Automatic Alcohol Hand Sanitizer Dispensers With & Without Microcontroller

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ABSTRACT

Hygiene for humans is necessary to maintain human health to keep the body clean and be free from germs without spreading the disease to various places, especially during this time with the spread of COVID-19 with increasing numbers continuing to evolve species to be able to reproduce and survive. For this reason, this research article therefore designed and invented an automatic liquid alcohol dispenser with and without a microcontroller, which would assist in preventing germs from spreading from the hands of people in that community by not having to touch any part of this device while using it. An Automatic Alcohol Hand Sanitizer Dispenser with a Microcontroller (AAHSDWM) has advantages for adjusting the amount of alcohol liquid by coding and speeds up installation faster than in the first stage. An Automatic Alcohol Hand Sanitizer Dispenser without Microcontroller (AAHSDWoM) has advantages such as cost savings of up to 30%, ease of configuration and maintenance, higher overall average user satisfaction scores, and ease of mobility due to the use of rechargeable batteries. In addition, AAHSDWoM is suitable to make a low-cost product for commercial use. These devices would then dispense liquid alcohol to the users' palms. Test results show that the unit is 100% efficient, providing up to 1,000 alcohol dispensing services.

Keywords: Alcohol Hand Sanitizer Dispenser, Microcontroller, Hand Hygiene, Arduino, PCB

1. INTRODUCTION

Due to COVID-19 [1], first found in December 2019 at Wuhan in China, it is a critical problem for the future of the world. There is no medicine or vaccine to protect people completely. Viruses can evolve or mutate so quickly that it doesn't help them develop traits that are advantageous to transmission. In addition, the virus could increase evading the defenses of our immune. Viral mutations could be dangerous. Compliance with hand hygiene is universally acknowledged as a vital act to prevent the transmission of infection. The research related to automatic liquid dispensers has been described widely [1].

Hand hygiene is one of the most effective ways to prevent the transmission of healthcare-associated infections. [2]. Alcohol-based hand sanitizer (ABHS) is a beneficial material against the spread of infectious viruses in crowded areas such as schools, universities, plaza malls, etc [3–4].

Hand hygiene sanitizers can be made contactless and automatic in different ways by various sensors. In general, infrared sensors [4, 6-7] and ultrasonic sensors [10–11] were used to make a low-cost sanitizer dispenser. Some use both sensors [5, 8–9, 14], with one sensor detecting hands and the other monitoring the level of alcohol. Specifically to use IoT to monitor the levels of water and alcohol. Use a new LDR sensor [13] to improve poor performance on a sunny day. The studies reviewed (listed and classified in Table 1) are discussed below.

With the beginning of COVID-19, tools and supplies are insufficient in many areas. There is a lack of tools and suppliers in many areas.

The main objective of these studies is to facilitate the processes of assembling and making a low-cost hand sanitizer dispenser fully touchless with an automatic device.

However, there is a significant cost associated with electronic and automated hand hygiene systems. The researcher has already made and implemented an automatic alcohol hand sanitizer dispenser at the university and in urban areas.

In this paper, the hand sanitizer dispensers were designed in two different ways as automatic devices. One is with a microcontroller, and the other is without a microcontroller.

2. METHODOLOGY

The research methodology followed in this study is depicted in Fig. 1. It can be divided into four steps:
1) Design

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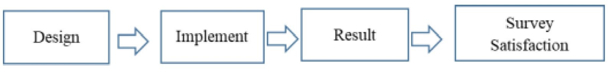


***Fig. 1**: Research Methodology.*

2) Implement
3) Result
4) Survey Satisifaction

These four steps method can be depicted as the following.

2.1 Design

The Automatic Alcohol Hand Sanitizer Dispenser with Microcontroller (AAHSDWM) has the microcontroller as the mainboard.The Automatic Alcohol Hand Sanitizer Dispenser without Microcontroller (AAHSDWoM) has only one circuit designed as the mainboard.

