International Journal of Reconfigurable and Embedded Systems (IJRES)
Vol. 13, No. 3, November 2024, pp. 681~686
ISSN: 2089-4864, DOI: 10.11591/ijres.v13.i3.pp681-686

Internet based highly secure data transmission system in health care monitoring system

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Article Info

Article history:

Received Aug 2, 2023
Revised Mar 30, 2024
Accepted Apr 19, 2024

Keywords:

Heartbeat sensor
Internet of thing
LM35 module
Saturation of peripheral oxygen
WIFI module

ABSTRACT

The health care systems in our contemporary countries are advancing rapidly in terms of maturity and professionalism. In an effort to alleviate the current burden on the public health system and boost the popularity of regular health self-checks, this method has been developed for producing prediagnoses that are easier to use, quicker, and more accurate. To ascertain how well the heart is circulating oxygen throughout the body, a pulse test, a painless examination that measures an individual's degree of oxygen saturation, is used. It can be used to evaluate the state of any patient with a disease, particularly those with pulmonary problems. Diseases in these patients could need ongoing observation and care. Our system comes to the rescue in order to resolve this problem. This portable system is simple to use and may be taken anywhere by the subject. The internet of things (IoT) will update the pertinent parameters. This health monitoring system's controller is made up of an adaptor, a saturation of peripheral oxygen (SPO_2) sensor (a blood oxygen meter), a temperature sensor, a heart rate sensor, a WiFi module, and a liquid crystal display (LCD).

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1. INTRODUCTION

People with chronic diseases are becoming more prevalent, and a variety of things, such as food decisions, alcohol consumption, and physical activity, may be to fault. Numerous symptoms and medical interventions can be used to treat chronic disorders [1]. Patients' health screening must be continuously maintained for the early identification and diagnosis of potentially fatal conditions including heart attacks after they are released from the hospital and are taken home [2]. Researchers found that 30% of people with coronary heart disease received rehabilitation at least once every 90 days, with study rates between 25% and 54% within 3-6 months [3]. A cheap solution to these kinds of needs is being provided in the form of health monitoring devices. In such a system, physiological data is stored, processed, and communicated via a local device like a smart phone, and a personal computer. Such systems should adhere to stringent standards for long-term real-time operation, dependability, safety, and security [4]. The advancement of technology has long captivated our attention. We also found that there aren't many comprehensive researches on the use of computer technology to hospitals' needs for an internet of things (IoT) based patient monitoring system [5]. All physical objects are connected to the internet through a network called the IoT using various sensors, and devices. IoT is a clever technique that can reduce the need for human effort and involvement [6]. The IoT, which has given us new ideas like smart parking, smart homes, and smart cities, has fundamentally altered

the way we live today [7], [8]. There are numerous useful uses for IoT in hospital administration. They joined us as we began reading the published piece and local developments. In the present day, medical knowledge is expanding daily [9], [10]. On the basis of this generating method, people are creating more significant logical accessories, such as a belt that can detect persistent breath and electro dermal movement sensors that may gradually reveal seizure physiology indicators at night [11]. The patient monitoring system is easy to use, comfortable, and painless [12], [13]. The present project's objectives are as follows:

- Because it demonstrates how all data and information are obtained only over the internet, it will be a highly useful tool. The burden and stress placed on the patient's family members who work outside is thereby reduced.
- By connecting with the IoT healthcare system, professionals may get all the required patient data, improving the precision of their diagnoses. Simply put, it enables ongoing and remote patient monitoring.
- By using this method, we may roughly estimate the outcome based on patient health. Furthermore, it will outperform human performance in terms of accuracy, data gathering speed, and error.
- When a patient receives home-based medical therapy in real time, a needless doctor or nurse visit is avoided. Particularly with this strategy, hospital stays and readmissions are less expensive.
- Because of IoT, doctors and family members can confidently carry out their specific responsibilities because they can remotely monitor the patient's health. Every time a certain health parameter raised or fell outside of the predetermined range, the system would also send out alarms. Additionally, family members and medical professionals can act appropriately after getting an SMS alert. Not least among its benefits is that it can assist save lives in an emergency.

