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Automatic Door Lock with Hand Cleaning and Infra-Red Temperature Detection System

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ABSTRAK

Kotak pembersih tangan otomatis merupakan perangkat yang dapat membantu proses pembersihan tangan lebih efisien dibandingkan dengan cuci tangan konvensional. Situasi pandemi Covid 19 membutuhkan perangkat yang dapat bekerja non-kontak untuk mengurangi penyebaran virus. Penelitian ini bertujuan mengembangkan sebuah kotak pembersih tangan otomatis yang dapat membaca suhu tubuh menggunakan sensor temperature MLX90614 dikombinasikan dengan kunci pintu solenoid, untuk menjaga seseorang yang ingin memasuki ruangan tertentu harus membersihkan tangan dan memiliki suhu di bawah batas. Saat memasuki ruangan, pengukuran suhu tubuh dilakukan dengan meletakkan tangan pengunjung di sisi kiri dan kanan kotak hand sanitizer otomatis yang dilengkapi sensor MLX90614. Sistem ini bekerja secara akurat dan dapat membaca suhu tubuh secara optimal dari 1 cm - 3 cm, dengan perbedaan dengan pengukuran thermometer guns hanya berkisar -0,27%~-1,92%. Selanjutnya sistem ADHC mampu meningkatkan efisiensi waktu sebesar 83,15% jika dibandingkan dengan metode konvensional.

***Kata kunci**: pembersih tangan otomatis, pengecek suhu tubuh, Bluetooth, RFID*

ABSTRACT

An automatic hand cleaning box is a device that can help the hand cleaning process be more efficient than conventional hand washing. The Covid 19 pandemic situation requires a device with a contactless system to reduce the spread of the virus. This research aims to develop an automatic hand sanitizer box that can read body temperature using MLX90614 temperature sensor combined with a solenoid door lock to keep someone who enters the room clean their hands and have a temperature below the limit. When entering the room, body temperature measurement is done by placing the visitor's hand on the left and right sides of the automatic hand sanitizer box, equipped with sensor MLX90614. This system works accurately and can read body temperature optimally from 1 cm - 3 cm, with the difference between the thermometer guns only ranging from -0.27%~-1.92%. Furthermore, the ADHC system is able to increase time efficiency by 83,15% if compared with the conventional method.

***Keyword:** automatic hand cleaning, body temperature check, Bluetooth, RFID.*

1. INTRODUCTION

Currently, all countries in the world are faced with the spread of a dangerous virus called COVID-19. The SARS-CoV-2 was first discovered in the city of Wuhan in China. Based on the World Health Organization **(Organization, 2020)**, the virus can spread from an infected person's mouth or nose in small liquid particles when they cough, sneeze, speak and breathe heavily. The spread of the virus from person to person is easy and rapid, and the number of infected victims continues to increase in Indonesia. This situation has prompted the World Health Organization to use health regulations when someone does outside activities like constantly washing their hands, wearing masks, and doing physical distancing **(Honey-Roses, et al, 2020)**. There are currently many automatic hand cleaning tools or touchless temperature body guns to minimize the spread of viruses like the project **(Aziz, et al, 2019) (Kencana, W.A, 2021) (Hendri, 2018)**, where the application is only intended for public places that do not require restricted access.

Other work is to explore automatic door control with fever screening and a non-contact sterilizer at the building entrance **(Vijayakumar, et al, 2021)**. The system will identify if any person is above the average body temperature and lock the door. However, this work has no feature that facilitates specific users for exceptional cases, like nurses or doctors wearing APD suits entering the room without following the checking many times. Even though it is applicable for specific places requiring high restricted access, like a hospital or warehouse, it has not been equipped with features that allow it to be integrated with RFID access, allowing unique access for specific needs as previously described. Some shortcomings in existing studies as described above still can be improved, and become the main idea of this research.

This Automatic Door Lock with Hand Cleaning and Infra-Red Temperature Detection System is conducted as an alternative solution to maintaining everyone who wants to enter a room. The device is placed at the entrance point and used to unlock the door when entering a room. The working principle of this system is to scan the user data on the card, check the body temperature on the palm, automatic hand sanitizer spray, and open the solenoid door lock. The person who has authorized access to the room at certain essential times can use an RFID tag to enter the room without washing hands and checking the temperature.

This research aims to design a system that can do a palm cleaning, body temperature checker, and automatic door lock to decrease the time of queues and minimize the spread of the virus, like warehouse area, manufacture area, inpatient room in the hospital, or office with restricted area. It is not only a solution during the pandemic era, but it is applicable and used as a standard for some specific rooms, such as storage and production warehouse or a patient room at a hospital with a high hygienist standard procedure. Not all public places are suitable for this final project. Only places that have access by registered people have few visitors and unique rooms. However, the implementation to places with significant visitors, which are tourist attractions, malls, restaurants, and others, is not suitable for this purpose because these places do not require automatic door locks.

2. METHODS

Automatic Door Lock with Hand Cleaning and Infra-Red Temperature Detection System is designed to spray hand sanitizer and check body temperature with a non-contact system combined with a solenoid door lock. When the visitors want to enter the room, they must clean their hands and have a body temperature below 37.5° C for the limited temperature use from the journal (**Safitri & Dinata, 2019).** The user puts their hand to the ultrasonic sensor, then the body temperature will be scanned using the temperature sensor, and the hand sanitizer will be sprayed using a water pump combined with a sprayer nozzle.

