

Smart Internet-Of-Medical Things Wearable Watch For Earlier Symptoms Detection, Monitoring And Tracking Of Covid-19 Patients

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ABSTRACT: This project has developed a way to remotely monitor and provide early detection of COVID-19 symptoms using smart watches and Internet-of-Medical-Things (IoMT) technology. This wearable watch detects symptoms and notifies healthcare professionals without the need for direct contact. This minimizes risks to caregivers and reduces the spread of the virus, which is crucial in both flattening the nation's infection curve and limiting disease morbidity and mortality. Results show that the smart watch in conjunction with the proposed system can effectively detect COVID-19 symptoms, signaling the project's high potential to aid in the nation's pandemic response.

Keywords: COVID-19 Symptoms Early Detection, Wearable Devices, Healthcare Monitoring

1. INTRODUCTION

The ongoing Coronavirus Disease 2019 (COVID-19) global pandemic is at a critical juncture, with new variants posing serious threats to public health. It has caused more than 187 million confirmed cases, with more than 4 million deaths as of July 2021 marking it as the deadliest pandemic in history [1]. This unprecedented disease has severely strained the healthcare systems of even developed nations as they faced sudden surges. In addition, we have also witnessed instances of healthcare collapse in various countries. Moreover, as new variants speed up the infection rates, hospital facilities and resources are over consumed, which exacerbates higher mortality rates. The currently used conventional reverse transcription-polymerase chain reaction (RT-PCR) technique in COVID-19 detection endures with some inevitable limitations [2]. Consequently, the establishment of reliable detection and monitoring system for earlier detection of COVID-19 symptoms is essential for effective prevention and to contain a growing public health crisis.

2. MOTIVATION

One of the main challenges facing health authorities is that they have to diagnose patients without knowing if they have already been infected. A patient may already be in the infectious stage, which is risks transmission to

attending medical staff. Remote and early detection of infections is important to mitigate disease spread through self-isolation, contact restriction and effective treatments. A recent study [3] have shown that elevated heart rate measurements from smartwatches can be used in epidemiological studies to track the spread of respiratory viruses. Moreover, since most infections become apparent only upon symptoms onset, current testing methods cannot identify pre-symptomatic carriers, which is a significant challenge for the implementation of early-stage interventions that reduce transmission. It is believed that as much as 50% of COVID-19 cases are asymptomatic, facilitating further viral spread. Hence, this project makes use of body temperature, heart rate and blood oxygen levels (SpO2) which are key indicators that can help detect COVID-19 infection.

3. NOVELTY AND INNOVATION

This project embodies the concept of COVID-19 symptoms detection driven by Internet-of-Medical-Things (IoMT). The novelty lies in the development of a wearable smartwatch that integrates with a Firebase cloud and real-time web-based monitoring system specifically tailored for COVID-19 detection. Our system can be divided into five distinct phases as shown in Figure 1(a) while the system prototype and the results obtained are illustrated in Figure 1(b). The 1st phase consists of data acquisition where vital signs from patients' smartwatches are collected at home and sent to a centralized cloud to power a multi-tiered alert system to doctors. This is made feasible by the use of sensors for temperature (DS18B20), heart rate & SpO2 (MAX30100). These rudimentary yet key signals can infer the general state of a person's health.

Subsequently, Phase 2 initiates COVID-19 symptoms detection using Raspberry Pi which then classifies the data into three conditions (low, medium and high risk). The aim here is to detect prolonged readings outside of pre-defined safe thresholds which can be inferred as potential symptoms of COVID-19. These classifications can also significantly guide medical staff on the appropriate level of action to be taken on infected patients.

Phase 3 involves alerts and notifications once dangerous thresholds are exceeded. This is done using