According to my assessment, there is a dearth of basic healthcare for the populace in rural areas. Additionally, they cannot find adequate medical care. After the illness or fever becomes too severe, a large number of people receive treatment. Numerous rural residents cannot afford treatment when the cost is taken into account. Therefore, this project is being designed to make the first part of the treatment procedure easier. Since the goal of this study is to provide a key metric for disease diagnosis. Lack of administration and resources make it difficult for developing nations to address the concerns of individuals. A regular person cannot afford the costly daily health checks. Numerous systems that provide simple and reliable care have been created for this aim. With properly handled equipment, this technique cuts down on time. This social contribution will be highly valuable. Because people can identify the body's improper behavior before developing any significant diseases. With the aid of IoT, the person who is more concerned about any other loved one can take care of and monitor his health while sitting in any location in the world.

2. SURVEY OF RESEARCH

In order to provide better healthcare, the IoT is being frequently used in the medical industry. IoT is a key element of providing patients with better healthcare facilities and assisting hospitals and professionals as well. The ability of this system to collect and exchange data is improved by the IoT network connectivity of connected devices, software, and sensors [14], [15]. The routine monitoring of a patient by reviewing a range of parameters measured and delivered by the sensors attached to the patient's body is the specialty of IoT in the healthcare system [16]. Hospitals are furnished with a large variety of sensor-enabled devices, even in conventional medical systems [17]. In areas where the disease is prevalent, it is always preferable to monitor these people using remote health monitoring technology.

A health monitoring system built on the IoT is the current solution for these kinds of problems [18]. By enabling patient observation outside of typical healthcare settings (such at home), such a remote patient monitoring setup improves access to human services offices while reducing costs [19]. There have been reports of numerical models for IoT in healthcare and the prediction of various diseases using various methods.

Kadarina and Priambodo [20] developed a smart chair that recognises non-constrained bio-signals and can be monitored with a system similar to the one they had established. The smart chair was used to develop a system for sensing physiological signals in sitting posture, such as electrocardiogram (ECG) and ballistocardiography (BCG). This is a prime illustration of how the IoT is being applied to the medical field. A framework was developed by Butt *et al.* [21] to protect the clinical information that must be transmitted over the internet for electronic patient record systems. Incorporating public key infrastructure, smartcard, and biometrics technologies into a multi-layered framework is what they advise [22].

An IoT-based platform was developed by Ding *et al.* [23] to let persons with disabilities research and find IoT developments in the healthcare sector that can help them and their community. To examine the most advanced IoT technology and its applications, which can primarily be used for the disabled, they chose

two use cases. Almotiri [24] looked into the potential and technical aspects of IoT in healthcare in order to make it a reality and uncover opportunities. After that, they put out a cloud-based conceptual framework that would establish a network between the patient, hospital, physicians, labs, and other parties, enabling the secure transfer of patient medical data and information with the patient's and their family's permission [25].

3. METHOD

Here, we make use of several hardware and software needs, including an IDE, project factory web server, a controller, a heartbeat sensor, a saturation of peripheral oxygen (SPO_2), an ESP8266, an LM35, and a heart rate sensor. The controller is a board designed for projects that require a maximum amount of random access memory (RAM), additional input and output pins, and sketch memory. For projects that need additional input and output pins, this board is suggested since it has 54 digital I/O pins, 16 analogue inputs, and more room for the sketch. This keeps the Raspberry Pi platform simple while providing a tone of potential for applications. A low-cost controller module that can be utilized for IoT project development is the ESP8266 module. In order to communicate with the ESP8266 module, a set of AT instructions are used. The integrated circuit (IC) temperature sensor LM35's output voltage is linearly proportional to the measured temperature in °C. For projects that are appropriately built plug-and-play heart rate sensors for Raspberry Pi, heart rate sensors are utilized. The sensor clamps onto a fingertip or earlobe and can be connected to a Raspberry Pi using some jumper cables so that we can measure the victim's heart rate. The Raspberry Pi integrated development environment (IDE) is a piece of free software used mostly for creating, editing, and compiling code into the Raspberry Pi module. An open source platform known as project factory web server offers a variety of services primarily intended for creating and developing IoT apps for diverse projects [26]. It offers the capability of gathering and displaying real-time data as graphs or charts.