Several temperature sensors options can be used to measure human body temperature, including the LM35 sensor, the MLX90614 infrared sensor, and the DS18B20 sensor. The study **(Achlison, 2020)** conducted a comparative analysis of the measurement results resulting from variations in the types of temperature sensors used to determine which one is more accurate and efficient in measuring human body temperature. The study results stated that the LM35 sensor was more efficient and accurate when used by attaching it to the forehead or armpit of the human body. Whereas MLX90614 sensor is more efficient and accurate when used with a distance of 2 cm directed at the face or human hand. From the previously research **(Bitar, et al, 2009)**, non-contract infrared thermometers were reported to have a sensitivity between 4.0% to 89.6% and a positive predictive value between 0.9% to 76.0%. Therefore, the authors used the MLX90614 sensor following the system design for placement at the room's entry point.

This system has three additional features: RFID, PIR sensor, and Bluetooth. RFID is used when special access is needed for specific users, like nurses or doctors wearing APD suits. The PIR sensor is used to open the solenoid door lock from inside the room with a non-contact system, and the user only needs to approach the door at a distance of 1 - 1.5 meters. The last is that the Bluetooth module controls the solenoid door lock. An additional buzzer is added via smartphone for an emergency condition, like when a technician in the production warehouse wants to call a supervisor or a patient to call a nurse or doctor using a smartphone.

2.1 Hand Cleaning Box Hardware

The hand cleaning box uses a 12 Vdc 5 A power supply and has four input systems as triggers: Ultrasonic and MLX90614 temperature sensor for the main system, RFID for the second system, and PIR sensor for the third sensor, and Bluetooth application for the fourth system. There are two outputs, the first is a buzzer, and the second is a two-channel relay to control the water pump and solenoid door lock. All temperature sensor and RFID information will be displayed on the LCD.

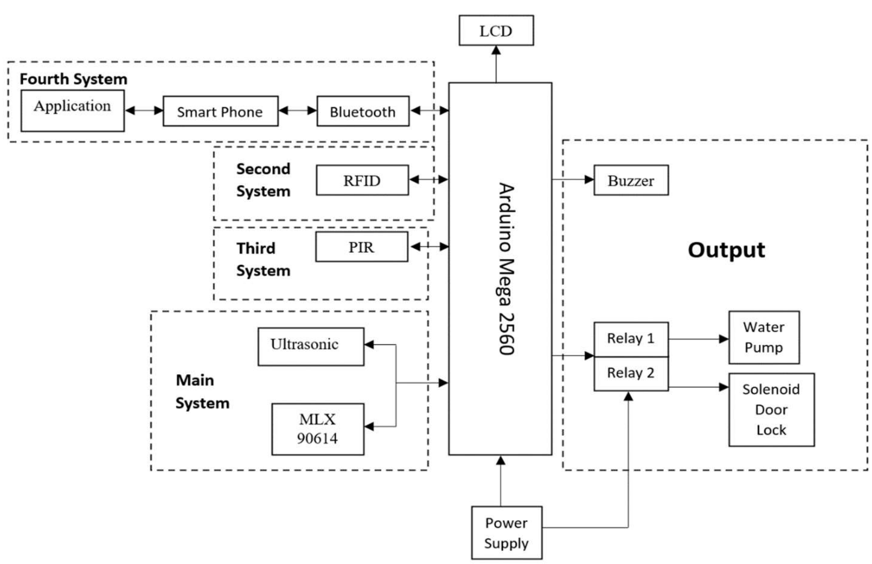


Figure 1. Block Diagram of Automatic Door Lock with Hand Cleaning and Infra-Red Temperature Detection System

2.2 System Design

This research was designed by combining hardware and software subsystems. The hardware subsystem uses MLX90614 and ultrasonic, PIR sensors, RFID, and Bluetooth HC-05 modules as triggers, while the software uses applications created from the MIT App Inventor website as input triggers. Using these different subsystems will maximize the non-contact system to use the device and provide wireless access control in areas that do not have internet access. The workflow of Automatic Door Lock with Hand Cleaning and Infra-Red Temperature Detection System is shown in Figure 2.

