enables people all across the world to create digital answers to critical problems. The microcontroller is now connected to the mobile application via the Bluetooth module HC-05.

The used components description in the circuit is as follows:

a) Arduino UNO: The Arduino Uno is a popular open-source microcontroller board designed for easy prototyping of electronic applications. The Arduino Uno is a microcontroller-based board developed by the Italian firm Arduino. It has 14 digital input/output pins, six analog inputs, a USB connection for programming and power, a 16 MHz crystal oscillator, and a reset button. It is extensively used by amateurs, students, and professionals for a wide range of applications, providing an accessible platform for building and testing electronic projects ranging from simple circuits to more complicated interactive systems.

b) Temperature Sensor (LM35): The LM35 is a precision analog temperature sensor that is commonly used in electronic circuits and applications to measure temperature. Texas Instruments developed this sensor, which produces an exact output voltage proportional to the Celsius temperature on a linear scale of 10 mV per degree Celsius. The LM35 operates in temperatures ranging from -55°C to 150°C and requires no external calibration or trimming. Its ease of use and simplicity make it a popular choice for applications requiring temperature monitoring, such as weather stations, temperature-controlled spaces, and other electrical equipment. The constant output and minimal self-heating properties of the sensor add to its dependability, making it an ideal component for temperature-sensitive projects.

c) Pulse Rate Sensor (MAX30100): The MAX30100 Pulse Oximeter and Heart-Rate Sensor is a small and multifunctional sensor module that measures heart rate and blood oxygen levels. This sensor, developed by Maxim Integrated, uses reflecting photoplethysmography (PPG) to quantify changes in blood volume in microvascular tissue. The MAX30100 incorporates red and infrared LEDs, as well as a photodetector, to detect differences in light absorption caused by blood flow. The sensor outputs a digital signal via I2C communication, making it simple to interact with microcontrollers such as the Arduino or Raspberry Pi. It finds use in wearable gadgets, fitness trackers, and medical monitoring devices, providing a handy solution for non-invasive and continuous monitoring of pulse rate and blood oxygen saturation.

d) 16 X 2 I2C LCD Display: The 16x2 I2C LCD display is a small module with a 2-line alphanumeric screen and 16 characters. Its I2C interface facilitates connections to microcontrollers. It is a popular choice for display applications because it efficiently delivers information such as sensor data or messages in a straightforward way.

e) Wi-Fi Module(ESP8266): The ESP8266 is a compact and versatile Wi-Fi module widely used in microcontroller projects. Developed by Espressif Systems, it enables seamless internet connectivity for IoT applications, making it popular for its affordability and ease of integration.

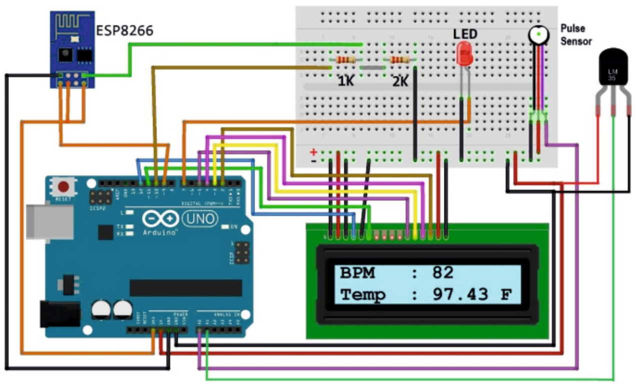

Fig. 2 Wiring Diagram of proposed circuit using Tinker CAD software

3. SIMULATION RESULTS

Here, we have simulated the circuit on tinker CAD software as well as experimental done in the laboratory with testing. Figure 3 shows the appearance of Arduino IDE tool with the program. As shown in Figure 2 the circuit is tested in the laboratory and interface with the mobile applications. Figure 4 shows the data of body temperature on the mobile application. The fetched data can be store on cloud for future patient reference.

Figure 5. presents the patient pulse rate data which is recorded also on the cloud and these data can be very helpful for the treatment of the patients.

The prototype model of hardware is presented in Figure 6.