4. PROJECT FACTORY INTERNET OF THING SERVER

Users are able to interface with gadgets that can connect to the internet thanks to the Ruby application known as project factory. By giving social network websites and mobile devices an application programming interface (API), it simplifies data access, retrieval, and logging. On the left, you can see the intelligent objects (also known as "things" in IoT) that are situated at the edge of the network [27]. A few examples of devices that gather data include wearable technology, manufacturing floor equipment, wireless temperature sensors, heart rate monitors, and hydraulic pressure sensors. Data from several sources in the cloud can be quickly and effectively gathered using an IoT analytics platform designed for this purpose. The graphic below illustrates how the IoT application's algorithm was developed [28]. A data scientist or engineer tries to understand the obtained data by doing historical analytics on it in this scenario. Data is gathered from the IoT platform and brought into a desktop software environment to allow the engineer or scientist to prototype algorithms that may eventually operate in the cloud or on the smart device. An IoT system is made up of all of these parts [29]. The cloud portion of the diagram's platform, which is offered by project factory, enables quick data collecting and analysis from internet-connected sensors. The Figure 1 gives clear idea of IoT secured server model.

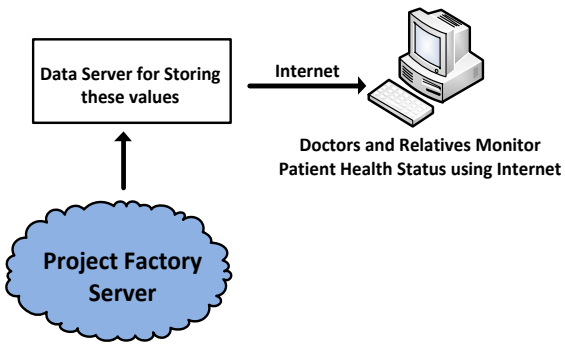

Figure 1. IoT secure server model diagram

The skin in these places has a substantially higher vascular density than, say, the skin on the chest wall. Pulse oximeters probe the finger, nose, ear lobe, and forehead for this reason. The two most common

types of pulse oximeter probes are the reusable clip probes and the single-patient sticky probes (finger, forehead). Reusable clip probes have the advantages of being simple to use, permitting sampling of numerous body sites when low amplitude waves are present, and being economical in outpatient settings where multiple patients can be measured sequentially with a single probe since only one SPO_2 reading is necessary. Pulse oximeters may be used in a variety of situations that need the monitoring of oxygenation and pulse rates. The use of pulse oximeters increases patient safety by alerting medical staff to hypoxia before, during, or after surgery. Oximeters indicate that the oxygenation during mechanical ventilation is adequate. A device known as a temperature sensor is designed to measure how hot or cold an object is. How well a temperature sensor works is determined by the voltage put across the diode. The relationship between the diode's resistance and temperature change is perfect. Temperature drops cause a decrease in resistance, and vice versa.

5. RESULTS AND DISCUSSION

A great platform for IoT-based projects is project factory. Using the channels and web pages given by project factory, we can retrieve our data and monitor our system using the thing speak website. For project factory, we have to register. The system then needs an API key in order to function after we've set up what we need on a new channel. This key is required for data setup and programming changes. After the API has been created, the outcome will be shown on a 16×2 liquid crystal display (LCD) display and stored on the project factory server. Users can access the data from that point, examine the findings, and manage their health. Data is gathered by hardware from a variety of sensors and uploaded to a cloud server for the project factory server. The graphical representation of captured data that of temperature, heart beat and SPO_2 is displayed on the server is shown in Table 1. This data can be processed further and utilized to predict the patient's health. This is helpful for those who require daily care and those who are unable to leave the hospital for doctor advice. The variation of temperature, heart beat and SPO_2 levels can also be observed in the form of graphs which are as shown in Figures 2 to 4 patient measurement.

