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# DEVELOPING AN INTELLIGENT SYSTEM FOR REMOTE MONITORING OF COVID-19 PATIENTS USING IOT TECHNOLOGY

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**Article Info**

**Keywords:** COVID-19, pandemic, smart monitoring, Internet of Things (IoT), health monitoring, remote.

**Abstract**

Technological advancements have always been crucial in creating a suitable living environment and improving the quality of life. However, various obstacles such as age, disease, medications, and epidemics hinder the goal of achieving an independent, comfortable, and healthy life. The emergence of the COVID-19 pandemic in 2019 has drastically changed daily life and had a profound impact on the global economy. The transmission modes of the virus are not fully understood, further complicating efforts to mitigate its effects. While a cure or vaccine for the virus is yet to be discovered, advanced technologies can play a significant role in minimizing the impact of the pandemic. This study focuses on utilizing smart monitor technology based on the Internet of Things (IoT) to reduce the effects of COVID-19. The implementation of a health monitoring system utilizing IoT technology offers several advantages, including minimizing physical contact, reducing hospitalization rates, decreasing wait times, lowering costs for patients, and alleviating the burden on medical staff. Previous research has demonstrated the effectiveness of remote health monitoring systems, such as the Remote Smart Home Healthcare Enhance System (ShHeS), which allows patients to monitor their health status remotely and receive instructions from doctors. By integrating sensors into the system, patients' physiological health parameters can be automatically captured and monitored, facilitating real-time communication with healthcare providers. Additionally, smart home applications can be controlled remotely, enabling individuals to manage their health while maintaining a sense of normalcy during the pandemic. Moreover, advanced technology has the potential to aid in the early detection of COVID-19 cases, reducing the spread of the virus. The importance of smart city technologies, such as location tracking, in mitigating the

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impact of the pandemic has been extensively discussed. Furthermore the use of drones and robots in healthcare settings has been explored, highlighting their role in providing medical assistance and essential services without direct human contact. Leveraging the capabilities of the Internet of Things (IoT) enables remote monitoring of COVID-19 patients during their quarantine period, allowing doctors to remotely diagnose patients, prescribe treatments, and monitor vital health parameters. In conclusion, this paper proposes an intelligent health support system that employs portable sensors for remote monitoring of COVID-19 patients during quarantine. Parameters such as temperature, pulse, oxygen levels, and blood pressure, which are significantly affected by COVID-19, can be remotely diagnosed, enabling timely medical interventions and prescriptions.

## 1 Introduction

Technological development always plays an important and essential role to provide a suitable environment for living [1]. The goal of any human being, regardless of this age, gender, location, or health condition is an independent, comfortable, and healthy life. However, obstacles arise due to age, disease, medications, epidemic, and other conditions. The spreading of coronavirus since 2019, all the characteristic of daily life has been changed. In addition, the economic side has been affected too. Moreover, the main cause of the infection is not known, whether by spray, touch, or air. Although the vaccine has not been known to cure this epidemic until now, we can reduce the impact of the epidemic by using one of the advanced technologies. In this paper, we used smart monitor technology to reduce the effect of covid-19 based on the internet of things (IoT). The system of health checking plays a very essential role in reducing bodily contact, hospitalization, discussion time, waiting list, the cost for the patient, and reducing the load of the medical staff. Therefore, developments in data and communication technologies provide contacting everywhere and anytime a valued contribution to the progress of the health care system and distant persistent checking [2, 3]. Barton, Duval et al. proposed remote smart home healthcare enhance system (ShHeS) for monitoring patients' health status and receiving doctors' instructions while staying at home [4]. In addition, the doctors can also give a diagnosis of illnesses by using the data collected remotely from the patients. The system made dual real-time communication between patients and doctors by implementing the application of an Android-based mobile that interrelates with the application of web-based. They integrated the sensors into a system automatically capturing patients' physiological health parameters. The system plays a dual role in monitoring health and controlling basic home applications remotely. So, the people can delight in their communal life while still managing and monitoring their health, especially during the era of the epidemic [5]. Bowen and Yanjing proposed an adaptive system by depending on the diagram implanting technique during the state representation and reinforcement learning in the training phase [6, 7]. The results show that the system can reduce the epidemiological reproducing rate of the infection beneficially by relying on a pair of real-life datasets. Advanced technology has the potential to help the detection of COVID19 situations at the initial point [8, 9]. In addition, Allam, Jones, Costa, and Peixoto studied the desired importance system of smart cities for falling the impact of the coronavirus [10, 11]. They discussed the uses of all smart city technologies broadly to alleviate the risks of covid-19 [12, 13]. Where they showed the importance of location technology in tracking infected people. Moreover, some researchers discussed the use of drones and robot technologies to work as medical staff and useful for other important facilities [14–16]. In addition, they show the importance of smart health care to take care of the injured and treat them without any contact [17]. As we explained, using the internet of things (IoT) will improve health care and also enables remote monitoring of patients, especially smart city technology covid19

