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Design and Fabrication of Smart Automated Shoes Sanitizing System Based on Arduino

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Abstract

Hospitals, shopping malls, and public places are crowded areas and easily infected by COVID-19. Poor or inadequate hand washing and shoe hygiene are problematic in hospitals, malls, offices, and house settings, so they are a significant source of contracted infections. The World Health Organization (WHO) advised us to wash hands, wear a mask, maintain social distance, and disinfect personal belongings to prevent coronavirus spread. Therefore, Automated Shoes Sanitizer System was proposed and developed in this project. This innovative system is a touch-less sanitizer system for sanitizing shoes to reduce contact risk and prevent coronavirus from spreading. This Automated Shoes Sanitizing System can sense the proximity with the help of an ultrasonic sensor and sends a signal to the microcontroller. The programming for this innovation is written using the Arduino software and interface with the Arduino UNO board. The Arduino UNO is a microcontroller responsible for coordinating the system, such as ON/OFF the liquid flows, sensing the shoes, etc. As a result, an ultrasonic sensor will detect the shoes/objects within 60cm and disinfection the shoes/objects automatically. Then, the system will stop disinfection automatically if the ultrasonic sensor detects no shoes/objects. In conclusion, an Automated Shoes Sanitizing System has been designed and developed to sanitize the shoes automatically. This innovation project can be modified for future work by combining a body sanitizer system to sanitize the body and shoes.

Keywords: - Arduino UNO; covid-19; ultrasonic-sensor; sanitizer system

1. Introduction

The COVID-19 pandemic in Malaysia is part of the current global pandemic of coronavirus illness 2019 (COVID-19), which is caused by SARS coronavirus 2 (SARS-CoV-2) (Ciotti et al., 2020; Elengoe, 2020). Therefore, World Health Organization (WHO) and all the countries need to implement good management in response to the lessons learned from the last pandemic (Low & McGeer, 2010). These precautions include preventing infection inside animals, transfer from animals to people, and transmission between humans.

Hospitals, shopping malls, and public places are crowded areas and are easily infected by COVID-19 (Morawska et al., 2020). The virus spreads through close contact, most commonly by minute droplets generated by coughing, sneezing, and talking. Droplets often fall to the ground or onto surfaces rather than travelling vast distances via air (Rusimamto et al., 2020). Therefore, people can become infected less often by contacting a contaminated surface and touching their face (Hafner, 2020). It is most contagious during the first three days after symptoms develop, although it can spread before symptoms occur and from those who do not display symptoms (Baslyman et al., 2014).

In hospitals, shopping centers, and homes, improper or insufficient hand washing and shoe hygiene are recognized as problems and a significant cause of infections (Birnbach, Thiesen, Rosen, Fitzpatrick, & Arheart, 2020). The World Health Organization (WHO) encouraged us to wash hands, wear masks, keep social

distance, and disinfect personal belongings to avoid the spread of coronavirus (Bloomfield, Aiello, Cookson, O'Boyle, & Larson, 2007; Bruchez et al., 2020; Dutta & Dontiboyina, 2016).

Automated systems are used to carry out several health-related tasks, such as air quality monitoring (Yang et al., 2014), hand sanitizers (Hong et al., 2015; Tartari et al., 2019), and hand hygiene (Birnbach et al., 2020; Bruchez et al., 2020). In a pandemic, sanitizers are an alternative for washing hands when water are not available. There are many varieties of sanitizer, including liquid (spray) and gel (Hayat & Munnawar, 2016). The ingredients like alcohol, polyacrylic acid, glycerin, propylene glycol, or plant extracts are used to make hand sanitizer (Ranabhat, Khatiwara, Paul, & Bagchi, 2021). Mostly, the hand/shoes sanitizers do not operate automatically. Therefore, Automated Shoes Sanitizer System was proposed and developed in this project. This innovative system is a touch-less sanitizer system for sanitizing shoes to reduce contact risk and prevent coronavirus from spreading. The design looks like a shoe mat. Place the sanitizer sprayer under the mat. When the device detects the shoes, it sprays liquid fluid. An ultrasonic sensor will detect the presence of shoes or persons. The microcontroller is in charge of coordinating the entire system, such as turning on and off the liquid flows, detecting the shoes, and so on.