2.1.1 System Architecture for AAHSDWM

The system architecture of AAHSDWM can be depicted in Fig. 2(a) and covers the three main components as follows:

2.1.1.1 Infrared sensor

The user's hands are placed under the nozzle, before the sensor, and then transmit data to an Arduino board.

2.1.1.2 Arduino Board (Hardware and Software on the Commercial Board)

The Arduino board received a signal to turn on the motor pump.

2.1.1.3 Motor Pump

The Arduino board activates the pump that dispenses a specific amount of alcohol liquid (or alcohol gel) from the nozzle.

2.1.2 System Architecture for AAHSDWoM

The system architecture of AAHSDWoM can be depicted in Fig. 2(b) and covers the three main components as follows:

2.1.2.1 Infrared sensor

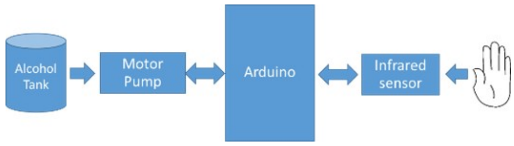
The user's hands are placed under the nozzle, before the sensor, and then transmit data to a PCB board.

2.1.2.2 PCB Board (only hardware-specific designs by the researcher)

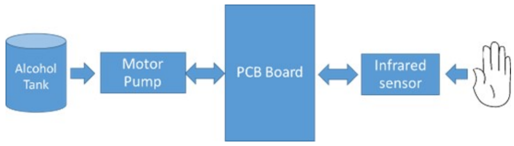
The PCB board received a signal to turn on the motor pump. (See Fig. 2(c) for circuit design.)

2.1.2.3 Motor Pump

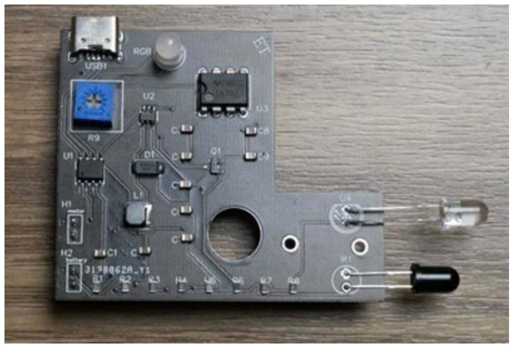
The PCB board activates the pump that dispenses a specific amount of alcohol liquid (or alcohol jelly) from the nozzle.



(a)



(b)



(c)

***Fig. 2**: (a) System Architecture for AAHSDWM, (b) System Architecture for AAHSDWoM, and (c) Circuit designed in PCB for AAHSDWoM.*

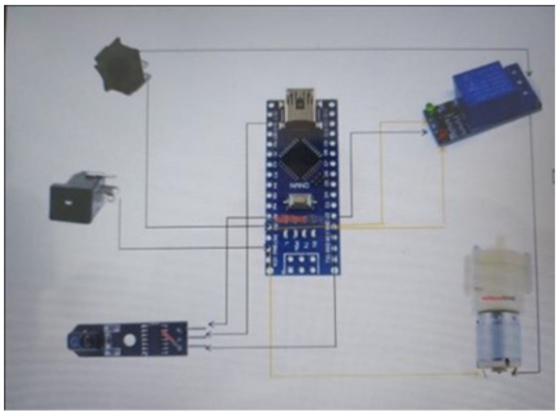


***Fig. 3**: Hardware wiring diagram for AAHSDWM.*

2.2 Implementing

2.2.1 Implementing for AAHSDWM

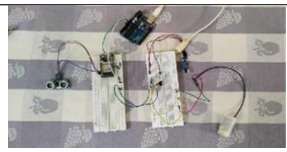
All hardware was wired as shown in the diagram of this system shown in Fig. 3.