patients during their quarantine [18–21]. Thus, doctors can display patients from their clinics, propose prescription, and view measured energetic health restrictions for distant diagnosis. In this paper, an intelligent health support system has been designed to monitor the covid-19 patients remotely during their quarantine. The parameters, such as temperature, plus, oxygen, and blood pressure which are affected by COVID19 can be diagnosed remotely by using portable sensors for medical diagnosis and prescriptions [22–24]. **2 Project requirements**

**2.1 Sensors**

In this paper, there are two sensors used to collect the data from the patients.

**2.2 MLX90614**

It is non-contact temperature reading, the smart metering thermometer, and it has a lot of applications like Windshield defogging, Livestock monitoring, and Movement detection, etc. In this paper, it is used to read the body and room temperature [25–27].

It is distinguished by its small size, low cost, and ease of integration.

**2.3 AX30100**

It is an integrated solution of pulse oximetry and heart rate detect sensor. It consists of LEDs, a photo-detector, optimized optics, and low-noise analog signal processing.

**2.4 Microcontroller**

ESP32 microcontroller is used with a node sensor to receive the data from the sensor and send it to the server. The ESP32 is a dominant 32-bit microcontroller, and it combined Wi-Fi, a full TCP/IP stack for internet connection, and Bluetooth 4.2. Due to the low cost combined with limitless power, and the chance to connect the ESP32 to many other electronic devices the microcontroller is well suitable for IoT projects [28–31].