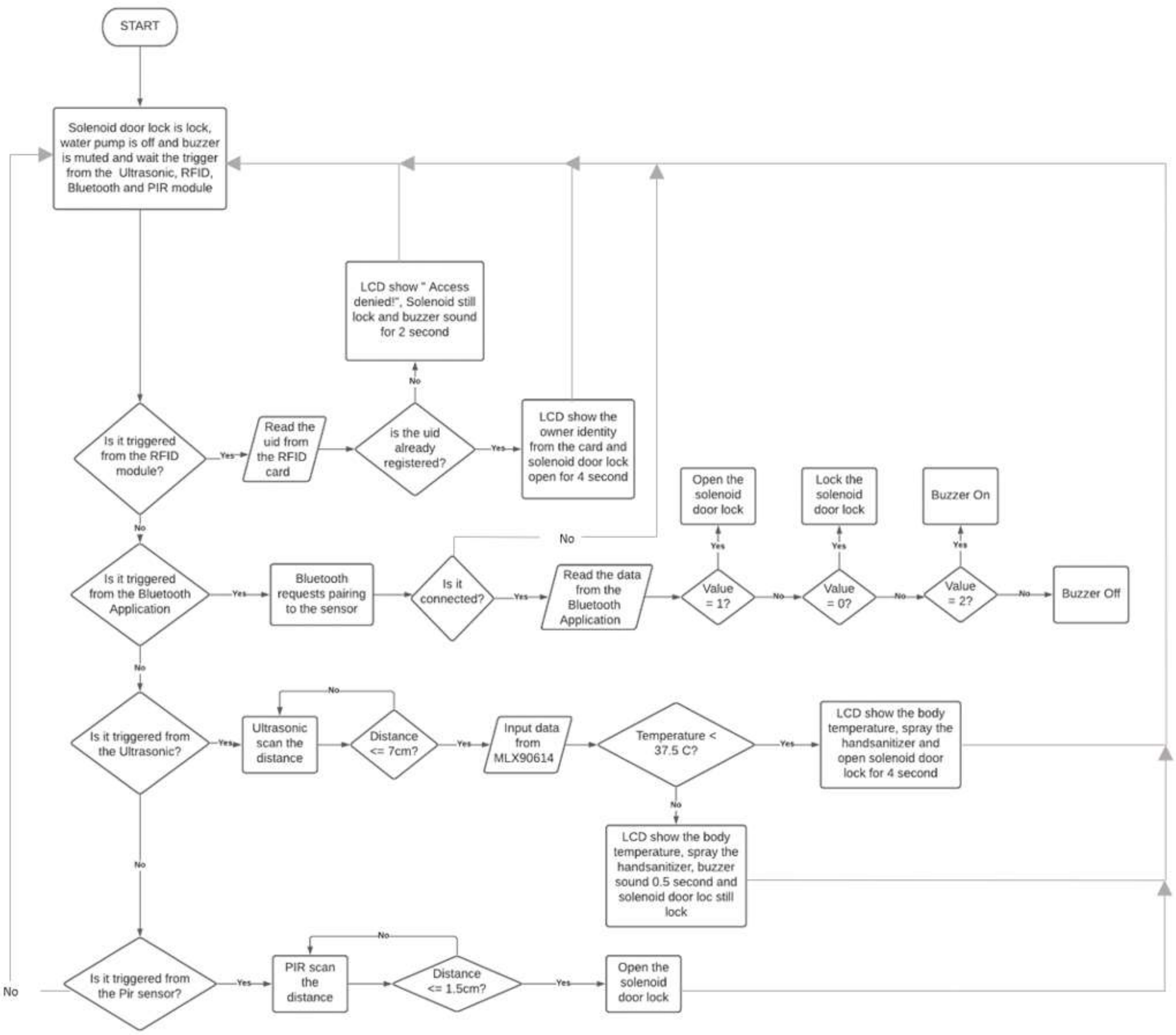


Figure 2. System Flow Chart

In the primary system, the trigger is ultrasonic, an LCD to show the body temperature inspired by the journal **(Dianty, 2020)**. The MLX90614 is I2C based infrared temperature sensor specially designed for contactless body temperature measurements. The MLX90614 sensor internally integrates two devices: the application processor and the infrared thermopile detector **(Qian, 2021).** This sensor-controlled the relay connected to the solenoid door lock and water pump. If the body temperature is lower than 37.5 °C, the solenoid door lock will be open, and the hand sanitizer will be sprayed. However, if the body temperature exceeds the limit, the solenoid door lock is still closed, hand sanitizer will be sprayed, and the buzzer will be turned on. The trigger is RFID connected to the relay for the second system and controls the solenoid door lock. This system is used for an emergency to control the solenoid door lock without cleaning the hand and scan the body temperature.

If the user uses a registered card, the LCD will show the identity of the user **(Junaidi, 2015)** and the solenoid door lock will be open for 3 seconds, and if the user uses the unregistered card, the LCD will show "access denied," the solenoid door lock still locked and the buzzer will be sound. Inspired by the journal **(Susanto, et al, 2018)**, in the third system, a PIR sensor is used as the trigger to maximize the non-contact system and make it easier for the user to open the solenoid door lock from inside the room. The user is only close to the door in the range of 1 – 1.5 meters, and the solenoid door lock will be open until the sensor does not detect any object. For the fourth system, the Bluetooth HC-05 provide wireless control in the area without the internet **(Hazarah, 2019)**. The user can use a Bluetooth application to control the solenoid door lock and the buzzer. If the user clicks the open door icon, the solenoid door lock will be open continuously until the user clicks the close door icon, and if the user clicks the sound icon, the buzzer will be sound continuously until the user clicks the muted icon.

2.3 Bluetooth Application Design

The author created an automatic temperature detection and hand cleaning point (ADHC) application. This is the author's name of this tool, referring to its function, and it is placed at the entry point of a specific room or area. Bluetooth is created from the MIT App Inventor application, as shown in Figure 3. With this application, users are able to connect their Android smartphone to a hand cleaning box by pairing their Bluetooth smartphone with the Bluetooth HC-05 module on the hand cleaning box named "ADHC."