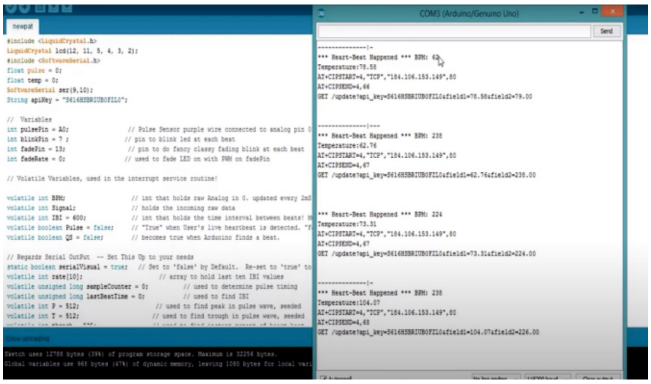

Fig. 3. Android IDE Platform for Integration of Arduino and Sensors

Fig. 5. Patient temperature data (day-wise)

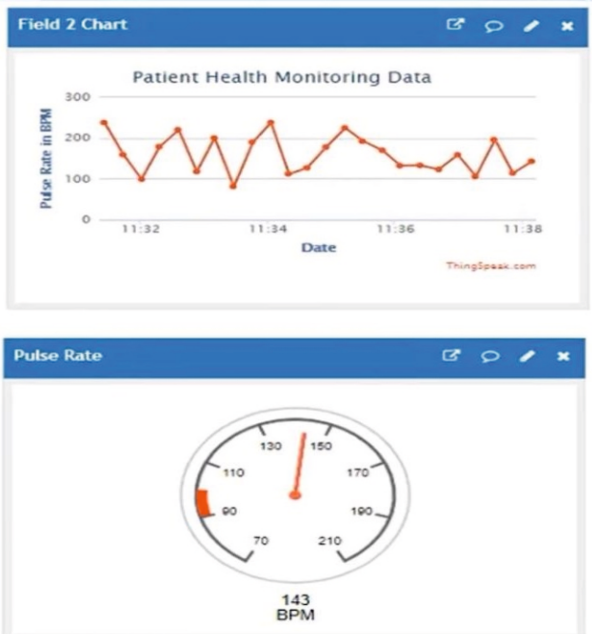

Fig. 5. Patient pulse rate data (day-wise)

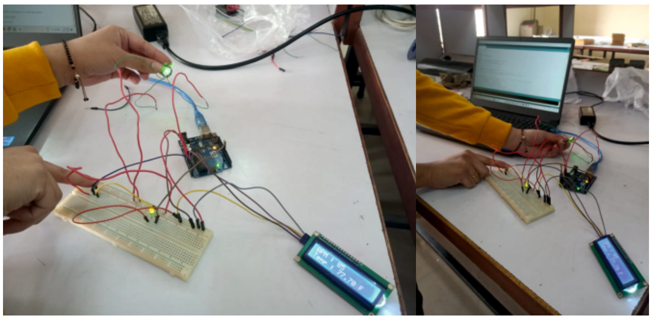

Fig.6 Experimental Setup of Prototype Model

4. CONCLUSION

In this work, describes the design and deployment of an Internet of Things-based health monitoring system. The device allows users to monitor their health metrics, allowing for self-regulation over time and prompt medical intervention as needed. The IoT technology used assures secure cloud storage of parameter data, allowing for remote monitoring by any clinician. The research focuses on an Arduino-based health monitoring system that analyzes body temperature, heart rate, and blood SpO2 levels and sends the data via Bluetooth to a mobile app. For easy patient reference, the information is also presented on an LCD monitor. The proposed system is especially advantageous to a variety of patient groups, including the elderly, asthmatics, and COPD patients, individuals with chronic conditions, COVID-19 patients, and diabetics.

Future improvements will include replacing the processor with a Raspberry Pi, improving sensor technology to assess additional health factors, and incorporating new algorithms to improve system security.