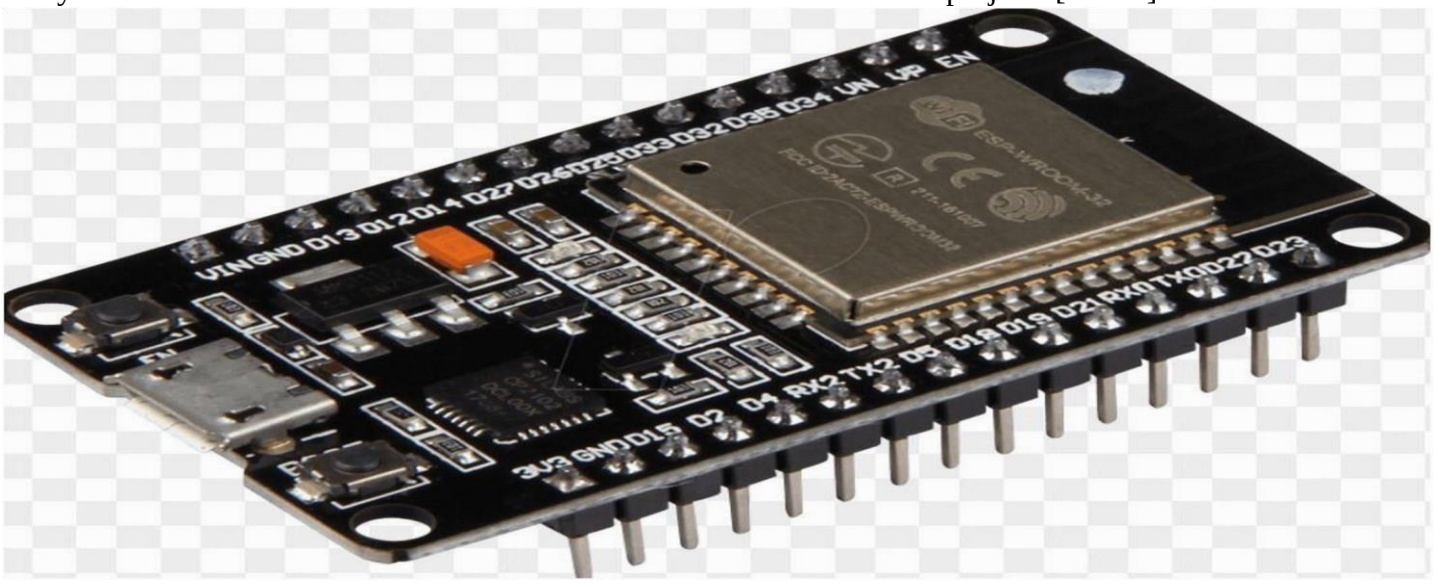


**Fig. 1.** It shows the ESP32 controller

**2.5 Server**

The server which is used is Raspberry Pi 3 Model B+. the Raspberry pi 3 variety boastful a 64-bit. The quad-core processor organization at 1.4GHz, dual-band 2.4GHz and 5GHz wireless LAN, Bluetooth 4.2/BLE, faster Ethernet, and PoE ability by an unconnected PoE HAT [32–34].


**Fig. 2.** Show the raspberry pi 3

### 2.6 Communication

To send data by **Wi-Fi, the MQTT** protocol (Message Queuing Telemetry Transport) is used. MQTT protocol is a light messaging transport protocol based on distributing/ contribute messaging and works on top of TCP/IP [35, 36].

### 2.7 Logic level converter

It is represented by a minor device that safely steps up 3.3v to 5v and steps down 5v signals to 3.3v at the same time, also it works with 2.8v and 1.8v devices.

### 2.8 Application

The application will be able to be retrieved through most tools like computers, phones, and tablets, individualistically of their operating system.

## 3 Proposed works

Health monitoring has become a reality. With the start of the internet of things (IoT), it became possible to monitor the patients, write prescriptions, and consult remotely. Medical equipment such as sensors, precise control, and actuators have become intelligent. As a result, it became easier to access patients' data to doctors and organize their health remotely. In addition, patients' health standards can be measured and transferred to the database for treatment diagnosis. Thus, people infected with the coronavirus or who contact infected patients can be quarantined at home or hospital and monitored remotely without any physical contact. In this paper, a health monitoring system is proposed for the patient during their quarantine. The function of our proposed system is to monitor and record the patient's physiological data such as body temperature, room temperature, pulse rate, and blood oxygenation. When this data is collected by sensors and then transferred via Wi-Fi to the server. The data can be displayed on the server by using a mobile, iPad, or laptop in the form of curves. The main goal of this system is that to reduce the crowded groups of patient's people in hospitals and reduce the transmission of infection from the patients who are infected by empedic to the medical staff. As well as it provides a comfortable life for the patient during quarantine or home quarantine. In this paper, we used health parameters such as body temperature, room temperature, blood oxygenation, and heart rate as a focus of our design.

### 3.1 System construction

Figure 3 illustrates the engineering design of the suggested system. This construction includes sensors, microcontroller, Wi-Fi network, server, and mobile or laptop. The scenario of this system is, the MLX90614 sensor measures both room temperature and body temperature, and the MAX30100 sensor measure both heart rate and blood oxygenation. The sensors have connected to a logic level converter, as we can see clearly in Figure 4. Because the sensors transmit their data at 5v, while the ESP32 works at 3.3v, a logic level converter is used to shift the signal from 5v to 3.3v or from 3.3v to 5v. So, ESP32 can read the data from the sensors.