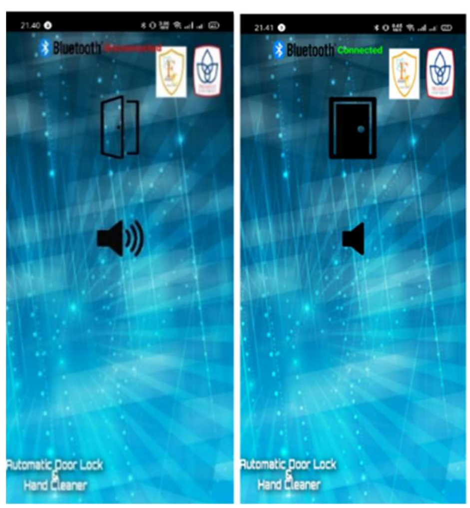


Figure 3. The Bluetooth Application Design

2.4 System Circuit Design

The primary system includes Arduino Mega 2560 as a microcontroller, MB102 as converter power supply from 12 V_{dc} to 5 V_{dc} or 3.3 V_{dc}, power supply for sensors and modules. The ultrasonic HC-SR04 is used to detect objects and trigger the system, and the MLX90614 is used to scan body temperature. It also includes dual-channel relay control output, the electromagnetic door lock as a door lock, and a water pump for hand sanitizer spraying. A buzzer will be activated whether the body temperature is higher than the limit and if the user uses an unregistered RFID card. Lastly, all the information from the temperature sensor and the identity from the RFID card will be exposed via LCD. The hand cleaner box was designed with four partitions: lower, middle, top, and hand cleaning space. The hand cleaning space size is created with several palm-size samples consideration. In the middle part is placed the hand sanitizer tank and water pump. This tool works by bringing the visitor's hand closer to the left and right side of the device, which is equipped with an MLX90614 sensor to measure the body temperature as described in Figure 4.

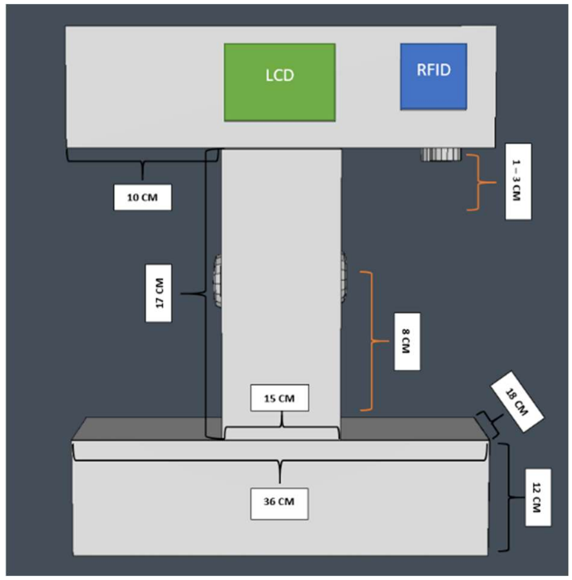


Figure 4. Design of Automatic Door Lock with Hand Cleaning and Infra-Red Temperature Detection System

The RFID provides limited access in other research **(Fauziah, et al, 2017)**. In this research, the RFID is proposed to provide unique access that verifies a specific person or for an emergency requiring authorized access to have to enter directly without washing hands and checking their body temperature. When a card tag is attached to the RFID, the ID data from the card tag will be read and matched with the ID tag data with the registered card tag. If the ID is registered, the door is will be unlocked. However, the door will remain locked if the ID is not registered. The PIR sensor and Bluetooth HC-05 application are designed to simplify the door lock opening system with the contactless method and provide wireless control for the solenoid door lock and the buzzer. With a Bluetooth connection, the solenoid door lock and buzzer can be controlled via a smartphone in the area without internet access. PIR sensors are used to open the door lock from inside the room without touching, and the user closes the door in the range of 1 – 1.5 meters **(Ada, 2021)**.

3. RESULTS AND DISCUSSION

For locking and opening the door from inside the room, the authors use the solenoid door lock and HC-SR14. The inner design, outer design, and all components are allocated inside the hand cleaning box and can be accessed by opening the front side box as seen in Figure 5.

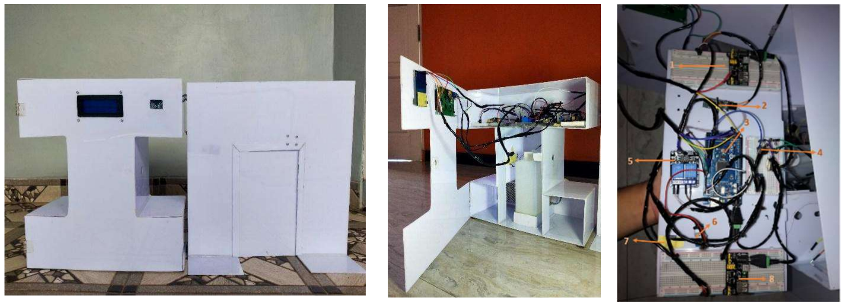


Figure 5. Inner and Outer Design of Automatic Door Lock with Hand Cleaning and Infra-Red Temperature Detection System

LCD has some information that will be displayed according to the device's condition when it is used. When the system is turned on and is not triggered by the sensor, the LCD will display "Temperature check, close to the sensor" to understand how to use the device. The sprayer hole is designed 8 cm from the bottom. Therefore, the wrist can close to the sensor. All components are placed inside the hand cleaning box that can be accessed by opening the front side box.

