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Design and implementation of a Social Distance Vest for Covid19 prevention (SODIV-COP)

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ABSTRACT

According to research, it is discovered that amongst the Covid19 preventive measures, social distance is easily neglected especially in a public setting such as markets, trading centers, social and political gatherings. Furthermore, according to World Health Organization (WHO), not observing social distance is one of the major ways that the coronavirus is being transmitted. Hence, working on a vest that can help to remind individuals and alert them in cases where they are not observing social distance. The Social Distance Vest for Covid19 Prevention, is based on Arduino Uno microcontroller board, DHT-44L-06 thermal sensor which detects the presence of a person, HC-SR04 Ultrasonic sensor that calculates the distance from where the person is standing and an alert/warning system that is composed of a Light Emitting Diode and a buzzer. Finally, the whole system is mounted on a reflective vest. The prototype vest works perfectly, in that it is able to detect a person which was not possible in the previous covid 19 distance vests which had only messages, and it is able to calculate the distance from where humans are standing and finally, triggers an alarm in a case where the person is standing at a distance of less than 1 m. The varying temperature ranges were in an array form and from 35 to 38°C Celsius it detected the obstacle to be a human and had some ranges of distance 0.334 m measured by the ultrasonic sensor. Key applications of the prototypes are in crowded places like stadiums hospitals and schools.

1. Introduction

The coronavirus disease was first identified in patients with severe respiratory disease in Wuhan, China in the year 2019 [1]. The cause of this was known to be a coronavirus scientifically named Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) [2]. Currently, there are no specific antiviral treatments or vaccines available for Covid19. Treatments mainly focus on symptomatic and respiratory support according to protocols issued by World Health Organization (WHO) [3]. People with Covid19 have had a wide range of symptoms reported ranging from mild symptoms to severe illness. Symptoms may appear 2–14 days after exposure to the virus and could have mild to severe symptoms. These symptoms include; Fever, Cough, Shortness of breath or difficulty breathing, fatigue, muscle or body aches, Headache, New loss of taste or smell, Sore throat, Congestion or runny nose and nausea or vomiting diarrhea. Some of these symptoms led to death of patients especially for those with weak immune system or were already suffering from other respiratory related diseases such as Tuberculosis, asthma etc. This had negative impacts on the world at large in all aspects of life and hence efforts were to be made to stop the virus from further spreading.

Since there was no cure or treatment, individuals are to follow preventative measures to keep the virus in check. Social distancing, also called “physical distancing”, means keeping a safe space between yourself and other people around you. To practice social distance, stay at a distance of at least 1 m away from other people. It should be practiced in combination with other everyday preventive measures to reduce the spread of Covid19, including wearing face-masks, avoiding touching your face with unwashed hands, and frequently washing hands with soap and water for at least 20 s [4].

Covid19 spreads mainly among people who are in close contact (within about 1 m) for a prolonged period [5]. Spread happens when an infected person coughs, sneezes, or talks and droplets from their mouth or nose are launched into the air and lands into the mouth and nose of another person nearby. The droplets can also be inhaled into the lungs. Since people can transmit the virus before they know they are sick, it is important to stay at least 1 m away from others when possible, even if you-or they-do not have any symptoms. Social distancing is especially...
important for people who are at higher risk for severe illness from Covid19. It helps limit opportunities to come in contact with contaminated surfaces and infected people outside the home [6]. As discussed, Social distancing can never provide 100% prevention rate, but by following these simple rules, individuals can play a critical role in slowing the spread of the coronavirus. If the number of cases isn’t kept below what the health care system can handle at one time-called flattening the curve-hospitals could become overwhelmed, leading to unnecessary deaths and suffering [7].

According to WHO, we can prevent the further spread of Covid19 by washing hands frequently, wearing face masks and maintaining social distance [8]. Washing hands has been an effective solution to dealing with the virus especially when touching of surfaces is concerned. For example, foot actuated hand washing machines were designed and implemented at the University of Malawi [9]. Maintaining social distance has been enforced effectively in offices, banks and other institutions by using floor markers [10]. The wearing of face masks and washing hands measures are easily enforced by not rendering any service to those who do not abide by them and in so doing, many people have been forced to observe them. However, Social distancing is the main tool used to curb the further spread of Covid19, and involves reducing contacts that could potentially transmit the infection [11].

Countries have attempted to limit the spread of SARS-CoV-2 in response to the COVID-19 pandemic by limiting population movement through social distancing measures, hence lowering the number of encounters. In Ref. [12] they characterized the link between transmission and mobility for 52 nations around the world as a key proxy metric of social distance. In 73% of the nations studied, transmission significantly dropped along with the first reduction in mobility, but for 80% of the countries, we observed evidence of a decoupling between transmission and mobility after the tightening of control measures. Mobility accounted for a significant fraction of the difference in transmissibility for the majority of the countries (median adjusted R-squared: 48%, interquartile range [27–77%] across countries). Mobility was associated with lower transmission rates after strict control measures were relaxed in countries where there was a clear relationship between mobility and transmission both before and after the measures were relaxed, showing that the positive effects of ongoing social exclusionary behaviors were significant.

