Microcontroller-based supporting tool for socializing in physical distancing during Covid-19 pandemic

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Abstract. Physical distancing is one of the procedures to avoid the spread of Covid-19. Several researchers have created tools to support physical distancing and the detection focus is on the front or back side with sound alert. However, this kind of sound alert can disturb other people activities. Moreover, people have a blind spot in their right and left side vision which is more than 40° on the horizontal plane. The study aims to design two bracelets for socializing in physical distancing during Covid-19 pandemic. It works at a distance of 1 meter within a radius of 120° on eye blind spot and provide the option of a vibration or sound alert or both with the push button. The main components of this tool are Arduino nano as the system controller, HC-SR 04 ultrasonic sensor as the distance measure, PIR HC-SR 501 sensor as the people movement detection, continuous rotation servo motor MG90S as the sensors driver of 120°, vibrating DC motor type 310-101 as the vibration output and buzzer as the sound output. The result of this study is two bracelets that available to detect distance and movement on the 120° rotation angle. When both of bracelets on the 1-meter distance, they will make vibration, sound, or both.

1. Introduction
Covid-19 is a disease caused by SARS-CoV 2 which is potentially fatal and is currently a major concern for the global community. This virus has spread and infects people in the world in a rapid time [1]. In the end, the SARS-CoV 2 virus will become a deadly disease in the form of hyper-inflammation and respiratory dysfunction [2]. Covid-19 cases in the world as of July 30, 2021, data reached 197 million people with 222 countries exposed and 4.2 million people died [3].

One of the efforts to prevent the spread of the corona virus is to carry out physical distancing movements. Physical distancing can be applied by maintaining a safe distance of at least 1 meter or as far as 3 feet from other people [4]. However, public understanding and awareness regarding Covid-19 is low. There are still people who crowd without implementing health protocols so that the spread of the corona virus cannot be resolved [5]. Therefore, the equipment that supports the physical distancing movement can be used to help prevent and even break the chain of the spread of the corona virus.

Along with advanced technology, several researchers have created tools to support physical distancing movements. A safe distance detection system in socializing during the Covid-19 pandemic which was made with a belt design to detect the back direction in the form of a sound alert generated on the mobile phone if you did not keep your distance is developed by Nadikattu et al [6]. A safe distance detection device in socializing during the Covid-19 pandemic by the front direction detection and the form of a sound alert is made by Malik [7], Waltz [8] and Mumi et al [9]. Social distancing detection
real-time application that is applied to a certain room by utilizing a camera and a sound alert is made by Yang et al [10], Punn et al [11], Militante et al [12], Hou et al [13] and Saponara et al [14].

The previous research focused on making a safe distance detection device in socializing during the Covid-19 pandemic on the front or back side, or in a room and in the form of a sound alert. However, sound alerts can interfere with activities carried out by others [8]. Vibrating alerts can be more effectively applied because they are aimed at the user of the tool and do not cause any disturb to others [15]. On the other hand, human vision has a blind spot, which is an area that cannot be seen directly by the eye. The normal human eye angle of view in the vertical plane is 60° and the horizontal one is 40°, but if you look intensively, the eye angle is reduced by 1° [16]. The blind spot area of the eye lies in a horizontal plane more than 40°.

The purpose of this study is to design a tool that can measure a safe distance in socializing in the blind spot area which is located on the right and left sides and can provide the option of vibrating or sound alert or both if it is identified that you are not socializing during the Covid-19 pandemic.

2. Method

The manufacture of supporting devices for maintaining distance (physical distancing) in socializing during the Covid-19 pandemic is made in two bracelets that are used to detect the blind spot area of the eye. This bracelet functions to measure a safe distance in socializing in the blind spot area with a detection angle of 120°, radius 1 meter on the right and left sides and emits a vibration output, or sound or both if it is identified that you are not socializing during the Covid-19 pandemic. The output given depends on the user's choice. The illustration of the detection of the two bracelets when walking and standing still is shown in Figure 1 and Figure 2.