2. Method

2.1 Block Diagram

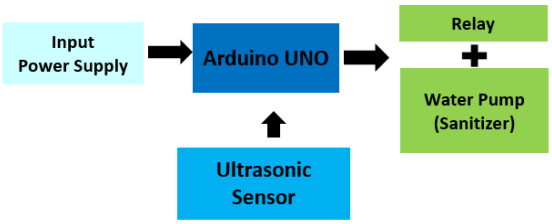

Fig. 1. Block diagram

The Smart Automated Shoes Sanitizing System's block diagram based on Arduino is shown in Fig. 1. The ATmega328P-based Arduino UNO is a microcontroller board with an input voltage 12Vdc (Arduino, 2015). It also serves as a control unit, controlling the entire system and maintaining fluid flow intervals. An ultrasonic sensor will be used for sensing shoes or people's feet. It will detect the shoes/objects within 60cm and disinfection the shoes/objects automatically. A water pump pumps disinfectant liquid from the tank to the mats. The reservoir of liquid fluids is the sanitizing tank. The fluids are sprayed using a water spring head. The connecting pipeline transports liquid sanitizer from the sanitizing tank to the shoe mats. The frame is customizable for attaching the disinfection mats and can be made of wood, steel, or PVC.

2.2 Arduino (IDE) Software

Arduino Integrated Development Environment (IDE) Software is open-source and used for writing, editing, compiling and uploading the code to the board (Arduino, 2015). As shown in Fig 2, this research is used Arduino (IDE) to create and upload programmes to Arduino-compatible boards and other vendor development boards that utilize third-party cores.

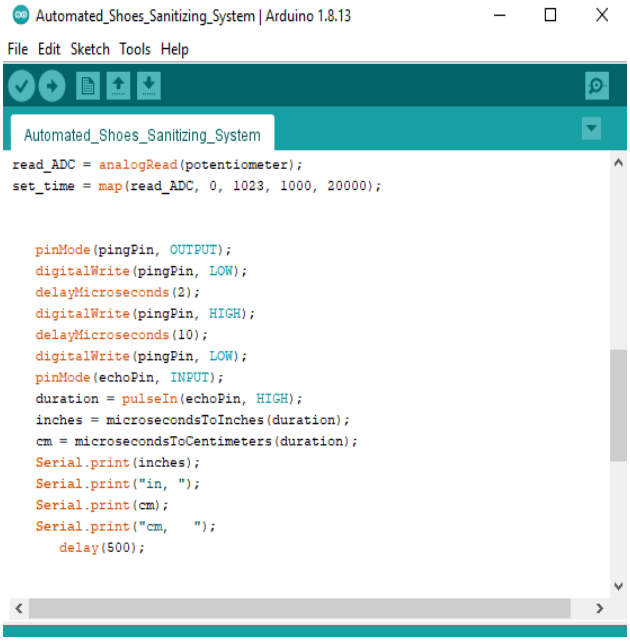

Fig. 2. Arduino IDE software

The Arduino programming flow chart for this system is shown in Fig.3. An ultrasonic sensor will detect when the user/object is in front of the system by 60cm. If an ultrasonic sensor detects objects, the system will automatically disinfect the shoes/objects. On the other hand, the system will stop disinfection automatically if an ultrasonic sensor detects not shoes/objects.