Unfortunately, it’s not easy to maintain social distance and as human beings we sometimes ignore/neglect this Covid19 prevention measure or easily forget to observe it and we cannot say that a person can maintain social distance throughout the day. In one way or the other we fail to abide by this prevention measure. This is the case especially in public places, streets, trading centers, business places, community gatherings, political meetings and even in schools. These are places where it’s almost impossible to put floor markers and expect that they will remind individuals to observe social distance. Despite all these drawbacks, observing social distance is the most effective measure for preventing the further spread of Covid19 beside washing hands and wearing face masks.

The deadly book COVID-19 quickly diffuses dangerous threats to people and the society at large. This virus not only compromises human health but also slows down the modern world and causes multidirectional loss. Nearly all nations tightly enacted lockdown and social seclusion laws to stop the COVID-19 virus from spreading. People are using more water for washing, cleaning, bathing, and hand washing in practically every region of the world. As a result, both per-person water demand and costs have dramatically grown. The study in Ref. [13] main goals were to assess household-level water usage trends and enhance water security with management for the future but did not look into other alternatives curbing alternatives of Covid19.

The COVID-19 epidemic has altered and accelerated technological advancements across many industries. Compared to the other industries, the rate of technological advancement in healthcare is fairly quick. According to research by Ref. [11], stronger active monitoring of symptom development and transmission should be carried out in order to stop and contain the pandemic’s subsequent waves. The Embedded Systems development is a technology that enables places and objects to produce various types of data for more actions and data analysis [13]. The usage of wearable technology in medicine is growing to solve more problems not only in health and help in abiding by the laws and prevention measures of COVID19 disease, hence the virus is still being transmitted, increasing the number of cases, leading to multiple deaths. To make sure that humans are observing social distance in places like these, where we cannot put floor markers and what should be done to make sure that everyone is reminded to observe social distance especially in public?

The curbing of the further spread of COVID19 by following and abiding by the preventive measures issued by WHO. These include; wearing face masks, washing hands frequently and observing social distance. While the washing hands and wearing of masks can easily be implemented by denying the provision of services to that are not willing to abide by them. Hence, these two measures can easily be implemented. On the other hand, social distance had been effectively implemented in offices, banks and other institutions through the use of posters and floor markers. Unfortunately, it’s almost impossible to use floor markers in public places like markets and trading centers or other social and political gatherings to remind individuals to keep their distance. Additionally, human beings will naturally forget or neglect an instruction or a message carried by posters, hence there is need for further efforts to enforce social distance in these places.

The main aim of this project is to design and implement a Social Distance Vest for Covid19 prevention which is uplifted by the following specific objectives; (1) to build a human-being detection circuit and an alert/warning alarm, (2) to develop a distance calculation system and (3) mounting the prototype on a reflective vest.

2. Existing literature survey

In an effort to enforce the social distance, many sectors stepped in to help in implementing it among individuals and one of them was the invention of the Social Distancing Hi-Vis vest [12]. This was a pre-printed vest that had “Keep Your Distance” text, reminding people to observe social distance. It was made using a reflective cloth so that people can see it from a far distance and read the text it carried and therefore, reminded to keep their distance. However, this invention was not effective enough in that you were supposed to see someone wearing it in order to be reminded to observe social distance. In other words, someone had to put on this vest and if you saw them, you were reminded to keep your distance. Your safety from COVID19 by observing social distance, depended on someone putting it on in order to remind you to keep your distance.

The introduction of Floor markers was another approach, where markers were pasted on the floor indicating where a person must stand in order to observe social distance [13]. These were implemented in banks, offices and other institutions and it was easy to abide by them. However, it’s impractical to paste these markers in public or on every other place where people go to and we cannot control the motion of people in public places. In general, these floor markers are effectively used in offices and other indoor places but not in public like streets, trading places etc. It is impracticable to say that we will paste floor markers on all roads and every part in our country in an effort to enforce observing social distance and help curb the spread of COVID19.

Social distancing posters provide essential messaging in an easy-to-read, effective format [14]. These posters have images and clear text that ensures people receive the information they need quickly. These posters are placed at any place as long as they are pasted in a way that people can easily see them and get the message they carry. It can be in front of entryways, in break rooms, and even on doors or windows. The point is to get the message across to as many people as possible within the workforce. However, they are not 100% effective in that, human
beings easily forget or neglects it after sometimes. As long as they interact, in one way or the other, after sometime they will be standing or sitting close to each other in a way that they are not observing social distance even though they started their conversation or dialogue while keeping their distance.