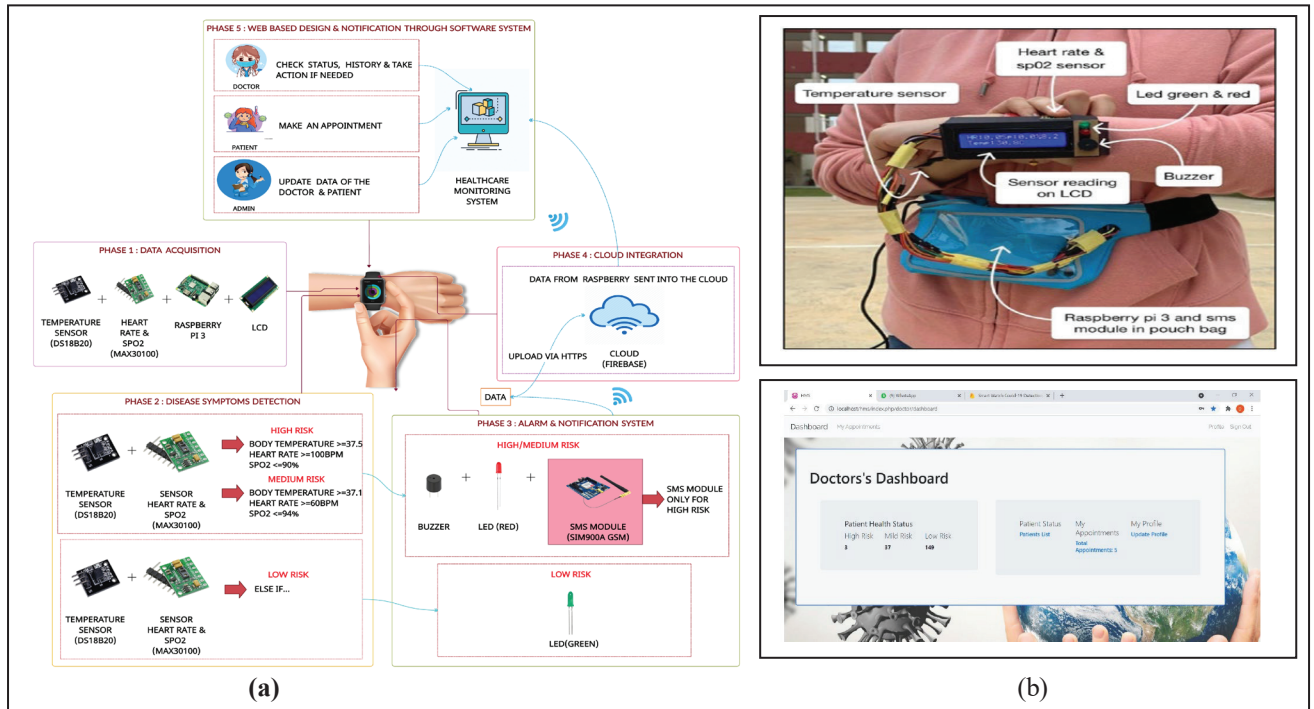


Figure 1: (a) System Overview (b) System Prototype and Results indicating high risk for Covid-19 patient

LED, buzzer and an SMS module (SIM900A GSM). Upon exceeding any normal threshold and classified as high risk for over 5 times, SMS alert will be sent directly to the doctor in-charge. As shown in the figure, the sensor attached to a patient’s finger is used to measure body temperature, with normal temperature identified as between 36 to 37.2 degrees (Celsius). Abnormal conditions are defined as anything other than within this range. Conversely, the sensor to measure the patient’s heart rate has a normal range from 60 to 85 beats per second (bps). Readings out of this range are considered critical to patient health as it may cause brain lesions to form in the target patient demography.

Moreover, Phase 4 emphasizes on cloud integration in which data will be securely uploaded into the Firebase cloud via HTTPS. Data transmission using HTTPS is crucial to protect sensitive information related to medical data. Finally, Phase 5 entails the development of Healthcare Monitoring System (HMS) for data analysis through cloud analytics. Real-time sensed data is continuously fed into the Firebase database, and updated in the HMS to be used by doctors for further diagnosis. This system also features graph visualization and patients’ historical data which allows for timely diagnosis of symptoms, without the need for ever-present medical staff. Doctors can directly observe whether the patient is in a high, mild or low risk based on data classification done on the microprocessor. For high-risk patients, immediate further actions can be taken by either urgently moving them to medical facilities via ambulance, or by calling on local health staff to further inspect patients. This system is also accessible by patients to monitor their own status and to make appointments with doctors. They can also see their prescriptions, and check whether their appointments are approved or if they should follow alternative medical instructions.

4. CONCLUSION

Collectively, the proposed IoMT smart watch and the developed HMS features would be useful to rapidly and safely detect COVID-19 patients. This will ameliorate the spread of viral infections during the current pandemic and allow greater control by health authorities. This will also limit community transmission and hence reduce the morbidity and mortality rates in the whole world. In Malaysia, this detection system will greatly help the management of COVID-19, protect our front-liners, and assist in timely disease containment.

Due to rapid spread of coronavirus, earlier detection of symptoms can greatly reduce the spread of the disease, and provide timely intervention before it severely affects patients’ health. Therefore, the developed product and system has a high commercialization potential due to its relatively low cost, operational simplicity, and ability to reduce the workloads of healthcare professionals, and ultimately save lives.

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