Journal of Engineering Science and Technology
Vol. 18, No. 4 (2023) 2035 - 2044

DESIGN AND REALIZATION OF EQUIPMENT FOR EARLY PREVENTION OF THE SPREAD OF COVID-19

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Abstract

This research discusses how to design and realize a system that prevents the early spread of the virus, especially COVID-19, through hand contamination. This equipment is an integrated system starting from detecting the presence of people in a certain radius, detecting human body temperature, and automatic hand washing equipment equipped with a hand dryer. This equipment consists of parts including sensors for the presence of people at a specific radius, temperature sensors, sensors on water taps, and sensors on hand dryers. In addition, this tool uses a bottom-loading system to make it easier to refill water and soap. Based on the results of the tests, this tool can operate adequately. The PIR sensor can detect people coming within 1-4 meters, non-contact temperature sensors can detect human body temperature well within a distance of 0-5 centimetres, whose results can be seen on the LCD and heard through speakers; IR proximity sensor can detect the user's hand at a predetermined distance so that water, soap, hand sanitizer and hand dryer can work at that distance. This equipment is expected to be used when entering public service areas to minimize the potential for the spread of COVID-19.

Keywords**:** Covid-19, Hand washing, Human temperature.

1. Introduction

Public service is one of the most vulnerable points to the spread of Covid-19. The spread of the virus can occur not only through aerosol droplets but also through unsanitary hand contact [1, 2]. This research designed a system that minimizes the potential for Covid-19 human-to-human transmission with the help of hand washing tools designed with the use of a microcontroller. The benefits of using antibacterial soap for hand hygiene compared to non-antibacterial soap are thar antibacterial soap is more effective against gastrointestinal and, to a lesser extent, respiratory infections [3].

When the Covid-19 virus first appeared, the number of infected cases continued to increase, and not a few have died until now [4]. One of the transmission media for the Covid-19 virus is hand-to-face which is one of the identifications of potential infection routes [5]. There is research on devices used to electronically calculate hand hygiene and hand hygiene compliance, where remote control and monitoring of physician hand hygiene is carried out during outpatient examinations [6-8].

Various studies related to automatic hand-washing equipment have been carried out. One of them is a research conducted in 2022, where the implementation uses the Proximity Infrared Switch Sensor as an automatic on-and-off switch [9]. Another research is about designing and realizing a hand wash basin that uses a foot pedal instead of a hand to open a water faucet [10]. Furthermore, a system or device was designed and implemented to wash hands before entering a locked door; this tool uses an ultrasonic transducer to detect the presence of hands under the hand-wash outlet [11]. A hand-washing device has also been designed and realized using infrared light emitters and receivers to detect the presence of hands when disinfectant is being dispensed into the hands. In addition, solar energy is also used to provide the power supply [12]. A similar innovative electronic hand-washing system was developed and manufactured, utilizing IR sensors [13, 14].

However, in this study, an equipment or system was designed and developed which, apart from washing hands with soap without touching the water and soap faucets, also provided the option of using hand sanitizer as a disinfectant. In addition, this system is also equipped with a thermal gun to check a person's temperature before entering the service door by displaying on the monitor and issuing a sound confirming the normal or abnormal temperature to enter the room. If the hand washing and temperature checks are carried out correctly and meet the requirements, a sound indicates that the person is allowed to enter the room, and at the same time, the door lock is unlocked.

The results of this study are expected to help provide hand-washing equipment that can minimize the transmission of Covid-19, which may originate from one person's hands to another person who is around the service area or other public space.

2. Research Method

The methods used in this study are Design and development as well as Experimental method. The design consists of two parts, namely hardware design and software design.

There are two main parts to the hardware design, namely: (1) Design and realization of the mechanics of the place/box for storing various hand sanitizers, design and realization of the mechanics of the faucet/valve that will dispense or close the amount of liquid to be used, as well as design and realization of barrier mechanics; (2) design and realization of electronic hardware consisting of design and selection of the various sensors needed, as well as design and selection of microcontrollers and ports used both input ports and output ports.

An Arduino microcontroller is the primary material used as a central processor in hardware design. On the input side, there are several sensors, namely the non-contact body temperature sensor MLX90614 [15], the IR Obstacle Infrared sensors FC-51 [16], and the presence sensor, the PIR sensor HC-SR501 [17].

On the output side, among others, a sound generator is used in the form of a DFP Player mini DFR0299 [18], Relays 4ch 5VDC [19], a 16x2 LCD [20], a liquid pump with the brand Mini Pump R356, heater as a hand dryer, and a speaker. The system hardware design is shown in Fig. 1.

