Improvised Remote Health Monitoring System Using Wearable Sensors

Dr. K.V.R.B. Prasad, Professor, CREC (A), Tirupati, India, prasad_brahma@rediffmail.com

Abstract–In recent years, the telemedicine is gaining popularity. This requires the effective operation of remote patient monitoring systems to provide physiological data of patients. In this paper, a tool is used to for sending data as well as notifications to observer's mobile. In this paper, different parameters such as body temperature, body temperature, oxygen levels, heart rate and movement of body are obtained from patient's body through various sensors. The patient's monitoring system collects data from different sensors and sends it to respective observers. This paper has two main stages such as improvised hardware circuit for collecting various parameters of patient and identifying software for sending data to relevant observers. In hardware circuit, different sensors are used to collect data from patient's body. This technique is very useful to the medical staff in monitoring the patient's health condition from a remote place, where it is difficult to approach the patient's region, to provide effective treatment.

Keywords —Health condition, monitor, patient, remote, sensor, telemedicine

I. INTRODUCTION

The rural health care in India poses one of the biggest challenges in India due to lack of quality infrastructure, dearth of qualified medical professionals and non-access to medical facilities. The combination of internet of things (IoT) sensing technologies, along with wireless data transfer protocols, is used to monitor the physiological parameters of a patient from a remote place. This is helpful in overcoming the shortage of qualified medical professionals in India which in turn improves the health care standards of public. These days, many countries are focusing on reducing the number of hospital beds and increasing the proportion of home healthcare, by undergoing hospital restructuring. The smart health monitoring system provides a seamless healthcare to patients in a comfortable home environment besides drastically reducing expenditure on medical treatment. It makes the limited hospital resources available to people who are in need of emergency care.

In recent years, the telemedicine is becoming increasingly popular. The telemedicine provides good health services to people located at far places from medical facilities. It is very helpful in situations where the patient need to be kept away from hospital [1]. The wireless medical sensors detects physiological data of patient and transmits through wireless channels. The blowfish algorithm is used for encoding medical data and CP-ABE combination is used for security and quick transmission [2]. The primary purpose of wearable health monitoring system is to facilitate people for leading active and independent lives in their home environment. It should also provide continuous, non-invasive, non-intrusive and seamless surveillance of patient's health along with their physical wellbeing [3]. The integration of many wearable sensors is used to measure different parameters of a patient. The IoT is integrated to obtain remote health monitoring of patients by medical experts. The final results were transferred to cloud through Raspberry Pi [4]. The graphene oxide-based wearable sensor is developed using gelatin nanofibers. This is capable of monitoring cardiovascular health. The detection results are communicated to mobile devices. The E-skins are expected to be a disruptive technology in real-time human health monitoring [5]. The blockchain-IoT provides decentralized health care systems. The private-by-design, blockchain-based solution is used to monitor health from a remote place. This provided improved performance as it is independent of centralized servers [6]. The use of remote patient observation system facilitates expanded access to medical experts with IoT. The security of data transfer needs to be taken care [7]. The role of wearable devices telehealth technology is significant in fighting against COVID-19 as they provide various physiological parameters of patients. This in turn reduced the burden on healthcare systems, providing safety to medical experts as well as healthcare staff besides facilitating best medication from a remote place [8]. During COVID-19 pandemic, it is critical to balance cardiovascular emergencies. The use of wearable sensors integrated with mobile health (mHealth) provides a real-time monitoring of patients from a remote place. This provides effective treatment of cardiovascular disease (CVD) patient with a reduced infection risk. The utilization of wearable sensors based mHealth system is helpful in providing effective medication for the patients besides reducing the readmissions of patients. The acquisition of various parameters may raise implications of

 DOI : 10.35291/2454-9150.2022.0420

having several wearable devices [9]. The wearable devices are useful in monitoring the personal stress of patients in real-time. The stress detection is carried out through electrocardiogram (ECG), electroencephalography (EEG) and photoplenthysmography (PPG). These wearable sensors need to provide accurate data with less error and noise. The heart rate and galvanic skin response are used to estimate the stress levels [10].

In this paper, the remote patient monitoring system is designed to obtain data from patients. This is aimed to assist the medical team in monitoring the patient's health from a remote place. In this system, four parameters such as body temperature, oxygen level, heart rate and motion of body are monitored. The system collects input from patient's body through sensors.