When an object is read by ultrasound, it will trigger the MLX90614 sensor to read whether the body temperature is below or above the limit. If the body temperature is lower than the limit, the LCD will display the body temperature, spray hand sanitizer and unlock the door. However, if the temperature exceeds the limit, the LCD will display body temperature, hand sanitizer will be sprayed, the buzzer will sound, but the door lock will remain locked to protect the room from people with signs of illness as shown in Figure 6.

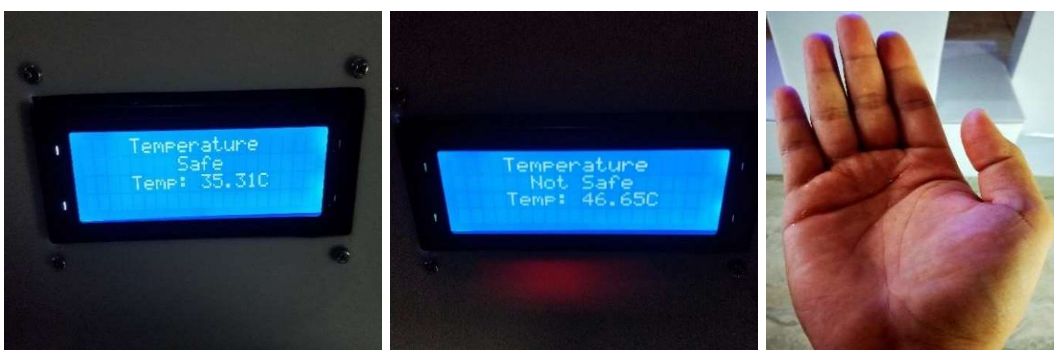


Figure 6. LCD Display and Hand Sanitizer Sprayer

According to **(Qian, 2021)** the measurement results from the MLX90614 sensor should be calibrated first before implemented in the system. The calibration was conducted by measuring the body temperature using the MLX90614 sensor, a thermometer gun, and a digital thermometer. All temperature data were compared and calculated to be used as a calibration reference. Thermometer guns and digital thermometers are devices with industrial-standard manufacturer quality with a proven level of measurement accuracy. This comparison aims to recognize the differences in temperature measurements produced by the MLX90614 sensor compared to thermometer guns and digital thermometers and determine the calibration value for the MLX90614 sensor. The comparison of the scan results of each device's body temperature is presented in Table 1.

Table 1. Scan Result Comparison

Device	Mouth	Head	Hand	Average		
				Mouth	Head	Hand
Digital Thermometer	35.6 °C			35.5 °C		
	35.6 °C					
	35.4 °C					
Thermometer Gun		35.2 °C	34.6 °C		35.1°C	34.7°C
		35.1 °C	34.6 °C			
		35.1 °C	34.8 °C			
MLX90614		31.4 °C	30.8 °C		31.5°C	30.8°C
		31.6 °C	30.8 °C			
		31.6 °C	30.9 °C			

From Table 1, it can be seen that the MLX90614 temperature sensor produces differences in the results of body temperature scans, with measurement points on the hand and head and measured from the same distance using a thermometer gun test. Calibration for the MLX90614 sensor uses the averages of the digital thermometer in the mouth test, the gun thermometer test on the head, and the MLX90614 sensor in hand. Calculation of the calibration value is shown in the formula below.

$$\text{Calibration} = \left(\frac{T_d+T_g}{2}\right) - T_m \qquad (1)$$

$$\text{Calibration} = \left(\frac{35.5\,°C+35.1°C}{2}\right) - 30.8°C = 35.3°C - 30.8°C = 4.5°C$$

Td value is the average body temperature from the digital thermometer, Tg value is the average body temperature from the thermometer gun, while Tm value is the average body temperature from the MLX90614 sensor. Based on the result 4.5 °C, the author performs the calibration by adding "± 4.5 °C" for the temperature reading on the MLX90614 sensor. This calibration value is used as the reference for adjustment in the coding part.

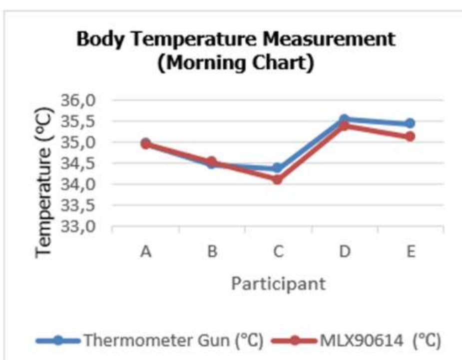
The first testing was conducted in the morning, the test was carried out three times for each device (hand cleaning box and thermometer gun) at 06:00 a.m. by 5 participants to find out the average body temperature in the morning before doing the activity with the results are presented in Table 2 (M=Morning).