Another innovative approach towards implementing social distance to avoid the further spread of Covid19 was the creation of paper wristbands [15]. These were designed to be worn on the arm wrist and to help remind visitors, staff, attendees, guests or individuals to keep to their distance. They are an affordable way of keeping people 2 m apart. They have a pre-printed text that says “Observe Social Distance” and they come in different colors. However, human’s behavior to easily forget or the act of not paying attention to important details makes them ineffective. In additional, they are not durable since they are made out of a paper-like material. As such they can easily be destroyed after being used just for some time.

The EB8 wristband [16] is a social distancing Bluetooth beacon with distance ranging, precisely sensing when other wearers come within 2-m and alerting the user with visual red light and vibration. EB8 wristband can store more than 20,000 data records that can be used for tracing other people that the wearer met in a case where he or she has tested positive for the virus. It is triggered only when the wearer comes in close range of about 2 m with the other wearer. In general, it needs both parties to put on the wristband for it to detect and alert them to observe their distance. This means it cannot alert them even when they are very close to each other just because only one person is wearing the wristband. This is not an effective approach, in that it still puts you in danger of being infected especially in cases where close to you are not wearing one.

In smart jacket for social distancing discussed the Covid19 affecting the world and altered our way of life [17]. It is necessary to preserve social distance from one another in crowded settings like schools, offices, malls, and markets in the modern day when the world is about to unleash. The issue appears when we are despite being constantly aware of the distance to keep, they gradually forget about it and draw closer to one another, which transmits the virus. Why not use smart technology from today’s connected society to combat this? On bringing the social distance to our attention. We are all aware of how crucial social distance is and how it was implemented dramatically, and one should be reminded of this but the prototype discussed could not detect humans but only objects and could not detect thermal temperature.

A Smart Surveillance Prototype Ensures the Respect of Social Distance During COVID19 was proposed in Ref. [18]. Limiting close contact with others is currently the best and only way to slow the spread of coronavirus disease as in recent years. Covid 19 Infection is less likely passed social distance and it is challenging to maintain distance constantly because everyone is adjusting to a new way of life. People either neglect to maintain their distance or don’t take the matter seriously. As proposed in Ref. [18] a smart surveillance system in this study. Through the detection of people, distance calculations, and loud voice alarms, the test prototype maintains adherence to social distance. The Raspberry Pi and Camera Pi are the foundation of the smart surveillance prototype. The prototype is expensive considering the use of raspberry pie as the central microcomputer and heavy in weight considering other open source microcontrollers like Arduino.

Using the Social Distance Vest for COVID19 Prevention (SODIV-COP) approach, which is a prototype design and the focus of this project, individuals can be reminded to keep their distance without the need for both parties to wear it [19,20]. This vest will alert individuals to keep their distance when both or only one of the two parties is wearing it. Secondly, the vest will attract people’s attention since its design includes a reflective vest. Furthermore, it has dealt with the problem of negligence in human beings in that it alerts them when they don’t keep their distance. For instance, in a case where they were observing social distance and in one way or the other, due to interaction, they end up standing/sitting close to each other at a distance of less than 1 m, the vest will detect this and will automatically alert them.

In addition, this vest can be worn in public and social gatherings where it is almost impossible to observe social distance. These are places where it’s almost impossible to put floor markers and they are locations where it’s not easy to pay attention to posters or signs that reminds people to keep their distance i.e. at funerals, markets etc. In so doing, SODIV-COP uses an approach that helps to seal the gap that was there with other implementations and approaches towards helping individuals to keep their distance and stop the further spread of COVID19.

3. Methodological approach

3.1. Prototyping a human detection system

This was the first part of project implementation, in which a human detection was built. The main goal was to come up with a system that was able to detect the presence of a human being only. To detect a human being, D6T-44L-06 was used to measure radiations emitted by humans. Fig. 1 below shows D6T-44L-06 and its pin configuration.

The VCC pin of D6T-44L-06 was connected to +5v power supply of the Arduino board and the GND pin was connected to ground. On the other hand, SCI and SDA pins were connected to the A4 and A5 pins of the Arduino, respectively. The code was written in C++ programming language using Arduino IDE and the results for temperatures were displayed on the Serial Monitor.

3.2. Development a distance calculation system

HC-SR04 Ultrasonic sensor was used to determine the distance from the where the person is standing. Likewise, VCC and GND pins were connected to positive 5V power supply and ground pin, respectively. The Trig and Echo pins were connected to digital pin 8 and 9. Fig. 2 shows the connection of Ultrasonic to Arduino board;

Using C++ programming language, a program was written in Arduino IDE that could send a HIGH value to the Arduino board if the distance from where the person is standing was less than 1 m. Finally, the AND logical operator was used to carry out the next instruction, which was to trigger the alert/warning alarm if and only if the two statements were true (a person was detected and was standing at a distance of less than 1 m from where the person wearing the vest was sitting or standing).