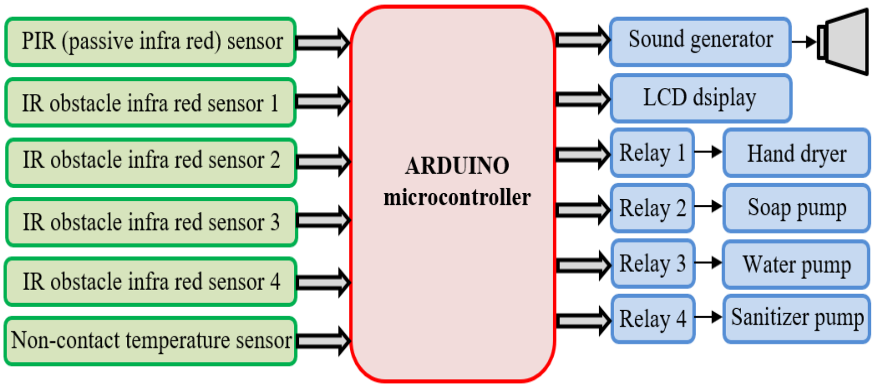
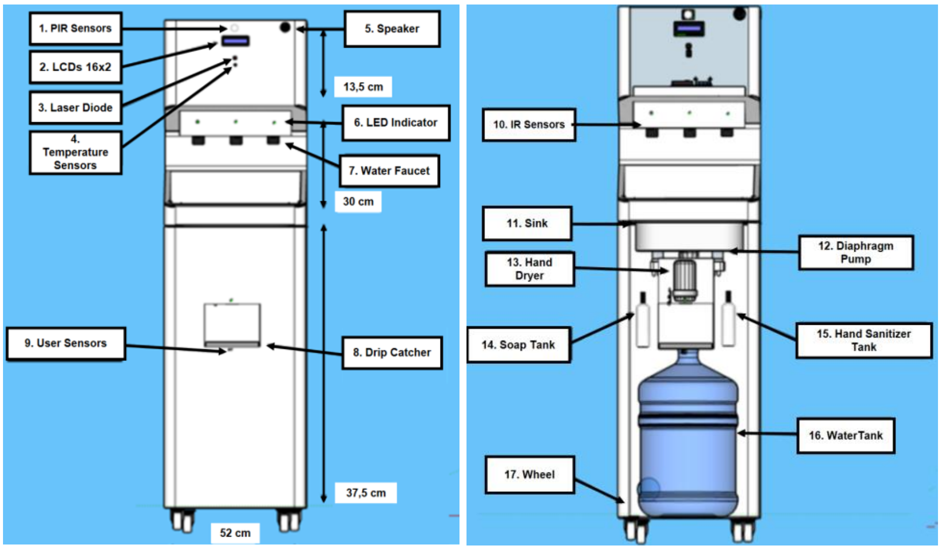


Fig. 1. Block diagram of the system hardware.

The system's working principle begins with detecting the presence of people entering the area with a specified radius; if the PIR sensor detects a person at a predetermined radius, the Arduino Microcontroller responds by activating the sound generator to sound the speaker. With the greeting "Welcome," and at the same time, when the person faces the non-contact temperature sensor, the Arduino Microcontroller measures the body temperature. It displays it on the LCD and provides voice information through the speaker, whether the person's temperature is normal or abnormal. When this process is successful, the latch opens immediately so the person can enter and proceed to the hand-washing sink.

Furthermore, when the person puts his hand under the water faucet and is detected by the IR obstacle infrared sensor 3, relay 3 triggers the water pump to drain water from the faucet. Likewise, the soap pump (relay 2) and the sanitizer pump (relay 4) will release their respective liquids when the hands are brought close to the IR obstacle infra-red sensor 2 and the IR obstacle infra-red sensor 4. The last step is to dry the hands. Under the IR obstacle infrared sensor 1, relay 1 activates the hand dryer.

The design of the mechanical hand washing box as well as the size and layout of the mechanical design of the hand sanitizer box can be seen in Fig. 2. In Fig. 2(a), the design of the external parts of the mechanical box is shown, and in Fig. 2(b) the design of the internal parts of the mechanical box is shown.



(a) (b)

Fig. 2. Mechanical box parts design, external (a), internal (b).

3.Results and Discussion

Based on the results of the realization of a mechanical box for hand washing tools made and arranged so that the tool functions correctly are shown in Fig. 3.

(a) (b)

Fig. 3. The realization of the mechanical box for hand washing equipment (external) (a) and the realization of the mechanical box for hand washing equipment (internal) (b).