The hardware prototype is developed and is integrated with an app in mobile. The circuit was tested for different persons and the data was received on the mobile integrated with the circuit.

The remainder of this paper is organized as follows. Section II outlines the major components of remote patient monitoring system. Section III delves the results of tests carried out during verification. Section IV summarises the findings and conclude the paper.

II. Remote Health Monitoring System

The hardware prototype consists of four sensors to monitor patient's body temperature, oxygen level, heart rate and motion of body. The sensor, used to identify the motion of body, is included to monitor the movement of patient who is in unconscious. This is also useful for treating children as well as aged patients. This sensor plays an important role when the medical attendant is away from a patient / unnoticed the patient's movement at any point of time. This is also helpful to quickly notice the patient's body movement, especially when the patient is ill.

Generally, the infrared (IR) sensor is used to detect infrared radiation in its surrounding environment. The IR LED transmits IR radiations infrared receiver detects the radiation. The pulse oximeter sensor has a low-power biometric sensor. It detects pulse oximetry (SpO_2) and heart rate (HR) signals. The temperature sensor measures temperature and displays it in numeric form over readout units.

The block diagram of the hardware prototype is shown in Fig. 1. From the block diagram, it is observed that the patient's parameters are collected from sensors. The data is transferred to the medical expert through 'Blink App'.

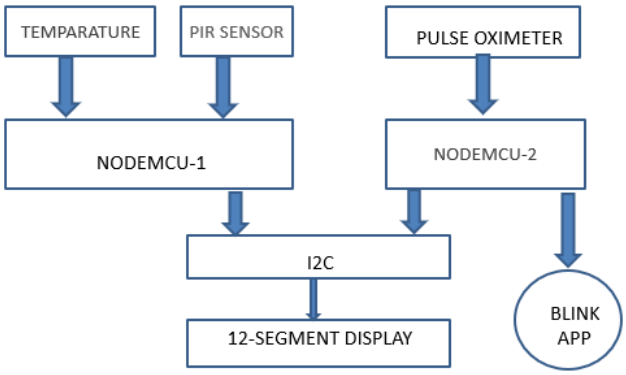

Fig. 1: Block diagram of prototype

The circuit diagram of the prototype is shown in Fig. 2. From the circuit diagram, it is observed that the controller is interfaced with a character LCD display, IR sensor, pulse oximeter sensor and temperature sensor. The LCD display shows patient's data collected by sensors from time to time. The 5 V DC supply is provided to the circuit through an adapter whose AC input is 100-240 V / 50/60 Hz and DC output is 5 V, 1 A.

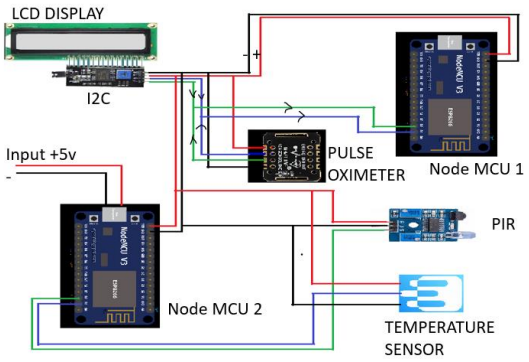

Fig. 2: circuit diagram of prototype

This circuit consists of two Node MCUs to integrate all the sensors. The Node MCUs are programmed as per the requirement. The Node MCU is connected to Wireless Fidelity (WiFi) network so that it interacts with other devices. It should be noted that the IR sensor should be placed in phase with the patient as the other directions would not give accurate result. For accurate results, the temperature and pulse oximeter sensors should be in contact with the patient's skin.

III. Results And Discussion

In this system, the patient's physiological parameters are obtained through sensors attached to patient's body. This data is transferred to remote base-station with PC/laptop/smartphone for storage and analysis. Initially, the sensors are placed on patient's body and the supply is provided to both Node MCUs. The red LED indicates power supply to circuit. The hotspot in mobile / WiFi

 DOI : 10.35291/2454-9150.2022.0420

connection is connected to the circuit. When the circuit is connected to internet, the circuit is integrated with the Blink App in a mobile.

Initially, all the parameters are set to zero. In this case, the temperature sensor measures the room temperature. After connecting the sensors to patient's body, the output is observed in Blink App and LCD screen, which is part of hardware circuit. The medical expert analyses the patient's health condition based on the data received in mobile through Blink App.