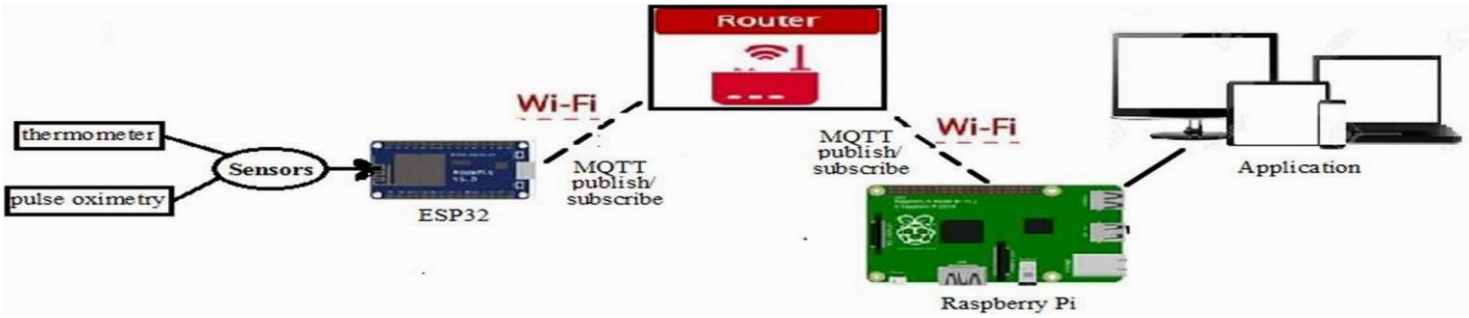


**Fig. 3.** It shows the system components

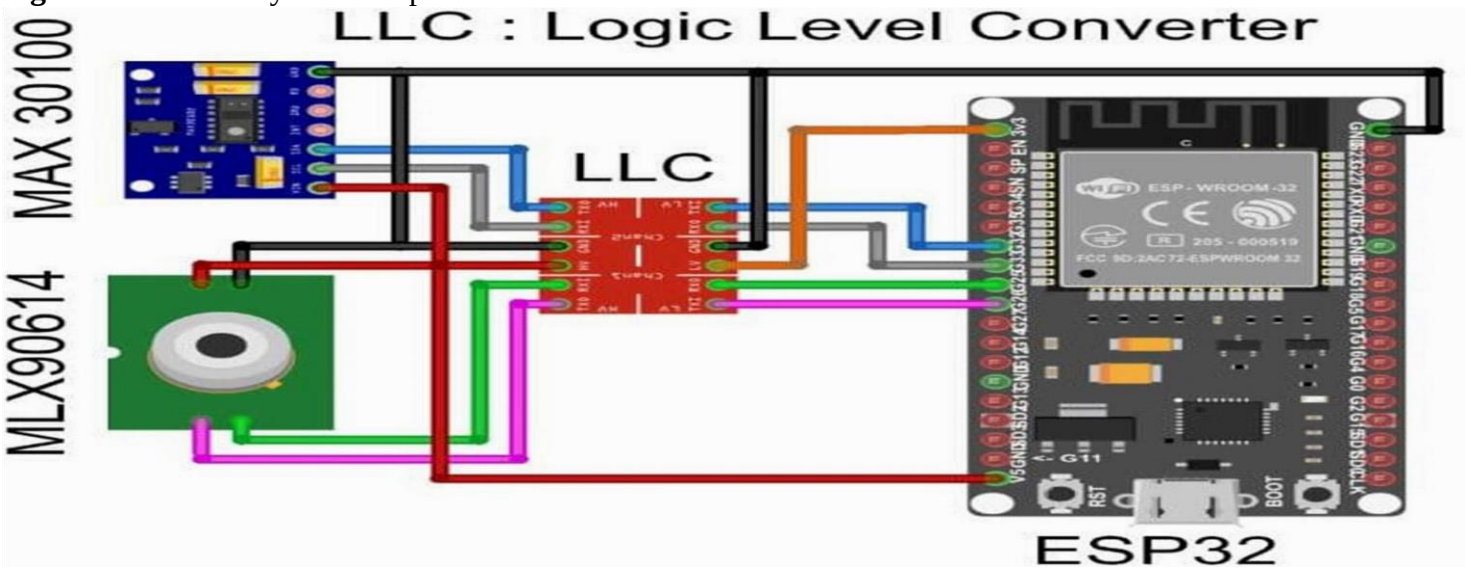


**Fig. 4.** It shows the diagram circuit of the proposed system

The readings obtained from the sensors will be collected in the ESP32 microcontroller connected with the sensors node. Then, the data will be sent from the ESP32 microcontroller to the server via the internet using the MQTT protocol. The server is Raspberry pi, where the data is stored and processed in the database, then extracts the minimum, maximum, and average rate from the data in the form of curves over time. Through a mobile phone, laptop, or iPad. The doctor can monitor the patient's status by entering the IP address of the server on the website. Through these curves, the doctor can know the status of quarantined covid-19 patients. By this, we can reduce the transmission of the covid-19 infection to the medical staff.