Next is a test in the afternoon to find out the average body temperature in the afternoon, with the results as presented in Table 2 (A=afternoon). Compared with the participants when they woke up in the morning, the temperature rose faster. The thermometer gun showed that the temperature was in 35.6°C to36.7°C ranges, while the MLX90614 sensor showed that the temperature was between 35.45°C and 36°C, with a deviation of -0.79% to 0.28. %. Night body temperature was tested after the participant had finished their activity. Using MLX 90614 sensor, the average body temperature at night time is between 34.2 °C to 35.4 °C, however using thermometer gun, the result is between 34.2 °C to 35.5 °C. There is a difference of -0.70% to 0.40% measurement results as shown in Table 2.

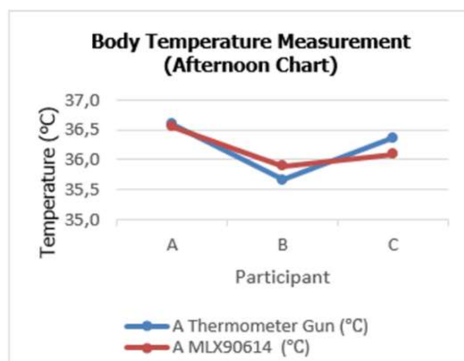
Table 2. Body Temperature in the Morning, Afternoon, and Night

P	T	Thermometer Gun (°C)			MLX90614 (°C)			Difference (°C)		
		M	**A**	**N**	**M**	**A**	**N**	**M**	**A**	**N**
A	1	35,1	36,7	34,6	35,2	36,7	34,4	0,1	0,0	-0,2
	2	35,0	36,7	34,6	35,0	36,6	34,4	0,0	-0,1	-0,2
	3	34,8	36,4	34,5	34,7	36,4	34,3	-0,1	0,0	-0,2
B	1	34,7	35,8	34,2	34,9	36,5	34,3	0,2	0,7	0,1
	2	34,5	35,6	34,2	34,6	35,7	34,2	0,1	0,1	0,0
	3	34,2	35,6	34,2	34,1	35,5	34,3	-0,1	-0,1	0,1
C	1	34,5	36,4	35,4	34,2	35,5	35,4	-0,3	-0,9	0,0
	2	34,3	36,4	35,2	34,1	36,5	35,3	-0,2	0,1	0,1
	3	34,3	36,3	35,2	34,0	36,3	35,3	-0,3	0,0	0,1
D	1	35,7		35,5	35,5		35,5	-0,2		0,0
	2	35,5		35,5	35,3		35,4	-0,2		-0,1
	3	35,4		35,4	35,3		35,3	-0,1		-0,1
E	1	35,7			35,0			-0,7		
	2	35,4			35,3			-0,1		
	3	35,2			35,1			-0,1		

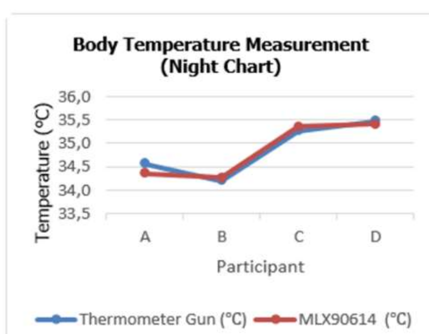
P = participants
T = test number (T1= first test, T2= second test, T3= third test)
M = morning, A = afternoon, and N = night)



(a)



(b)



(c)

(a) Morning Chart; (b) Afternoon Chart; (c) Night Chart
Figure 7. Body Temperature Measurement Results

Figure 7 shows the comparison of the temperature measurement value between the thermometer gun and the system. From the results, the temperature read by the MLX90614 sensor is close to the thermometer gun. A high body temperature test was conducted to measure high temperatures above 37.5 °C. Research from **(Sibuea, 2018)** measurement to determine the high-temperature readings on the MLX90614 sensor using 40 watts of electric solder. The measurement starts when the solder is unplugged from the power source until it is turned on for 40 seconds. The test was conducted for 10 seconds per scan, with the results presented in Table 3.

Table 3. The Accuracy Test of System Compared to Thermometer Guns for The Higher Temperatures.

Time	Thermometer Gun	ADHC	Difference (Percent)
0s	28.7℃	28.5℃	-0.45%
10s	32.7℃	33.3℃	1.83%
20s	36.9℃	37.4℃	1.36%
30s	39.6℃	40.2℃	1.52%
40s	44.8℃	45.2℃	0.89%

Table 3 describes the results of temperature measurements on a 40-watt solder. This test focuses on measuring the accuracy of the MLX90614 sensor for the higher temperatures and exceeding 37.5°C without activating the solenoid door lock and water pump. When the solder rod is turned on for 40 seconds, the measurement results comparison between the MLX90614 temperature sensor and a Thermometer gun with the same sampling time are close, with differences between 0.2°C to 0.6 °C. A detailed comparison of the temperature measurement value between the thermometer gun and this system (ADHC) is shown in Figure 8.