The setting of remote health monitoring system hardware prototype, during initialization process, is shown in Fig. 3. In this case, the data is displayed in LCD screen. The demonstration of remote health monitoring system hardware prototype, while testing oxygen level and heart rate, is shown in Fig. 4. In these images, the data is displayed in LCD screen.

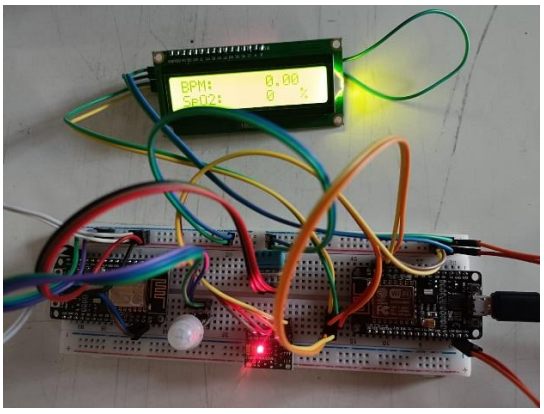

Fig. 3: Initializing the hardware circuit

The hardware circuit is demonstrated on three different persons to test the performance of the prototype. It is observed that the data is successfully displayed LCD as well as the data is also transferred to the mobile at a far place. The mobile linked with the circuit obtained the test data through Blink App.

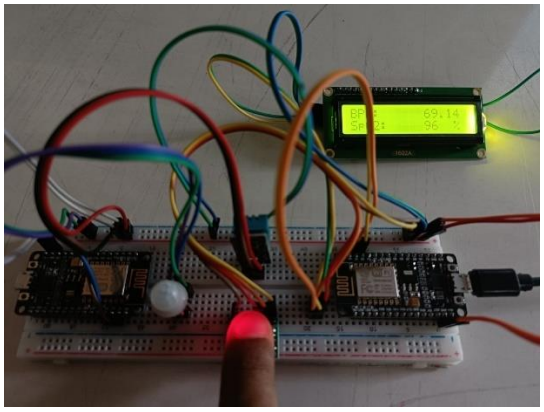

Fig. 4: Testing the oxygen level and heart rate of a patient

The test results obtained through Blink App are shown in Fig. 5 and Fig. 6.

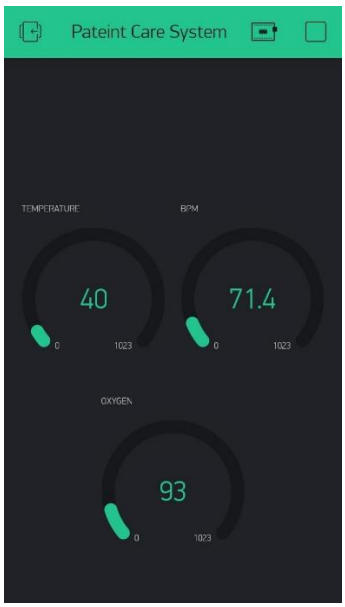

Fig. 5: Patient's data on experts mobile through Blink App

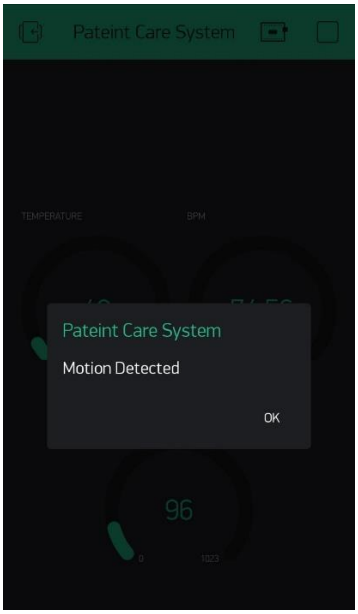

Fig. 6: Patient's body movement detection data through Blink App

The test results, carried out on three different persons, are shown in Table 1. From the test results, it is observed that the four parameters such as body temperature, oxygen level, heart rate and body movement of three different persons are verified through the prototype circuit. It is also observed that the Blink App is providing patient's data to the user. This is very useful to medical experts in monitoring the patient's data in real-time, analyze it and provide appropriate medication to patient from time to time. This is also useful for the patients who are not in a position to travel or residing in remote places, to get best medication for their health problems from medical experts. This is also helpful for the medical experts to treat any kind of complicated diseases from a remote place by providing suitable medical advice.

