IoT Based COVID Patient Health Care and Monitoring System

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Abstract— **Patients health care monitoring has become one of the major concerns in this present era. Since the technology has also been evolving, it is getting more advanced and technical, typical manual methods of health monitoring. They do not only consume a huge time and resources but impossible to monitor each patient all the time. Fact is that not all diseases require the real-time monitoring of a patient, but some of them are fatal needed due to slight negligence. These types of disease must be monitored such as heart problems and COVID-19 on regular basis, which consume millions of lives. Current epidemic of COVID-19 is not like ordinary disease that can not only damage the human health as lungs, abnormal heartbeats, but also decreased oxygen saturation which leads to death. To overcome this issue, we propose a real-time monitoring system that is exclusively designed for COVID patients. This paper aim is to develop a COVID-19 wearable band and mobile application which is purely based on internet of thing (IoT). Our system requires all integrated sensors along to display readings on screen, and to communicate wirelessly with respective medical person if any critical situation rise with its mobile application. This wearable band perform completely autonomous to monitor patient condition parameters like temperature, heart rate, and .oxygen level**

Keywords— **Arduino, Health System, IoT, Real-Time COVID Detection**

INTRODUCTION

Since the COVID-19 pandemic, health care organizations and health services are struggling to improve health system. COVID-19 is wide-spreading disease that has been seriously affected the world [1]. Generally, COVID-19 is virus of flu disease that can spread along additional diseases. It can fall in several stages, including the overnight incubation, which has least noticeable symptom because it has no characterized as asymptomatic. The next stage includes severe symptom such as fever, cold, and cough to make weak immune system. This virus spreads subsequent stage throughout the whole body [2]. The early symptoms of COVID-19 are expected to monitor the patient health to isolate the spread of the virus. To detect the symptoms of new virus is difficult to observe health and measure certain symptoms like body temperature, oxygen saturation, and pulse rate.

Considering the present situation of COVID-19, Pakistan is

top most hit country after the fifth wave of COVID all over the world. It is very difficult to detect and control the virus when it is optimal follow instruction and make distance. It can be optimally managed and monitored when a better system can serve for COVID patients. Monitoring and inspecting patients can help healthcare personnel to eliminate social interactions. Wearable technology is one of the most demanded product in the market that can detect and anticipate the prevalence of COVID-19 using a sensor to monitor health parameters such as heartrate, temperature, and oxygen saturation [3]. Wearable technology has now been playing a great role in the diagnosis and detection of the COVID-19 pandemic in the medical and healthcare industries, [4].

As, the world has been moving towards automation and smart systems, Internet of things (IoT) is one of the most adopted technology and researched in various field of study. IoT offer to connect to many embedded sensors to integrate programmable modules for performing a specific task [5]. This technology presents the idea of smarter devices and is to introduce hustle-free way for isolated COVID patient when there is no or very few medical staff or concerned require strong emergency situations. IoT can be used microcontroller and alert service to detect the patient condition [6-7].

Previous studies present wearable wristwatch that can detect the body temperature, oxygen level, and heartbeat of a patient, but some researches has not included the same features as our proposed system. It contains oximeter and heartrate embedded DIY smart watch fitness tracker, monitoring the heartrate wearable/portable and wireless using electrocardiogram (ECG), COVID-open-source pulse oximeter, FITBIT INSPIRE wrist-watch and so on [8]. Oximeter and heartrate and DIY fitness tracker watch can track the fever but doesn't have any application to maintain history. Hence, it is difficult to use these devices because of its hardware design, as shown in Figure1

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Fig.1. DIY Fitness tracker watch

Wearable/portable devices using electrocardiogram (ECG) monitors the heartbeat and heartrate. This device shows their results in ECG report that can help person while monitoring the heartbeat with some LED colors alerts. It can show light blue LED light when a heartbeat is normal and gets darker when the heart goes up. It turns red when the heartbeat is highest in the last stage [9], as shown in Figure.2.
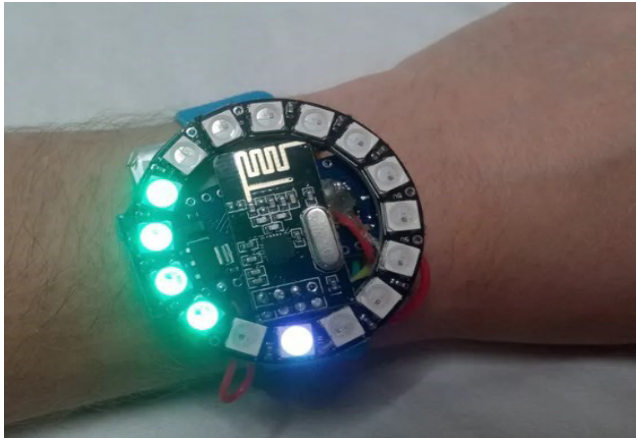
Fig. 2. ECG -Heartrate monitor