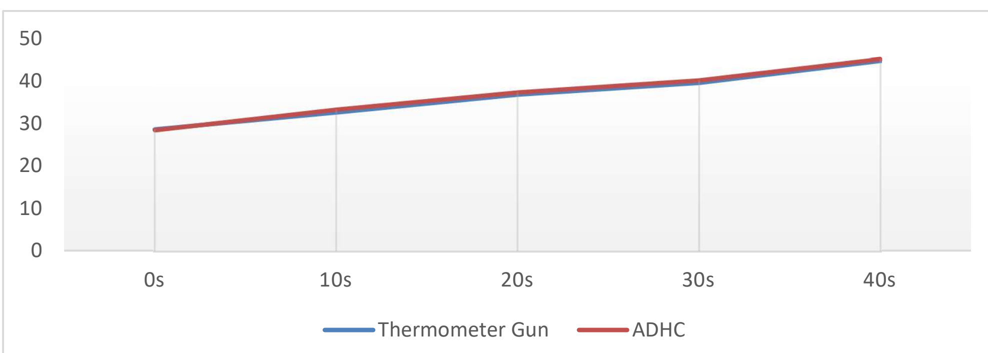


Figure 8. Temperature of 40 Watts Electric Solder Chart

Automatic Door Lock with Hand Cleaning and Infra-Red Temperature Detection System has 7 cm of space for the hands, so the temperature readings are tested at different distances to determine the temperature sensor's accuracy. For the MLX90614 sensor reading at a distance of 1 cm - 7 cm, the thermometer gun only at 1 cm as presented in Table 4. Table 4 shows the results of the MLX90614 sensor for several different distances, compared with the results of measurements using a thermometer gun (with standard manufacturers, which is used as a reference), with three times measurement in every distance tested. The results found that the MLX90614 sensor can read the temperature optimally from 1 cm - 3 cm, with the difference between the thermometer guns only ranging from -0.27%~-1.92%. With the subsequent increase in distance in the range of 4 cm - 5 cm, the percentage difference in temperature increases and the increase in distance in the range of 6 cm - 7 cm. From these data, it can be seen that the most accurate temperature reading on the MLX90614 sensor is at a distance of 1 cm - 3 cm and is increasingly inaccurate at a distance of 4 cm - 7 cm. This data is then used as a reference to determine the distance of the sprayer hole at a distance of 8 cm, which is ideal where the top of the hand can be brought closer to the MLX90614 sensor at a distance of 1 cm - 3 cm.

Table 4. Temperature in Different Distance

<table>
<tr><th>Distance</th><th>ADHC</th><th>Thermometer Gun</th><th>Difference (Percent)</th></tr>
<tr><td rowspan="3">1 cm</td><td>36.2℃</td><td>36.5℃</td><td>-0.82%</td></tr>
<tr><td>36.4℃</td><td>36.5℃</td><td>-0,27%</td></tr>
<tr><td>36.2℃</td><td>36.5℃</td><td>-0.82%</td></tr>
<tr><td rowspan="3">2 cm</td><td>36.2℃</td><td>36.6℃</td><td>-1.09%</td></tr>
<tr><td>35.8℃</td><td>36.5℃</td><td>-1.92%</td></tr>
<tr><td>36.1℃</td><td>36.5℃</td><td>-1.10%</td></tr>
<tr><td rowspan="3">3 cm</td><td>36.0℃</td><td>36.5℃</td><td>-1.37%</td></tr>
<tr><td>36.1℃</td><td>36.5℃</td><td>-1.10%</td></tr>
<tr><td>36.1℃</td><td>36.4℃</td><td>-0.82%</td></tr>
<tr><td rowspan="3">4 cm</td><td>35.4℃</td><td>36.5℃</td><td>-3.01%</td></tr>
<tr><td>35.6℃</td><td>36.6℃</td><td>-2.73%</td></tr>
<tr><td>35.4℃</td><td>36.6℃</td><td>-3.28%</td></tr>
<tr><td rowspan="3">5 cm</td><td>35.2℃</td><td>36.5℃</td><td>-3.56%</td></tr>
<tr><td>35.4℃</td><td>36.5℃</td><td>-3.01%</td></tr>
<tr><td>35.0℃</td><td>36.5℃</td><td>-4,11%</td></tr>
<tr><td rowspan="3">6 cm</td><td>33.8℃</td><td>36.5℃</td><td>-7.40%</td></tr>
<tr><td>34.1℃</td><td>36.6℃</td><td>-6.83%</td></tr>
<tr><td>38.6℃</td><td>36.6℃</td><td>-5.46%</td></tr>
<tr><td rowspan="3">7 cm</td><td>33.1℃</td><td>36.5℃</td><td>-9.32%</td></tr>
<tr><td>32.5℃</td><td>36.5℃</td><td>-10.96%</td></tr>
<tr><td>32.6℃</td><td>36.6℃</td><td>-10.93%</td></tr>
</table>

This research is expected to reduce conventional hand cleaning and body temperature checking. To obtain the ADHC system efficiency compared with the conventional method, five participants conducted the trial with the result shown in Table 5.