 DOI : 10.35291/2454-9150.2022.0420

Table 1: Test results of three patients

Patient	Age	Body Temperature (°C)	Oxygen Level	Hear Rate	Body Movement
1	25	40	93	71.4	Yes
2	23	37	92	81	Yes
3	20	38	94	78.6	Yes

From Table 1, it is observed that the patient 1 is suffering from high temperature. The patient 2 is a healthy person with normal body temperature. The patient 2 is suffering from slightly high temperature. All three patients are in conscious and hence, their body movement is detected. The above parameters are useful to medical expert in providing appropriate medication to respective patients.

IV. CONCLUSION

After developing the prototype of hardware circuit and integrating it with the Blink App, it is concluded that the controller collects patient's data through various sensors which include body temperature, oxygen levels, heart rate and movement of body. The Blink App provides health details of a patient to respective users (the medical experts) who are at remote place. The IoT collects real-time data of patients and provides it to respective users, which is useful to medical experts in monitoring patient's health from a remote place. The medical experts analyze real-time data and advice the telemedicine to patients for a quick recovery. Hence, the proposed work is useful to medical experts in monitoring the patients from a remote place. This work is also useful for the patients in remote places to get best medication that helps them for quick recovery. In the next stage, this work will be modified by incorporating smart sensors to medicines and pill boxes. These sensors will be used to generate alerts regarding the status of scheduled medication dose.

REFERENCES

[1] R.G.F. Yusuf, L. Kamelia, E.A. Zaki hamidi, and Ulfiah, 'The Monitoring System Prototype of Health Condition for Home Care Patients Base on the Internet of Things', in *Proc. 6th Int. Conf. Wireless and Telematics,* Yogyakarta, 2020, pp. 1-4.

[2] D. Sathya, and P.G. Kumar, 'Secured Remote Health Monitoring System', *Healthcare Technology Letters 2017,* 4 (6), 2017, pp. 228-232.

[3] S. Majumder, T. Mondal, and M.J. Deen, 'Wearable Sensors for Remote Health Monitoring', Sensors 2017, 17 (1), 130. https://doi.org/10.3390/s17010130.

[4] M. Hamim, S. Paul, S.I. Hoque, Md.N. Rahman, and I.A. Baqee, 'IoT Based Remote Health Monitoring System for Patients and Elderly People', in *Proc. Int. Conf. Robotics, Electrical and Signal Processing Techniques (ICREST),* Bangladesh, 2019, pp. 533-538.

[5] Y. Liu, F. Meng, Y. Zhou, S.M. Mugo, and Q. Zhang, 'Wearable Sensors: Graphite Oxide Films Prepared Using Gelatin Nanofibers as Wearable Sensors for Monitoring Cardiovascular Health', Advanced Material Technologies 2019, 4 (11), 1900540. https://doi.org/10.1002/admt.201970059.

[6] M.S. Ali, M. Vecchio, G.D. Putra, S.S. Kanhere, and F. Antonelli, 'A Decentralized Peer-to-Peer Remote Health Monitoring System', *Sensors 2020,* 20, 1656. https://doi.org/10.3390/s20061656.

[7] D. Sam, S. Srinidhi, V.R. Niveditha, S. Amudha, and D. Usha, 'Progressed IOT Based Remote Health Monitoring System', International Journal of Control and Automation 2020, 13 (2), pp. 268-273.

[8] X. Ding et al., 'Wearable Sensing and Telehealth Technology with Potential Applications in the Coronavirus Pandemic', in *IEEE Reviews in Biomedical Engineering 2021,* 14, pp. 48-70.

[9] N. Ji et al., 'Recommendation to Use Wearable-Based mHealth in Closed-Loop Management of Acute Cardiovascular Disease Patients During the Covid-19 Pandemic', IEEE Journal of Biomedicaland Health Informatics 2021, 25 (4), pp. 903-908.

[10] S. Gedam, and S. Paul, 'A Review on Mental Stress Detection Using Wearable Sensors and Machine Learning Techniques', IEEE Access 2021, 9, pp. 84045-84066.

 DOI : 10.35291/2454-9150.2022.0420