Open-source pulse oximeter monitors the heartbeat and body temperature either the person has symptoms of COVID-19 or not [10]. This device is only work as long the finger of the person is right placed on the device, as shown in Figure.3.
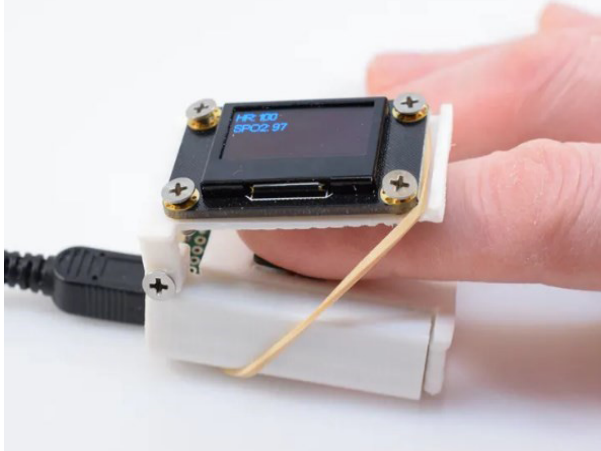
Fig. 3. COVID-19 -open-source pulse oximeter

FITBIT INSPIRE wristwatch is an activity tracker which can measure by heartbeat, distance walk and display complete details on mobile screen, as shown in Figure. 4. It generates an emergency alert if it observes any unusual number in the person's heartbeat. Some of the latest FITBIT watches are now becoming more advance as they record oxygen levels and the number of steps taken by the person [11]. The message alert feature is an attractive service of the Fitbit wristwatch. Alert system is also found in some of the previously designed watches by FITBIT. This feature of FITBIT has saved many

lives [12]. We present some real life case studies that shows how a FITBIT has saved people's lives, including a well-known case of 73-year-old woman. FITBIT was alerted to indicate the medical issue when her FITBIT revealed a resting pulse of 140 beats per minute [13-15].

Fig.4. FITBIT INSPIRE wrist watch

Many other lives are protected using FITBIT as we presented into two case studies as follows [16-17]:

A. Case study I
According to CNN news headlines, patricia lauder was call emergency service when her device alert. Doctors diagnosed her heartrate was spiked, and physicians discovered. She found that her two major blood blockages in lungs when she scans and diagnostics. The blockage in her lungs had controlled heart to function harder to pump blood throughout the body, which might have been catastrophic if left untreated. She reported that "my heart had enlarged to about 65% beyond its normal capacity,". She had been battling a sinus infection, which she initially blamed for increasing pulse rapidly. However, when FITBIT revealed that her heartrate was not slowing down. When she visited to general care physician, diagnose such as X-rays revealed that it was not a cold or pneumonia. She noticed something was awry when her pulse reached 140 beats per minute.

According to NHS, most adults has increased resting pulse of 60-100 beats per minute. Patient call to ambulance to the Farmington clinic's emergency unit. she was hospitalized and found had blood clots in her lungs, which were putting strain on heart functions.

B. Case study II
 According to USA TODAY news, Deanna Recktenwald got a strange notice from Apple Watch Series 2 in April 2018. the monitor system alert that "Seek medical attention". She diagnosed 18-year-resting old's heart rate and soared to 190 beats per minute. According to health clinics, the typical heart rate of person is between 60 to 100 beats per minute.

These real life case studies indicate that such kinds of feature have to use in other things to measure oxygen level, and body temperature. During the COVID-19 period, the main problem is faced by our front-line doctors and nurses. This is study aim to provide the smart health monitoring system that can detect and track the patient history and emergency situations.