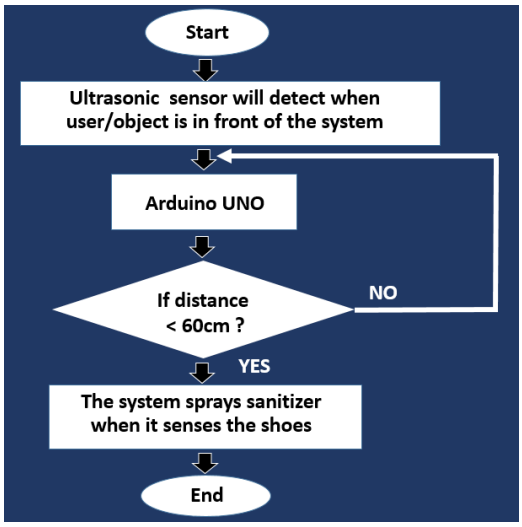

Fig. 3. Arduino programming flow chart

2.3 Experimental Setup

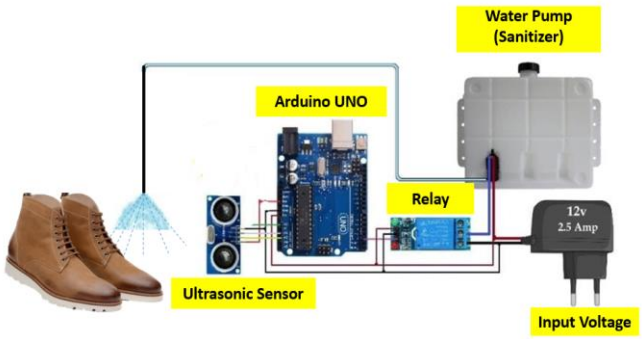

Fig. 4. Experimental setup for an automated shoe sanitizing system

Fig. 4 demonstrates the experimental setup for Smart Automated Shoes Sanitizing System. Firstly, connect the adapter input voltage 12v 2.5A with the Arduino UNO board in pin VCC and GND. Next, connect the relay between the Arduino board and the water pump. A Relay is a programmable electrical switch. It is used for triggering the water pump. The data port of the relay is connected with Arduino and used to programmatically control on/off the devices, which the high voltage and high current. HC-SR04 ultrasonic sensor will be connected with the signal port in Arduino UNO board according to Fig 3. This sensor is very easy to setup due to it only has four pins: VCC (power), Trig (Trigger), Echo (Receive), and GND (Ground). This sensor also provides non-contact measurement with ranging accuracy up to 3mm. Finally, this system needs testing and troubleshooting before installing the casing, as shown in Fig. 5.

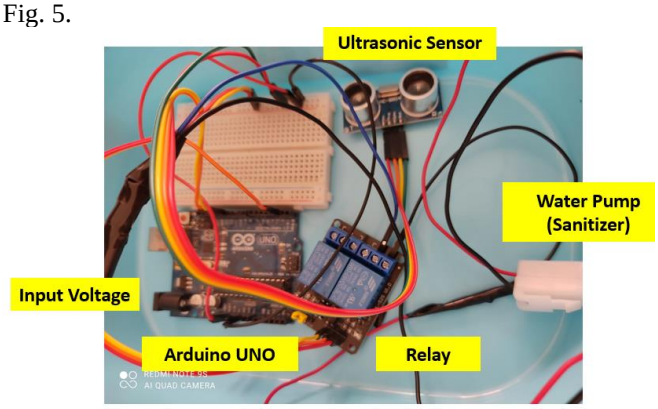

Fig. 5. Project setup and testing

2.4 Casing Design and Development

Fig. 6 shows the complete casing for this project that builds by using plywood with a length of 50cm and a width of 50cm.

Fig. 6. Casing design

After that, the casing will be sprayed with black colour as shown in Fig. 7. The component box and water pump will be installed on the side of casing as presented in Fig.8.