![Figure 1. Illustration of the right and left wristband detection area when walking](image1)

![Figure 2. Illustration of the right and left wristband detection area when stationary (standing still)](image2)
2.1. Tools and materials

In the manufacture of tools, the necessary components of tools and materials are needed. Identification of the tools and materials needed to make 1 bracelet supporting the physical distancing movement is shown in table 1.

| No. | Tools and Materials                      | Function                                    |
|-----|------------------------------------------|---------------------------------------------|
| 1.  | Arduino nano                             | Device control system                       |
| 2.  | Ultrasonic Sensor, HC-SR 04              | Distance meter                              |
| 3.  | PIR Sensor, HC-SR 501                    | Detection of human movement                 |
| 4.  | Vibrating DC Moor, type 310-101          | Vibrating output generator                  |
| 5.  | Active buzzer, KY-012                    | Sound output generator                      |
| 6.  | Servo Motor continuous rotation, MG90S   | Drive the two sensors by 120°               |
| 7.  | Lithium polymer battery, type 103450     | Power supply tool                           |
| 8.  | DC step up Motor, MT3608                 | Increase the battery voltage to 7.05 V      |
| 9.  | Charger Module, TP 4056                  | As the charger module of the power supply   |
| 10. | Male to male jumper cable, female to female jumper cable | Connecting the circuit ports |
| 11. | Components Box                           | Tool circuit box holder                     |
| 12. | SPDT Push button                         | Disconnect or connect the on/off switch     |
| 13. | Switch 4 pin foot Push button            | Output switch button                        |
| 14. | Breadboard                                | Circuit board                               |
| 15. | Strap                                    | A tool fastener by hand                     |

2.2. Tools Design

The tool design consists of system design, tool shape design, pin configuration between components, and software design. Block diagram of physical distancing support tools is shown in Figure 3. As input, ultrasonic sensors are used to detect distance and PIR sensors to detect human movement. The servo motor is used to move the two sensors so that they can detect up to an angle of 120°. The control center of this tool uses an Arduino nano and the output is in the form of a vibrating effect caused by a vibrating DC motor, sound effects from an active buzzer. Lithium polymer battery is used as the power supply of this tool.

Ultrasonic sensors, PIR sensors, and servo motors become one unit in detecting humans within a certain distance. Ultrasonic sensors are used to measure the distance of objects. When applying a voltage to the trigger pin for 10 uS, the ultrasonic sensor will send an 8-step ultrasonic signal with a frequency of 40 kH. Then the signal will be received by the echo pin. The time difference between sending and receiving the signal is used for measuring distances to objects [17]. PIR sensor is used to detect human movement. When infrared radiation from the human body is detected, it will change the resulting voltage measured by an on-board amplifier and indicate the presence of movement [6]. The servo motor is used to drive the two sensors by 120°. The servo motor is angled by providing a pulse width modulation (PWM) signal. When the pulse width control has been given, the servo motor shaft will move to the commanded position and will maintain its position [18].
The two bracelets are identical to each other; the only difference is in the angular movement. This bracelet is used on the back of the outer hand. The first bracelet can detect a safe distance in socializing during the Covid-19 pandemic from the right side with 120° movements worn on the right hand. The shape of the first bracelet is shown in Figure 4 (a). The second bracelet can detect a safe distance in socializing during the Covid-19 pandemic from the left side by a 120° movement worn on the left hand. The shape of the second bracelet is shown in Figure 4 (b). The weight of each bracelet is ± 100 grams. Each component is interconnected with other components. The connection between the pins on the component and the microcontroller is shown in table 2. The schematic of a series of physical distancing support tools is shown in Figure 5.