Concerning the all developments were found fair and enough to perform with their specific features [18], but some issues still arise with them [19]. In this research work, we include all features like device availability for 24/7, availability of emergency alert service message, measure basic and vital symptoms reading for estimating human internal health parameters such as heartbeat, oxygen level, body temperature. In details, we present comparison work of our proposed system with other projects on the basis of their features and their performances in Table I.

Table 1. Comparative work

Features	[7]	[9]	[10]	[11]	Our system
(Body Temperature (°C	-	-	-	-	36.5
(Heart-Beat(BPM	88	89	86	-	67.229
(%) Oxygen Level	-	-	92	Only by Light	

The main contribution of this paper is to develop the health care monitoring system that is especially designed for COVID patient. This research present an IoT based health monitoring system and design of hardware and software of wearable real monitoring using Arduino microcontroller. We develop android application and wearable band of COVID detection. Our proposed work can detect with features as body temperature, heart beat (BPM) and oxygen level. The SMS alert system is proposed in our research work as well. This is first research is designed and made in Pakistan, and we believe that there is no such type of health monitoring products is completed in our country.

Further, the paper organization is divided into V sections. Section II present the methodology of our proposed work. Section III shows the hardware and software development and interface. Section IV present results and discussion of the mobile application, and its features in details. Section V conclude the proposed work.

METHODOLOGY

Wearable technology is main consideration, progress and designed globally. If there is any wearable band for COVID detection is made, it has a highly cost which is not affordable for a middle- or lower-class person. Our idea is to design such a product that is not only efficient but also cost-effective that can be able to serve everyone. IoT COVID patient health monitor is a wearable electronic device for COVID and heart patients which monitors heartrate, oxygen and temperature as

well. If any anomaly is being detected by the device, it will generate an alert to the doctor or any health care person having the application. This system allows doctors or users to monitor patients remotely without the risk of infection. It also helps the doctor or user get an instant alert in case of health fluctuations or emergencies.

HARDWARE AND SOFTWARE DESIGN

The basic system contains two different types of sensors, i.e., temperature sensor and oxygen and pulse rate sensor for measuring body temperature, oxygen saturation, and heart rate of the patient respectively. The sensors are connected to a microcontroller (ESP8266), which has a built-in WI-FI module. Our proposed IoT COVID band wired diagram is shown in Figure.5.

The microcontroller is programmed to communicate the real-time readings to the mobile application via Wi-Fi, these readings are compared to a range of normal values provided to the system and if there is any high or low value has been detected, an alert will be generated for the respective health care person.

A. Mobile Application Development

The development is divided into two parts, the testing phase and the finalization of the prototype. The testing of sensors is performed with microcontroller Arduino UNO, and the project is finalized with the ESP8266 controller. Both parts are further divided into hardware for making and coding. The final prototype construction was divided into three parts, i.e., making of hardware, coding, and integration of hardware with the android application according to IoT COVID band wired diagram.
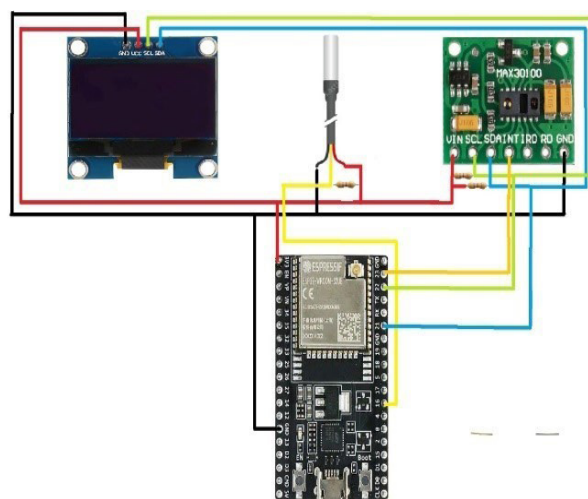
Fig. 5. IoT based COVID band wire diagram

Inter-Integrated Circuit (I2C) is a communication protocol that can be used for data and signal transfer to sensors to

micro-controller, and to the basic hardware structure after completion. The final presentation of connected hardware as shown in Figure.6.

Fig.6. Presentation of connected hardware

Sensors infrastructure is placed into a small box and the final prototype with a cloth band as shown in Figure. 7and Figure. 8.


Fig. 7. Sensor system of acrylic box

IoT based COVID detection system-complete prototype

After the completing the hardware specifications, micro-controller coding is proceeded by android application development on Blynk as shown application interface in Figure.9.