Table 1. Output results with respective of time

S. No	Temp	HB	SPO_2	Date
1	57	0	0	2022-01-10 10:11:36
2	322	55	96	2022-01-06 14:44:39
3	74	75	96	2022-01-02 17:35:46
4	81	0	0	2022-01-02 17:34:27

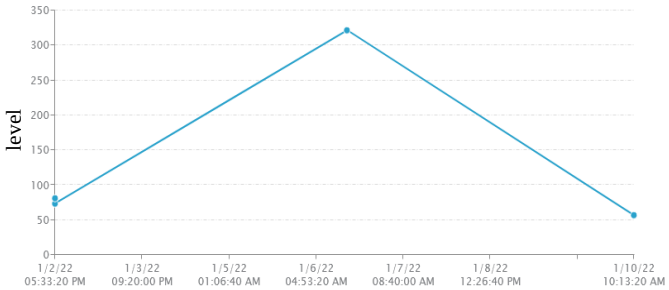

Figure 2. Body temperature levels with respective of time

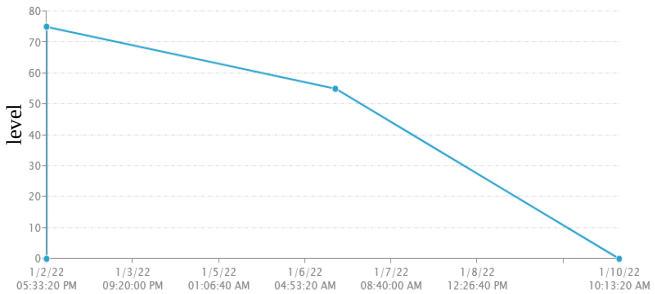

Figure 3. Heart beat levels with respective of time

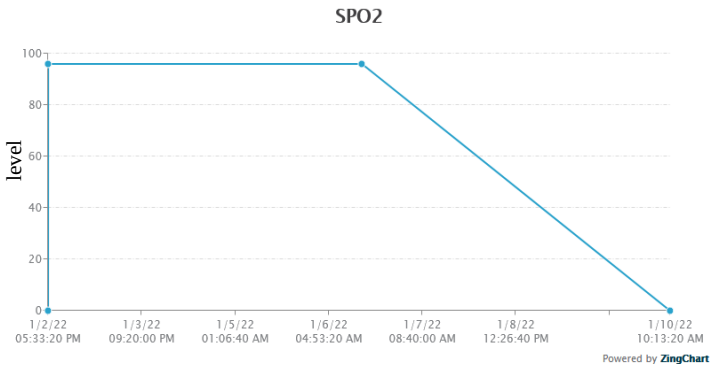

Figure 4. SPO_2 levels in IoT server

6. CONCLUSION

This project is focused on using internet technology to develop a system that would interact via the internet for better health because of how widely utilised the internet is. The IoT is king across many industries, but it reigns supreme in the healthcare sector in particular. The goal of the current project is to develop a smart IoT-based controller-based patient health tracking system. Before transferring the information to the cloud over the internet, this uses a temperature sensor to calculate the temperature and a pulse rate sensor to measure the heartbeat. This data is additionally delivered to the LCD display so that the patient can fully comprehend their health situation. In an emergency, a buzzer also sounds to warn the carer and an alert message is sent to the doctor's phone. By noting the specific website or IP address, the doctor can examine the supplied data. As a result, a system for ongoing patient observation was developed.

REFERENCES

[1] V. R. Parihar, A. Y. Tonge, and P. D. Ganorkar, "Heartbeat and temperature monitoring system for remote patients using arduino," *International Journal of Advanced Engineering Research and Science*, vol. 4, no. 5, pp. 55–58, 2017, doi: 10.22161/ijaers.4.5.10.

[2] M. U. H. A. Rasyid, B. H. Lee, and A. Sudarsono, "Wireless body area network for monitoring body temperature, heart beat and oxygen in blood," in *2015 International Seminar on Intelligent Technology and Its Applications, ISITIA 2015 - Proceeding*, IEEE, May 2015, pp. 95–98. doi: 10.1109/ISITIA.2015.7219960.