While the realization of the hardware in the form of a schematic circuit of a hand-washing tool made can be seen in Fig. 4. This system is an integrated schematic circuit with several items as follows:

(i) Arduino Mega 2560, Serves as a regulator of the entire process carried out by the system.
(ii) C Language Program Module serves to process data from operator input to run the system.
(iii) PIR sensor HC-SR501 serves to detect incoming visitors.
(iv) IR Obstacle Infrared sensors FC-51 serve to detect the presence of the hand.
(v) Non-contact body temperature sensor MLX90614 measures body temperature within a certain distance.
(vi) LCD 16x2 displays information and data on the results of the Non-Contact Temperature Sensor.
(vii) Laser Diode detects the straight distance efficiency of non-contact temperature sensor readings.
(viii) DF Player mini DFR0299 processes audio files from the SD Card to the Arduino microcontroller and forwards them to the speakers.
(ix) The speaker serves to issue information in the form of a specific sound which is the output of the PIR Sensor and Infrared Temperature.
(x) Relays 4ch 5VDC functions as a switch.
(xi) Mini Pump R356, a pump for water, soap, and hand sanitizer, functions as a pump from the shelter to the faucet.
(xii) The dryer functions as a hand dryer.

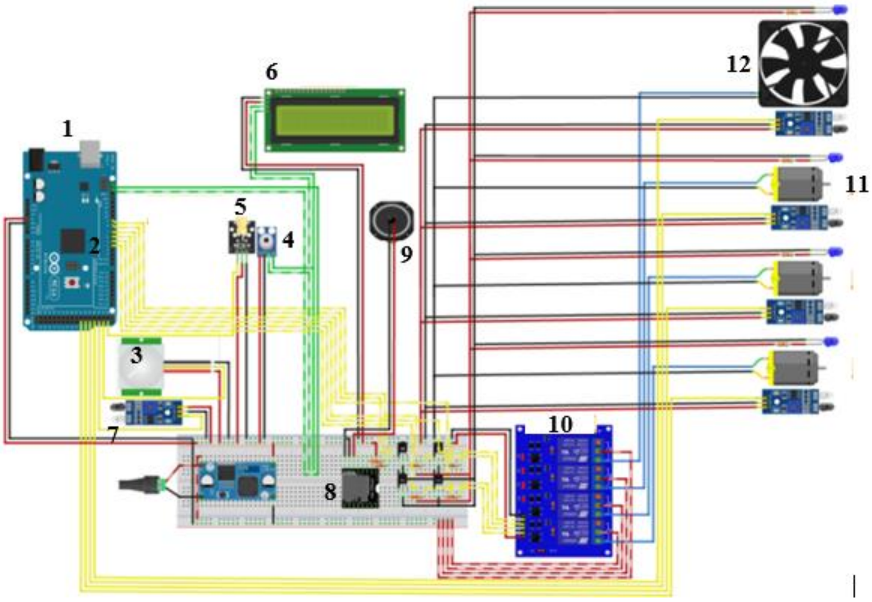


Fig. 4. Realization of the schematic circuit of the hand washing tool.

Figure 5 shows the realization of the system in the form of a photo of the system's physical and electronic board. Functional testing is conducted to determine whether every part of the device has worked according to the expected function.

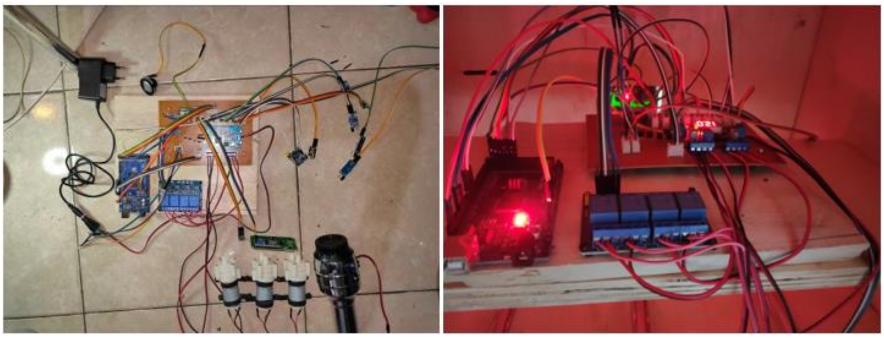


Fig. 5. Image of the system's electronic board.

3.1. Testing on the PIR sensor HC-SR501

The dataset size for the distance or radius of detection of people entering the PIR sensor area is set at a distance of 4 meters. If someone enters the sensor detection area, a welcome sound is sounded at this distance, indicating that someone will wash their hands and measure body temperature. Testing on the PIR sensor is done by looking at the sensor's sensitivity to the distance of a person's presence. Based on the test results and measurement of the angle of detection are given in Table 1. The result is that at a distance of 3 meters, this sensor can work well, and if it is more than 4 meters, it is not detected because PIR observes not only human movement but also passive infrared rays from the human body. When a visitor is detected by the PIR sensor within the given radius, the loudspeaker emits a welcome greeting.

Table 1. Test results on the PIR sensor HC-SR501.