RESULTS

In this section, we present the results of the proposed systems. Results show that the initial prototype proves to be beneficial in taking the readings and providing a real-time performance which can be presented the real time monitoring and performance in Figure.10.
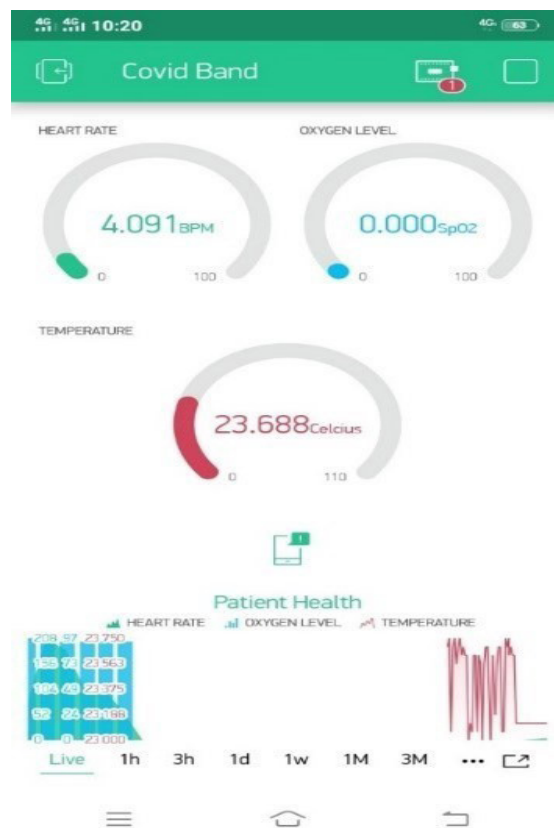
Fig.9. Mobile application interface

Fig.10. Real-time monitoring and performance results

We compared results of our proposed work with other similar projects on the basis of their features available. We can found that the proposed system is more beneficial for society and health specialist. All these tests of our proposed system are conducted with a person of age 24 years as shown in Table I and II.

Table 2. Test Results

PROJECTS	Monitoring temperature	Oxygen Level	Heart Rate ((BPM
Proposed IoT COVID Patient Health Monitor in Quarantine	C° 36.5	95	67.229
Oximeter and Heart Rate embedded DIY Smart Watch Fitness Tracker	N/A	N/A	82
FITBIT Inspire Wristband	N/A	N/A	88
Open Source Pulse Oximeter for COVID-19	N/A	92	86
Monitoring the heart rate Wearable/portable) and Wireless Using (Electrocardiogram	N/A	N/A	Only by Led Light

Table 3. Service results

PROJECTS	Work 24/7	SMS alert	COVID Detection
Proposed IOT COVID Patient Health Monitor in Quarantine	Available	Instant Alert	Instant Alert
Oximeter and Heart Rate embedded DIY Smart Watch Fitness Tracker	Available	N/A	By Showing temperature
FITBIT Inspire Wristband	Available	Instant Alert	Instant Alert
Open Source Pulse Oximeter for COVID-19	N/A	N/A	By Showing temperature
Monitoring the heart rate Wearable/portable) and Wireless Using (Electrocardiogram	Available	N/A	N/A

The benefits of this system is that it can also be observed in the hospital where doctors can monitor the patient while maintaining social distancing. Doctors can be available to the serious patient immediately when any alert SMS found on application. These types of features are vitals measurement of this system. Secondly, it is helpful for every person dealing with some health issues to monitor his /her health vitals all the time and receive an alert before it gets worse, and immediately send another alert to the respective healthcare person with the application.

CONCLUSION

This research has proved to be a great success since the concept has fulfilled many flaws of existing fitness and smart health watches such as being expensive, not taking oxygen saturation, temperature levels, and not being able to send alerts to health specialists. In this paper, we propose monitoring system that is efficient method of monitoring the serious patients which has been previously done manually or through the camera. Previous devices was not more effective and required a lot of hard work and time from the doctor for monitoring every patient all the time. Hence, we improved and present an advanced form of a wearable electronic watch for COVID and heart patients that can monitor their heartbeat, oxygen level, and temperature as well and in case of an anomaly being noticed. Our proposed system will generate an alert to the doctor or any health care person having the application.

We believe that our research is quite economical and helpful for largescale implications such as the hospital, health centers, and COVID quarantine.

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