Applications used in making this tool include Arduino IDE, Fritzing and Sketch up. Arduino IDE is used as Arduino nano data programming. Programming in this tool is using the C programming language. Each component variable is declared in the prefix program. In the Arduino IDE programming void setup, it contains variable initialization, pin mode, library usage. The Arduino IDE void loop contains programming to run programs continuously and sequentially and to control the Arduino nano board. The If-Else If-Else If command is used in this programming to select the next command to be executed based on the conditions that are met. If-Else If-Else If logic is used to control the output switching push button. Controlling a condition using a boolean operator, namely AND (&&). This AND logic is used to combine the conditions on the ultrasonic sensor HC-SR 04 and PIR sensor HC-SR 501. The conditions in this programming are to produce output, namely when the ultrasonic sensor HC-SR 04 detects objects as far as < 1 meter and the PIR sensor HC-SR 501 detects human movement. Output is executed when all conditions are met using high-low logic. The flowchart of how the tool works is shown in Figure 6.

![Figure 3. Block diagram of the design of physical distancing support tools during the Covid-19 pandemic](Image)

![Figure 4. (a) The first ring for detection on the right side and (b) The second ring for detection on the left side](Image)
Figure 4 descriptions:

a. Ultrasonic sensor, type HC-SR 04
b. PIR Sensor, type HC-SR 501
c. Continuous rotation servo motor, type MG90S
d. Active buzzer, type KY-012
e. Output switch push button
f. Push button
g. Arduino nano
h. Lithium polymer battery
i. Charger module, type TP 4056
j. DC motor Steap Up, type TP 4056
k. Vibrating DC motor, type 310-101

Table 2. Connection between input, output and control system pins

| No. | Components | From Pin | To Pin Arduino Nano |
|-----|------------|----------|---------------------|
| 1.  | Ultrasonic Sensor HC-SR 04 | Vcc 5 V | Gnd |
|     |            | Gnd Gnd | D8 D9               |
| 2.  | Continuous rotation Servo Motor MG90S | Yellow Wire D3 | Red Wire 5 V |
|     |            | Black Wire Gnd | D10              |
| 3.  | PIR Sensor HC-SR 501 | Vcc 5 V | Gnd |
|     |            | Gnd Gnd | Output D10         |
| 4.  | Vibrated DC Motor Type 310-101 | Pole (+) D11 | Pole (−) Gnd |
|     |            | Pole (−) Gnd | D12              |
| 5.  | Active buzzer KY-012 | Pole (+) D12 | Pole (−) Gnd |
|     |            | Pole (−) Gnd | D5               |
| 6.  | Push button switch | 1 Pole Gnd | 1 Pole D5          |

(Source: Author, 2021)

Figure 5. Schematic circuit of the Arduino nano microcontroller system
Figure 6. Flowchart of how the tool works

Variable initialization is the state when the push button is high so that the initialization of the variable input-output declaration occurs on the microcontroller. After initializing the variables, initialization of conditions occurs, i.e., each component is in the initial position. The default condition, if there is no pressing on the push button, is the command in condition A (vibrating alert output). If the push button is pressed 1 time, it will run the command in condition B (sound alert output); if the push button is pressed 2 times, it will run the command in condition C (vibrate and sound warning output); and if the push button is pressed more than 2 times, it will run the default again, which is in condition A. The continuous rotation servo motor MG90S moves from an angle of 0° to 120°. The ultrasonic sensor HC-SR 04 and the PIR sensor HC-SR 501 work in detecting objects. If a distance of < 1 m is detected on the detection of the ultrasonic sensor HC-SR 04 and the PIR sensor HC-SR 501 detects movement, it will give a vibration alert, sound, or both depending on the user's choice. The alert is generated by the operation of a vibrating DC motor type 310-101 and, or an active buzzer KY-012.

2.3. Tools testing
Tool testing consists of testing each component and testing the entire tool. Testing on the ultrasonic sensor HC-SR 04 consists of 2 tests, they are: the comparison of operating voltage measurements and distance measurements on the ultrasonic sensor HC-SR 04 and then calculated by error rate. Testing on the PIR sensor HC-SR 501 consists of a comparison of operating voltage measurements, testing based on objects, testing based on the position of human movement, and based on the distance range then the success rate is calculated. The test on the MG90S continuous rotation servo motor consists of 3 tests,
which are comparison of operating voltage measurements, angle measurements on the MG90S continuous rotation servo motor and then the error rate is calculated, and the movement of the MG90S continuous rotation servo motor which is used for physical distancing support tools. The power supply of the tool is tested by measuring current and voltage and then calculating the battery capacity in backing up the load.