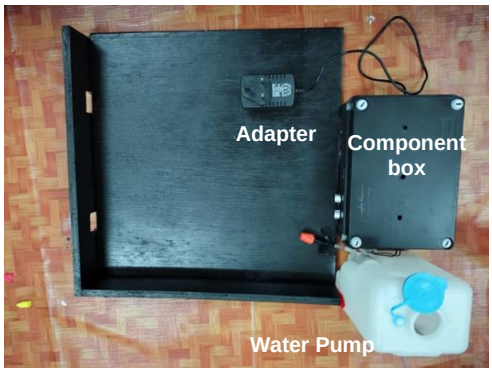

Fig. 7. Installation component

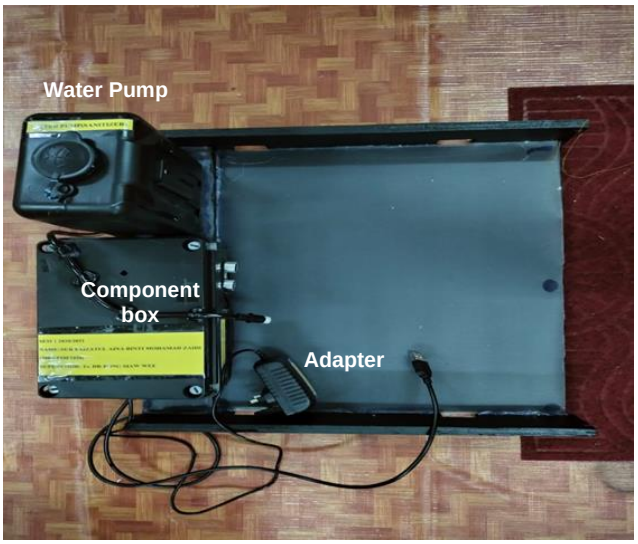

Fig. 8. Complete install the components into the casing

3. Results and Discussion

Automated Shoes Sanitizer System was proposed and developed in this project, as shown in Fig. 9 and Fig. 10. This innovative system is a touch-less sanitizer system for sanitizing shoes to reduce contact risk and prevent coronavirus from spreading. This Automated Shoes Sanitizing System can sense the proximity with the help of an ultrasonic sensor and sends a signal to the microcontroller. The programming for this Innovation is written using the Arduino software and interface with the Arduino UNO board. The Arduino UNO is a microcontroller responsible for coordinating the system, such as ON/OFF the liquid flows, sensing the shoes, etc. As a result, an Ultrasonic sensor will detect the shoes/objects within 60cm and disinfection the shoes/objects automatically. Then, the system will stop disinfection automatically if an ultrasonic sensor detects no shoes/objects.

Fig. 9. Top view of Automated Shoes Sanitizer System

Fig. 10. Side view of Automated Shoes Sanitizer System

The instructions user manual for this project are as below:-

i. First, connect the system to the power supply.
ii. Press "ON" the power supply.
iii. Put the shoes or feet on the Automated Shoes Sanitizing System.
iv. An ultrasonic sensor will detect the shoes/objects within 60cm.
v. The system will disinfect the shoes/objects.
vi. The system will stop disinfection if not shoes/object detection by ultrasonic sensor.

The functionality of this innovation project has been tested by User 1 and User 2 as shown in Fig. 11 and Fig.12. When the ultrasonic sensor detect the shoes within 60cm, it will send a signal to the microcontroller. The microcontroller will send the signal to ON the liquid flows and disinfection shoes automatically.

Fig. 11. Testing for User 1

Fig. 12. Testing for User 2

Table 1. Shoes distance experimental result of ultrasonic sensor

User	Distance	Ultrasonic Sensor Information
Haifaa	10cm	Sensor Detection
Atirah	20cm	Sensor Detection
Varo	30cm	Sensor Detection
Angely	40cm	Sensor Detection
Vannessa	50cm	Sensor Detection
Usun	60cm	Sensor Detection
Faizal	70cm	Sensor not Detection

Contactless Automated Shoes Sanitizing System for Sanitation is efficient, and the cost is minimized. The automated Shoes Sanitizing System is an innovation that can be applied at many locations such as public places, offices, and homes. This Innovation saves cost, saves time, user friendly and is more efficient. This innovation system is beneficial for sanitizing the shoes and able to prevent the spread of coronavirus and reduce the risk due to contact

4. Conclusion

In conclusion, an automatic shoe sanitizing system has been designed and developed. The system may be implemented at the entrance gates of any building, including a society, a school, or a college. It is efficient at maximizing the usage of liquid sanitizer and can spray 40 times with 100 ml of liquid. The technology operates as intended after more than a week of testing for 24-hour operation. It reduced the need for sanitizer purchases and the amount of labour required to use a spray bottle to apply sanitizer. The Automated Shoes Sanitizer System is the most crucial application because the product is beneficial for preventing people by infected with covid-19. The price of this product is also affordable and worth it. That can be used easily. The detailed procedure can consume all the proceeds from this project more efficiently. For the reduction of coronavirus spread, the system is helpful in the fight against the global pandemic since it emphasizes the social distancing among the passengers. The human body emits infrared detected by the ultrasonic sensor, thus opening the sanitizer valve. The system timing can be adjusted depending on the nature of the train/line under which the train operates. However, it is recommended to use a maximum of 5 seconds per passenger, i.e. two seconds for sanitizing and 3 seconds for movement. Installation of the system will keep the passengers from contacting COVID19 and improve train performance operations during the COVID19 pandemic period.

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