REFERENCES

[1] I. S. Areni, A. Waridi, I. Amirullah, C. Yohannes, A. Lawi, and A. Bustamin, "IoT-Based of Automatic Electrical Appliance for Smart Home", Int. J. Interact. Mob. Technol., vol. 14, no. 18, pp. pp. 204–212, Nov. 2020. https://doi.org/10.3991/ijim.v14i18.15649

[2] Rout, S., Patra, S.S., Mohanty, J.R., Barik, R.K., Lenka, R.K. (2021). Energy Aware Task Consolidation in Fog Computing Environment. In: Satapathy, S., Zhang, YD., Bhateja, V., Majhi, R. (eds) Intelligent Data Engineering and Analytics. Advances in Intelligent Systems and Computing, vol 1177. Springer, Singapore. https://doi.org/10.1007/978-981-15-5679-1_19

[3] P. Valsalan, T. A. B. Baomar and A. H. O. Baabood, "IOT BASED HEALTH MONITORING SYSTEM," JCR, Volume 7 , Issue-4: 739-743, 2020, https://doi.org/ 10.31838/jcr.07.04.137

[4] T. Vineela, J. NagaHarini, C. Kiranmai, G. Harshitha and B. AdiLakshmi, "IoT Based Agriculture Monitoring and Smart Irrigation System Using," International Research Journal of Engineering and Technology (IRJET) , vol. 5, no. 1, 2018.

[5] A. Gondalia, D. Dixit, S. Parashar, V. Raghava, A. Sengupta and V. Sarobin, "IoT-based Healthcare Monitoring System for War Soldiers using Machine Learning", Procedia Computer Science, vol. 133, pp. 1005-1013, 2018, https://doi.org/10.1016/j.procs.2018. 07.075

[6] A. Pantelopoulos and N. G. Bourbakis, "A survey on

wearable sensor-based systems for health monitoring and prognosis," IEEE Transactions on Systems, Man, and Cybernetics, Part C (Applications and Reviews), vol. 40, no. 1, pp. 1–12, 2010.

[7] I. Korhonen, J. Parkka, and M. Van Gils, "Health monitoring in the home of the future," IEEE Engineering in medicine and biology magazine, vol. 22, no. 3, pp. 66–73, 2003.

[8] K. Vijayalakshmi, S. Uma, R. Bhuvanya, and A. Suresh, "A demand for wearable devices in health care," Int. J. Eng. Technol, vol. 7, no. 1-7, pp. 1–4, 2018.

[9] J.-P. Couderc, "The telemetric and holter ecg warehouse initiative (thew): a data repository for the design, implementation and validation of ecg-related technologies," in 2010 Annual International Conference of the IEEE Engineering in Medicine and Biology. IEEE, 2010, pp. 6252–6255.

[10] R. Jane, A. Blasi, J. Garc´ıa, and P. Laguna, "Evaluation of an automatic threshold based detector of waveform limits in holter ecg with the qt database," in Computers in Cardiology 1997. IEEE, 1997, pp. 295–298.

[11] B. A. Jnr, "Use of telemedicine and virtual care for remote treatment in response to covid-19 pandemic," Journal of medical systems, vol. 44, no. 7, pp. 1–9, 2020.

[12] N. Mohammadzadeh, M. Gholamzadeh, S. Saeedi, and S. Rezayi, "The application of wearable smart sensors for monitoring the vital signs of patients in epidemics: a systematic literature review," Journal of ambient intelligence and humanized computing, pp. 1–15, 2020.

[13] D. Carter, J. Kolencik, and J. Cug, "Smart internet of things-enabled mobile-based health monitoring systems and medical big data in covid-19 telemedicine," American Journal of Medical Research, vol. 8, no. 1, pp. 20–29, 2019.

[14] M. E. Chowdhury, A. Khandakar, K. Alzoubi, S. Mansoor, A. M Tahir, M. B. I. Reaz, and N. Al-Emadi, "Real-time smart-digital stethoscope system for heart diseases monitoring," Sensors, vol. 19, no. 12, p. 2781, 2019.

[15] A. Alic, I. Lackovic, V. Bilas, D. Sersic, and R. Magjarevic, "A novel approach to wheeze detection," in World Congress on Medical Physics and Biomedical Engineering 2006. Springer, 2007, pp. 963–966.

[16] R. Jane, A. Blasi, J. Garc´ıa, and P. Laguna, "Evaluation of an automatic threshold based detector of waveform limits in holter ecg with the qt database," pp. 295–298, 1997.

[17] T. C. Lu, P. Liu, X. Gao, and Q. Y. Lu, "A portable ecg monitor with low power consumption and small size based on ad8232 chip," vol. 513, pp. 2884–2887, 2014.

[18] P. Elbanowski and S. Marcin, "Ai-powered smart stethoscope revolutionizing remote medicine," carfagno, vol. 9, no. 14, p. 1481, 2019

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