3.3. Prototyping an alert/warning alarm

The next step towards project implementation was to develop an alert/warning system. A buzzer and a Light Emitting Diode (LED) were used to build a warning system. A 220Ω resistor was connected to pin 7 of the Arduino and to the positive supply pin of the LED in order to step down the voltage and the negative lead was connected to the ground pin of the Arduino. The positive lead of the buzzer was connected to pin 6 of the Arduino and the GND pin was connected to ground. On the other hand, SCI and SDA pins were connected to the A4 and A5 pins of the Arduino, respectively. The code was written in C++ programming language using Arduino IDE and the results for temperatures were displayed on the Serial Monitor.

Fig. 1. D6T-44L-06 (a) and the pin diagram showing the SCI, SDA, VCC and GND combination (b) [18].
3.4. Mounting the prototype on a reflective vest

Finally, the Human detection system, the distance calculation circuit and the alert/warning system were all mounted on a reflective vest as shown in Fig. 4. The reflective vest was chosen as ideal for the prototype because it attracts people’s attention in public and it mostly represents caution (see Fig. 5). In this way, it was ideal for the implementation of the prototype. Finally, the connecting wires from all the circuits mounted on the vest were all covered in cloth pieces so that there was no direct contact with the human body when a person puts it on. Furthermore, all these connecting wires were directed toward the back of the vest. At the back of the vest, all circuits were connected to the Arduino Uno board, which was then powered by a 9V battery. These were then enclosed in a box-like container for safety and for the vest to look presentable. Fig. 6 shows, the back-view and the inside of the prototype vest;

After that, the Arduino program sketch for the Human Detection System, the distance calculation system and the alert/warning alarm were all combined and compiled to check for errors. In general, the alert/warning system was commanded to be triggered ON, if and only if D6T-44L-06 thermal sensor detected the presence of a Human being “AND” the distance from where the person was standing was less than 1 m. Fig. 7 shows the flow diagram for the execution of the algorithm that illustrates the operation of the vest. Finally, the vest was ready for testing and debugging in the case of possible errors.

4. Results and discussions

4.1. Human detection circuit

Fig. 8 below shows the results obtained from a Serial Monitor display. These results are mapped by D6T-44L-06 sensor that is used to detect the presence of human beings. Shown in the figure above are temperature reading as detected by D6T-44L-06. They are a mapping of different temperature detected by thermal radiation from the object in focus. It is observed that within the array of the temperature readings, we have higher values than the others. The points where D6T-44L-06 is giving higher values are where it is detecting radiations emitted by a human being. The lower temperature readings represent radiations from the surrounding of the human being. In other words, if no one is standing in front of the sensor the temperature readings were the same throughout all the mapped pixel arrays.
4.2. Distance calculation circuit results

Fig. 9 below shows the distance values obtained using Ultrasonic Sensor;

From the results shown, it can be drawn that the Ultrasonic sensor was working perfectly and was able to measure distance up to 3 m.

4.3. Alert/warning alarm circuit

Fig. 10 below shows the alert/warning alarm in which the blinking of the LED and the turning ON/OFF of the buzzer were all synchronized to occur at the same time and hence providing an effective alert/warning system.

After testing the whole prototype mounted on the vest, the alert/warning alarm was triggered ON when social distance was not being observed and it was triggered Off when the next person moved to a far distance of greater than 1 m, thus observing social distance. The results obtained after testing the whole prototype came out as expected and there were no errors because each sensor was configured correctly and the logic of execution of operation was correctly designed and implemented. In other words, the vest worked perfectly as planned.

However, the Covid19 vest needs some improvements in that its operation is unidirectional, thus it only works effectively in the direction of focus where both the human detection and distance calculation
5. Conclusion

Social Distance Vest for COVID19 Prevention prototypes in this paper has almost proved to be an effective and efficient approach to this problem. The vest is made up of a human detection system, a distance calculation circuit and alert/warning system which are mounted on a reflective vest. The vest triggers an alarm when a person is standing at a distance of less than 1 m to the person wearing the vest and hence reminds them to keep their distance. Thus, it can be used to curb the further spread of the Covid19 virus. This can be used in public, social and political gathering to enforce social distance. The varied temperature ranges were arranged in an array, and between 35 and 38˚ Celsius, the obstacle was identified as a human, with some distances of 0.334 m measured by the ultrasonic sensor. The prototypes are mostly used in crowded settings like stadiums, hospitals, and schools.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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