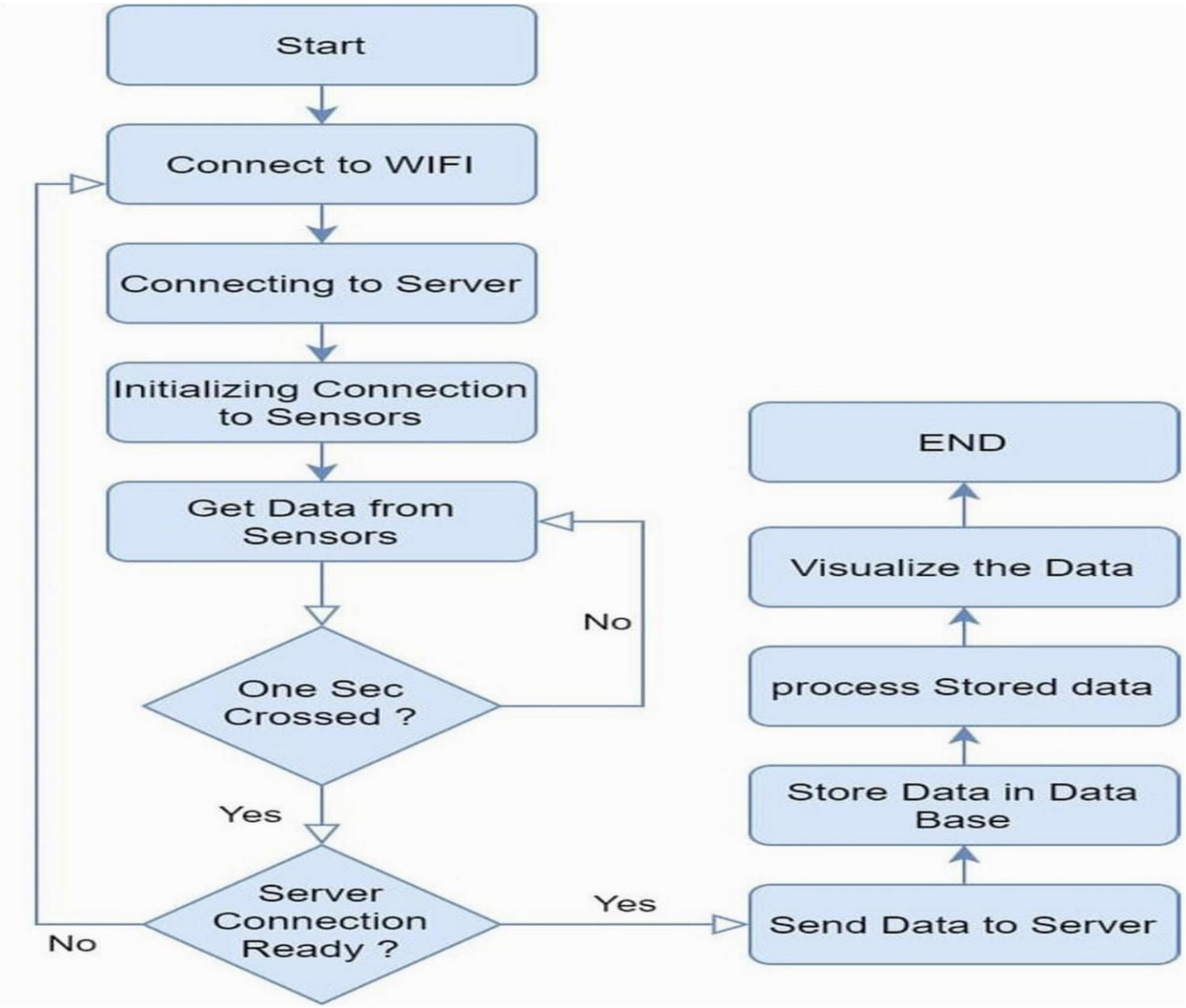


**Fig. 5.** It shows the flow chart of the proposed system

## 4 Results and discussion

The proposed smart health monitoring system has both patient and physician sides. On the part of the patient, the sensors measure the patient's health standards and collect this data in the microcontroller and send it to the doctor automatically every period of time. On the other part, the doctor can check the results through a mobile phone, display screen, or laptop as soon by entering the IP address of the server on the website. In addition, the doctor can monitor many patients who are infected with covid-19 and view their health standards remotely. In this system, health parameters that are affected by the covid-19, such as body temperature, the oxygen level in the blood, and heart plus rate are monitored. The proposed system extracts these correct parameters from the server in the form of curves over time, as shown in Figure 6.

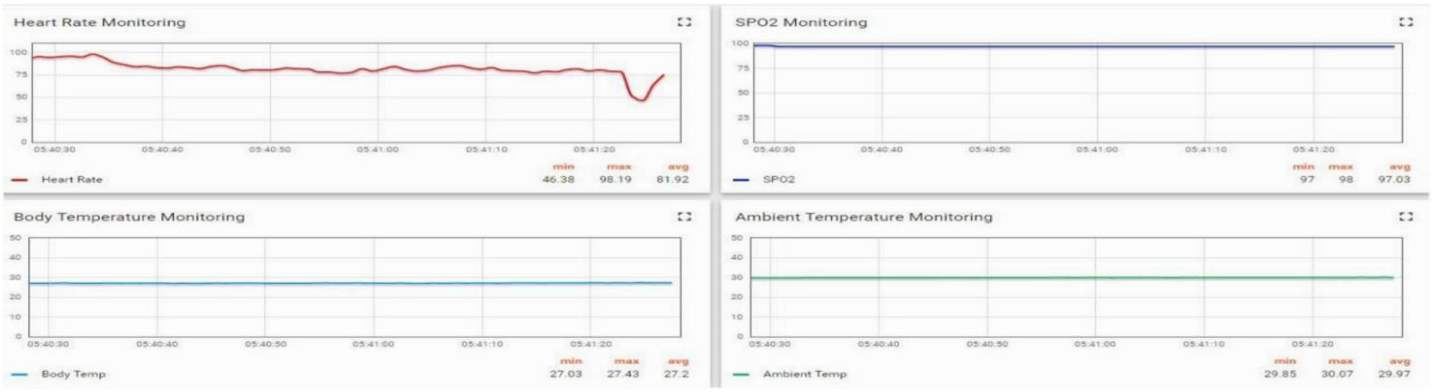


**Fig. 6.** It shows the results of the system

Figure 6 shows the correct standards for the covid-19 patient every ten seconds. In addition, it extracts the minimum, maximum, and average rate that the patient reached based on these measurements. The range of time, we can change it from the website interface. In addition, the doctor can view the data for the last minute, day, or month, etc. Thus, the doctor can monitor and see the health standards of the covid-19 patient, know the response rate to the treatment provided, and prescribe drugs if needed. The system is designed for the medical staff to monitor the largest possible number of patients at the same time and remotely without any contact with the patients. This proposed system serves the great purpose of activating a distant checking of covid-19 patients. Also, it is used to protect the medical staff from contact with coronavirus infection.

## 5 Conclusion

The implementation of the internet of things (IOT) has greatly improved comfortable living, health care, and improved social lifestyle for the people. The monitoring system makes the contact between the patients and doctors easy. In this paper, an intelligent monitoring system was suggested for covid-19 patients. This work has mainly focused on reducing transmission of coronavirus infection and medical staff through smart monitoring. Also, this system monitors health parameters that are affected when infected with covid-19, such as body temperature, blood oxygen level, and heart rate. The proposed method will have a significant impact on the rate of coronavirus transmission within hospitals. By using this system, it will be no need for a doctor to visit covid19 patients and check their health status. Through this application, the doctor can know their health standards, which ensure the reduction of infection transmission to the medical staff.

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