Test trial	Distance between PIR sensor to people (meter)	Coverage angle			DF player mini	Welcome voice pronunciation (voiced to loudspeaker)
		0°	60° (right)	60° (left)		
1	1	ON	ON	ON	ON	Welcome
2	2	ON	ON	ON	ON	Welcome
3	3	ON	ON	ON	ON	Welcome
4	4	0N	OFF	OFF	ON	Welcome
5	5	OFF	OFF	OFF	OFF	No sound

3.2. Testing on the non-contact temperature sensor MLX90614

The characterization of the non-contact temperature sensor MLX90614 with variations in the sensor distance to the object is shown in Table 2, ranging from 0 cm (direct contact) to 5 cm at the source (on the human forehead). The results show that the sensor value detected by the MLX90614 sensor compared to the Thermogun has an average measurement error of 1oC or about 0.23% with a minimum measurement error of 0.04% and a maximum measurement error of 0.66%.

The dataset size for the temperature of people allowed to enter the area is, at most, 37 degrees Celsius. When the meter detects a person's temperature exceeding 37 degrees Celsius, the display on the screen gives an abnormal temperature warning, and the barrier will not open. Then after the test on the Non-contact

Temperature sensor, MLX90614 was successfully carried out. A sample of human body temperature was taken from several volunteers. In Table 3, several results of body temperature measurements are given through the LCD, indicators of body temperature status through loudspeakers (normal/abnormal), and the status of the door latch lock (open/closed).

Table 2. Test results on the non-contact temperature sensor MLX90614.

Test trial	Distance between non-contact temperature sensor MLX90614 to people (centimetre)	Temperature measurements on Non-contact temperature sensor MLX90614 (ºC)	Temperature measurements on comparison tool (Thermogun) (ºC)	Temperature differences	
				ºC	%
1	0	36.57	37.3	0.73	0.19%
2	1	35.35	35.2	0.15	0.04%
3	2	35.05	35.3	0.25	0.07%
4	3	33.13	35.5	2.37	0.66%
5	4	33.83	35.3	1.47	0.41%
6	5	32.47	33.5	1.03	0.03%
Average error				1	0.23%

Table 3. Test results on user temperature and doorstop lock status.

Test trial	Initials name of volunteer	Gender	Age (years)	Body temperatu re On the LCD display (ºC)	Temperature status (voiced to loudspeaker)	Status of doorstop lock
1	RH.	M	24	33.56	temperature is normal	doorstop open
2	D. M. F.	F	4	34.47	temperature is normal	doorstop open
3	N. W.	F	29	34.14	temperature is normal	doorstop open
4	C. S.	M	45	35.88	temperature is normal	doorstop open
5	A. R.	M	28	37.31	temperature is abnormal	doorstop closed
6	S. W.	P	31	34.11	temperature is normal	doorstop open
7	T. K.	P	18	34.33	temperature is normal	doorstop open
8	R. R.	L	20	35.45	temperature is normal	doorstop open
9	A. K.	L	35	37.87	temperature is abnormal	doorstop closed
10	A. N.	P	42	37.12	temperature is abnormal	doorstop closed

3.3. Testing on the water pump, soap pump, sanitizer pump, and hand dryer

The last test was testing on several pumps that functioned to dispense water, soap, and liquid sanitizer and run a hand dryer. The size of the water dataset that was issued when the water faucet/valve is open is approximately 350 ml, the dataset size for the soap liquid is approximately 10 ml, and the hand sanitizer's liquid dataset size is approximately 3 ml. This process was done by opening the liquid valve for different durations to obtain each size of the desired dataset. The water pump driven through relay 3 will issue a volume of 350 ml of water with a 15-second delay, the soap pump driven through relay 2 will issue a volume of 10 ml of liquid soap with a 0.5-second delay, and the sanitizer liquid pump driven through relay 4 will issue a volume of 3 ml of sanitizer liquid with a delay of 0.5 seconds. The test on the hand dryer will be active through relay 1 for 20 seconds. All these tests have been successful.

4. Conclusion

The design, realization results, and equipment testing conclude that this equipment can operate as expected. PIR sensors can detect people coming within 1-4 meters, non-contact temperature sensors can detect human body temperature well within 0-5 centimetres, and the result can be seen on LCD and can be heard through a speaker; IR Obstacle Infrared sensors can detect the user's hand at a predetermined distance so that the Arduino Microcontroller can respond and move all actuators to drain water, soap, hand sanitizer and activate the hand dryer. This equipment is expected to be used, for example, when someone wants to enter a public service area, to minimize the potential for the spread of COVID-19.

Acknowledgment

We want to thank the Rector of the Universitas Komputer Indonesia for the motivation and financial support that has been given. We also thank the head of the microprocessor systems laboratory of the study of computer systems, Universitas Komputer Indonesia, who has provided facilities during this research.

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