[3] S. S. Thomas, A. Saraswat, A. Shashwat, and V. Bharti, "Sensing heart beat and body temperature digitally using Arduino," in *International Conference on Signal Processing, Communication, Power and Embedded System, SCOPES 2016 - Proceedings*, IEEE, Oct. 2017, pp. 1721–1724. doi: 10.1109/SCOPES.2016.7955737.

[4] J. Jalinas, W. K. Raharja, and B. P. E. Wijaya, "Design of monitoring tool heartbeat rate and human body temperature based on WEB," *MATEC Web of Conferences*, 2017, doi: 10.1051/matecconf/201816401017.

[5] M. Bsoul, H. Minn, and L. Tamil, "Apnea MedAssist: real-time sleep apnea monitor using single-lead ECG," *IEEE Transactions on Information Technology in Biomedicine*, vol. 15, no. 3, pp. 416–427, May 2011, doi: 10.1109/TITB.2010.2087386.

[6] M. Wagner, B. Kuch, C. Cabrera, P. Enoksson, and A. Sieber, "Android based body area network for the evaluation of medical parameters," *WISES 2012 - Proceedings, Workshop on Intelligent Solutions in Embedded Systems*, pp. 33–38, 2012.

[7] H. Fotouhi, A. Čaušević, K. Lundqvist, and M. Björkman, "Communication and security in health monitoring systems - a review," in *Proceedings - International Computer Software and Applications Conference*, IEEE, Jun. 2016, pp. 545–554. doi: 10.1109/COMPSAC.2016.8.

[8] N. Oliver and F. Flores-Mangas, "HealthGear: a real-time wearable system for monitoring and analyzing physiological signals," *Proceedings - BSN 2006: International Workshop on Wearable and Implantable Body Sensor Networks*, pp. 61–64, 2006, doi: 10.1109/BSN.2006.27.

[9] E. Jahan, T. Barua, and U. Salma, "An overview on heart rate monitoring and pulse oximeter system," *International Journal of Latest Research in Science and Technology ISSN*, vol. 3, no. 5, pp. 148–152, 2014.

[10] D. Ibrahim and K. Buruncuk, "Heart rate measurement from the finger using a low- cost microcontroller," *Electronic Engineering*, vol. 4, no. 1, pp. 25–29, 2017.

[11] N. Patel, P. Patel, and N. Patel, "Heart attack detection and heart rate monitoring using IoT," *International Journal of Innovations & Advancement in Computer Science*, vol. 7, no. 4, pp. 611–615, 2018.

[12] J. Arora, Gagandeep, A. Singh, N. P. Singh, S. S. S. Rawat, and G. Singh, "Heartbeat rate monitoring system by pulse technique using HB sensor," in *2014 International Conference on Information Communication and Embedded Systems, ICICES 2014*, IEEE, Feb. 2015, pp. 1–5. doi: 10.1109/ICICES.2014.7033986.

[13] P. Soam, P. Sharma, and N. Joshi, "Health monitoring system using iot: a review," *SSRN Electronic Journal*, 2020, doi: 10.2139/ssrn.3606060.

[14] U. Lahamge, P. Phatale, D. Shimpi, S. Walke, and A. Butalia, "Survey paper for health recommender system," *International Journal of Innovative Research in Science and Engineering*, vol. 2, no. 12, pp. 232–239, 2016.

[15] G. Sowmya and B. Sandeep, "Remote healthcare monitoring system using arduino board over distributed ubiquitous environment," *International Journal of Advanced Research in Computer and Communication Engineering*, vol. 5, no. 4, pp. 816–819, 2016.

[16] S. M. R. Islam, D. Kwak, M. H. Kabir, M. Hossain, and K. S. Kwak, "The internet of things for health care: a comprehensive survey," *IEEE Access*, vol. 3, pp. 678–708, 2015, doi: 10.1109/ACCESS.2015.2437951.