3. Results and Discussion
The hardware circuit in this tool is shown in Figure 7. Bracelet 1 is worn on the right arm shown in figure 8 (a) and bracelet 2 is worn on the left arm shown in figure 8 (b). The use of this bracelet is on the arm of the back of the hand. The two bracelets are identical to each other, the difference lies in the direction of detection movement. The first ring moves from 0° to the right to 120°. The second ring moves from 0° to the left to 120°. The movement speed of the servo motor is 3.4 s.

![Figure 7](image1.png)

**Figure 7.** A series of hardware supporting tools to maintain distance (physical distancing) in socializing during the Covid-19 pandemic

**Figure 7 descriptions:**
- a. Tool power supply circuit
- b. Vibrating DC motor circuit, 310-101
- c. Active buzzer Circuit, KY-012
- d. Output switching push button circuit
- e. Ultrasonic sensor circuit, HC-SR 04
- f. PIR sensor circuit, HC-SR 501
- g. Continuous rotation servo motors MG90
- h. Arduino nano V3 Circuit

![Figure 8](image2.png)

**Figure 8.** (a) The first bracelet for detection on the right side and (b) The second bracelet for detection on the left side

**Figure 8 Descriptions:**
- a. Active buzzer, KY-012
- b. Output switch Push button
- c. USB type C charging port
- d. On /off SPDT Push button
- e. PIR Sensor, HC-SR 501
- f. Ultrasonic sensor, HC-SR 04
- g. Strap
The measurement of the operating voltage on the tool is using the EZREN DT-9205A multimeter. The voltage measurement results from the ultrasonic sensor HC-SR 04 and the PIR sensor HC-SR 501 get the same results as the datasheet, namely 5 V and 3.3 V. The results of the measurement of the operating voltage of the MG90S continuous rotation servo motor get a difference of 0.02 V with MG90S continuous rotation servo motor datasheet. In this study, the average error value of the ultrasonic sensor HC-SR 04 is 0.267 cm, the detection of human movement is functioning properly and the movement of the two sensors using the MG90S continuous rotation servo motor is 120° at precise angle accuracy. The results of the overall study of the tool in the form of 2 physical distancing bracelets can function properly when it is used in a stationary position (standing still) and walking.

Previous researchers have made physical distancing tools in various forms and are more specialized in detecting the front or back area or in a room in the form of sound alerts including by Nadikattu et al [6], Malik [7], Cheney [8], Mumi et al [9], Yang et al [10], Punn et al [11], Militante et al [12], Hou et al [13], and Saponara et al [14]. Based on the research that has been done, this research has differences and advantages compared to the previous research. The advantage of this study lies in the detection sensor used using 2 sensors, namely the ultrasonic sensor HC-SR 04 and the PIR sensor HC-SR 501. By these two sensors, the object detected is more specific, namely humans and more accurate distance-keeping measurement. The detection area of the tool made is the blind spot area of the eye located on the right and left of the eye (in a horizontal plane of more than 40°) which has not been fully accommodated by previous studies. This distance-keeping support tool has more varied output options than in previous studies, namely in the form of vibration, sound or both depending on the user's choice.

Vibrating alerts are proposed to reduce disturbance to nearby people.

4. Conclusion
This physical distancing support tool in the form of 2 bracelets is succeeded in measuring a safe distance in socializing in the blind spot area located on the right and left sides of 120° and can provide the option of vibrating or sound alert or both if identified as not keeping a distance (1 meter) in socializing during the Covid-19 pandemic which is used in a walking position and a stationary state (standing still). Distance detection on this tool has an average error value of 0.267 cm, the detection of human movement is functioning properly and the movement of the two sensors uses a continuous rotation servo motor MG90S 120° at precise angle accuracy. Further development is to minimize the dimensions and weight of the tool.

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