Table 5. Time Comparison for Hand Washing

Participants	Conventional Method (seconds)	ADHC System (seconds)	Time Efficiency (%)
A	25 s	4,5 s	82%
B	33 s	4,5 s	86.36%
C	27 s	4,5 s	83,33%
D	29 s	4,5 s	84.48%
E	22 s	4,5 s	79.55%

Table 5 result compares the time required to wash hands between conventional methods with water and soap or using a hand sanitizer from the system. The use of hand sanitizers in the system can reduce the time to wash hands from 22-33 seconds to 4,5 seconds. In otherwise, the ADHC system is able to increase time efficiency by 83,15% and reduce queuing time to wash hands. The consistency of the RFID reader testing was conducted using three registered, and unregistered cards for triggering the door lock solenoid and buzzer, with the results are presented in Table 6.

Table 6. RFID Test

RFID reader testing (Authorized Card)					RFID reader testing (Un-authorized Card)				
Card	**Test**	**LCD**	**Solenoid Door Lock**	**Buzzer**	**Card**	**Test**	**LCD**	**Solenoid Door Lock**	**Buzzer**
Doctor Card	1	Show the identity	Open	Off	Not Registered Card (1)	1	Show "Access Denied "	Close	On
	2	Show the identity	Open	Off		2	Show "Access Denied "	Close	On
	3	Show the identity	Open	Off		3	Show "Access Denied "	Close	On
Compa nion	1	Show the identity	Open	Off	Not Registered Card (2)	1	Show "Access Denied "	Close	On
	2	Show the identity	Open	Off		2	Show "Access Denied "	Close	On
	3	Show the identity	Open	Off		3	Show "Access Denied "	Close	On
Room Service	1	Show the identity	Open	Off	Not Registered Card (2)	1	Show "Access Denied "	Close	On
	2	Show the identity	Open	Off		2	Show "Access Denied "	Close	On
	3	Show the identity	Open	Off		3	Show "Access Denied "	Close	On

From Table 6, the RFID system in the hand cleaning box works appropriately according to the program design. For three tests per card, the RFID system can recognize the identity of registered cards and open the solenoid door lock. Furthermore, the system can determine which cards have not been registered so that the buzzer sound and the solenoid door lock remain locked.

A Bluetooth application test is conducted to ensure the application works properly, including testing the consistency of control of the door lock solenoid and buzzer. The test was carried out in a room with an area of 4.5 m X 3.5 m at a distance of 1 meter to 8 meters from the system's position. The test results show that the application is able to appropriately control using a Bluetooth connection at a distance of 1 m to 6 m, an error occurs at a distance of 7 m and 8 m which sometimes succeeds or fails, and at a distance of 9m - 10m, the application cannot control the solenoid door lock and buzzer as presented in Table 7.

Table 7. Bluetooth Application Test

Distance	Test	Solenoid Door Lock	Buzzer
1 m	1	Open	On
	2	Open	On
2m	1	Open	On
	2	Open	On
3m	1	Open	On
	2	Open	On
4m	1	Open	On
	2	Open	On
5m	1	Open	On
	2	Open	On

Distance	Test	Solenoid Door Lock	Buzzer
6m	1	Open	On
	2	Open	On
7m	1	Open	On
	2	Failed	On
8m	1	Failed	Failed
	2	Open	Failed
9m	1	open	Failed
	2	Failed	Failed
10m	1	Failed	Failed
	2	Failed	Failed

The purpose of PIR sensor is to check the consistency of the door lock solenoid control from inside the room. The test is carried out at a distance of 1 m to 4 m in light and darkroom conditions as presented in Table 8.

Table 8. PIR Sensor Test

Distance	Test	Solenoid Door Lock	
		Light	Non-light
1m	1	Open	Open
	2	Open	Open
2m	1	Open	Open
	2	Open	Open
3m	1	Open	Closed
	2	Closed	Closed
4m	1	Closed	Closed
	2	Closed	Closed

In the lighted room, the PIR sensor is able to operate correctly to control the solenoid door lock with a maximum distance of 3 m. However, at a 4 m or more distance, the sensor cannot read objects. In the darkened room, the PIR sensor works appropriately to control the solenoid door lock at a distance of 1 m – 2 m but cannot read objects at 3 m or more. From the test results, the PIR is able to trigger and unlock the door when someone is 1 m away from the door.

4. CONCLUSION

Automatic Door Lock with a Hand Cleaning and Infra-Red Temperature Detection System was successfully implemented with the following methods: designing the system, configuring and installing the components, performing function testing, and collecting data to test the system function. The system detects the body temperature by bringing the visitor's hand closer to the left and right sides of the device, which is equipped with an MLX90614 sensor. Hand sanitizer sprayer, solenoid door lock, and temperature sensor are applied and work properly to provide access to enter the room for the visitor with body temperature below the set limit. If the body temperature detected exceeds the threshold, the buzzer will sound, and the door will not open. The results found that the MLX90614 sensor can read the temperature optimally from 1 cm - 3 cm, with a -0.27%~-1.92% difference compared with the thermometer guns. Furthermore, the ADHC system can increase efficiency by 83,15% and reduce queuing time to wash hands compared with the conventional method. The application can work properly using a Bluetooth connection to control the buzzer and door lock and can be automatically opened inside the room using the PIR sensor.

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