[17] A. M. Fernandes, A. Pai, and L. M. M. Colaco, "Secure SDLC for IoT based health monitor," in *Proceedings of the 2nd International Conference on Electronics, Communication and Aerospace Technology, ICECA 2018*, IEEE, Mar. 2018, pp. 1236–1241. doi: 10.1109/ICECA.2018.8474668.
[18] A. Srilakshmi, P. Mohanapriya, D. Harini, and K. Geetha, "IoT based smart health care system to prevent security attacks in SDN," in *5th International Conference on Electrical Energy Systems, ICEES 2019*, IEEE, Feb. 2019, pp. 1–7. doi: 10.1109/ICEES.2019.8719236.
[19] R. DInesh and R. Marimuthu, "A survey about WSN and IoT based health care applications and ADPLL contribution for health care systems," in *2019 IEEE 10th International Conference on Awareness Science and Technology, iCAST 2019 - Proceedings*, IEEE, Oct. 2019, pp. 1–8. doi: 10.1109/ICAwST.2019.8923167.
[20] T. M. Kadarina and R. Priambodo, "Preliminary design of internet of things (IoT) application for supporting mother and child health program in Indonesia," in *2017 International Conference on Broadband Communication, Wireless Sensors and Powering, BCWSP 2017*, IEEE, Nov. 2018, pp. 1–6. doi: 10.1109/BCWSP.2017.8272576.
[21] S. A. Butt, J. L. Diaz-Martinez, T. Jamal, A. Ali, E. De-La-Hoz-Franco, and M. Shoaib, "IoT smart health security threats," in *Proceedings - 2019 19th International Conference on Computational Science and Its Applications, ICCSA 2019*, IEEE, Jul. 2019, pp. 26–31. doi: 10.1109/ICCSA.2019.000-8.
[22] J. Rauscher and B. Bauer, "Safety and security architecture analyses framework for the internet of things of medical devices," in *2018 IEEE 20th International Conference on e-Health Networking, Applications and Services, Healthcom 2018*, IEEE, Sep. 2018, pp. 1–3. doi: 10.1109/HealthCom.2018.8531121.
[23] D. Ding, M. Conti, and A. Solanas, "A smart health application and its related privacy issues," in *Proceedings of the 2016 Smart City Security and Privacy Workshop, SCSP-W 2016*, IEEE, Apr. 2016, pp. 11–15. doi: 10.1109/SCSPW.2016.7509558.
[24] S. H. Almotiri, M. A. Khan, and M. A. Alghamdi, "Mobile health (m-Health) system in the context of IoT," in *Proceedings - 2016 4th International Conference on Future Internet of Things and Cloud Workshops, W-FiCloud 2016*, IEEE, Aug. 2016, pp. 39–42. doi: 10.1109/W-FiCloud.2016.24.
[25] L. A. Tawalbeh, H. Tawalbeh, H. Song, and Y. Jararweh, "Intrusion and attacks over mobile networks and cloud health systems," in *2017 IEEE Conference on Computer Communications Workshops, INFOCOM WKSHPS 2017*, IEEE, May 2017, pp. 13–17. doi: 10.1109/INFCOMW.2017.8116345.
[26] A. A. Khan, M. Faheem, R. N. Bashir, C. Wechtaisong, and M. Z. Abbas, "Internet of things (IoT) assisted context aware fertilizer recommendation," *IEEE Access*, vol. 10, pp. 129505–129519, 2022, doi: 10.1109/ACCESS.2022.3228160.
[27] R. N. Bashir *et al.*, "Intelligent optimization of reference evapotranspiration (ETo) for precision irrigation," *Journal of Computational Science*, vol. 69, p. 102025, May 2023, doi: 10.1016/j.jocs.2023.102025.
[28] A. A. Khan *et al.*, "Context aware evapotranspiration (ETs) for saline soils reclamation," *IEEE Access*, vol. 10, pp. 110050–110063, 2022, doi: 10.1109/ACCESS.2022.3206009.
[29] A. A. Khan and F. A. Khan, "A cost-efficient radiation monitoring system for nuclear sites: designing and implementation," *Intelligent Automation and Soft Computing*, vol. 32, no. 3, pp. 1357–1367, 2022, doi: 10.32604/IASC.2022.022958.

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