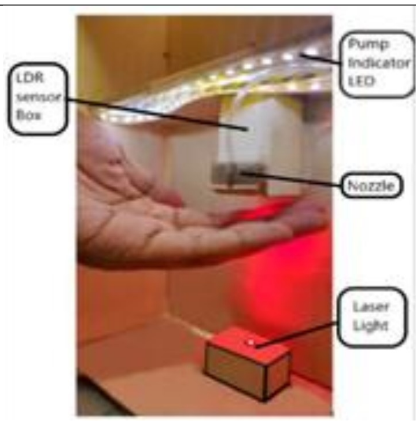
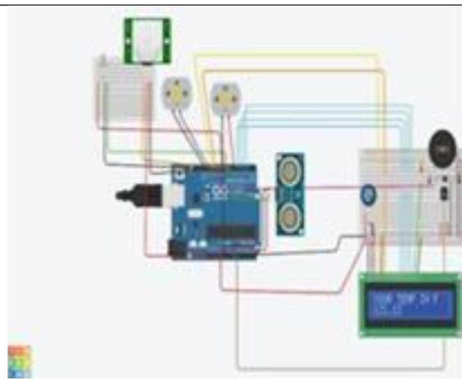
However, all of the components were wired as shown in the figure above. The system needed coding to allow the connected devices to communicate with each other. This paper demonstrates a flow chart of Arduino coding for this system, shown in Fig. 4.

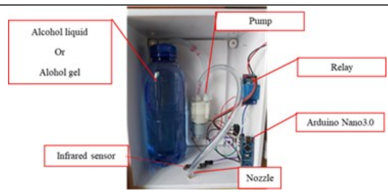
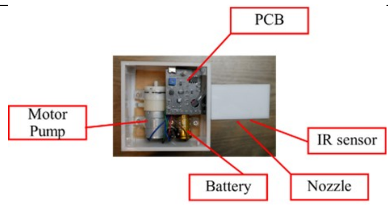
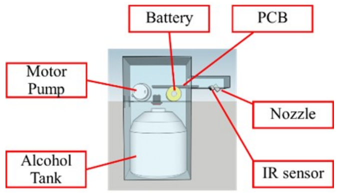
2.2.2.1 Flow chart of the system for AAHSDWM

It began to detect whether the hand was in the range of operation or not in Fig. 4. If it is in the range of operation,

***Table 1**: Summary and classification of the researchers reviewed.*
Notice: IR is an infrared sensor, US is an ultrasonic sensor, and PIR is a passive infrared sensor.

Paper	Main Board (Hardware)	Software	Sensor	Proposed	Motor	Picture of Device
[4]	PCB	-	IR	- Commercial product by buying.	Pump	
[5]	Arduino	C	US & IR	- IR checking for Temperature and using US for hand hygiene. - Bigger device.	Pump	
[6]	PCB	-	IR plus adjust	- Have function to show light for the status of battery.	Pump	
[7]	Arduino	C	IR	- Press the alcohol.	Servo Motor	
[8]	Arduino	C	- US check level of water - IR check hand	- IoT : Mobile App can monitor the level of water - Not design in package completed set.	Pump	
[9]	Arduino	C	- US check level of water - IR check hand	- IoT: Mobile app can check level of water - Bigger size	Pump	

Paper	Main Board (Hardware)	Software	Sensor	Proposed	Motor	Picture of Device
[10]	Arduino UNO	C	US	- Show principle working but not in completed set.	Pump	
[11]	Arduino	C	US	- Show principle working but not in completed set.	Pump	
[12]	Arduino	C	IR	- Dispensing Soap liquid & Water separated.	Pump	
[13]	Arduino	C	LDR	- New sensor Light-dependent resistor(LDR) - Higher cost	Pump	
[14]	Arduino	C	US, PIR	- Show Thinkercad simulation.	Pump	

Paper	Main Board (Hardware)	Software	Sensor	Proposed	Motor	Picture of Device
Our Works Proposed: Automatic Alcohol Hand Sanitizer Dispensers with Microcontroller (AAHSWM) and without Microcontroller	I. Arduino UNO	C	IR	- Lower Cost 690 Baht - Can adjust time to dispensing alcohol	Pump	
	II. PCB self-designed	-	IR (can adjust)	- Lower Cost than I (200 Baht) - Flexible to installation by batter charging. - Not complicated (Only Hardware) -Easier than I for moving & Installation	Pump	 

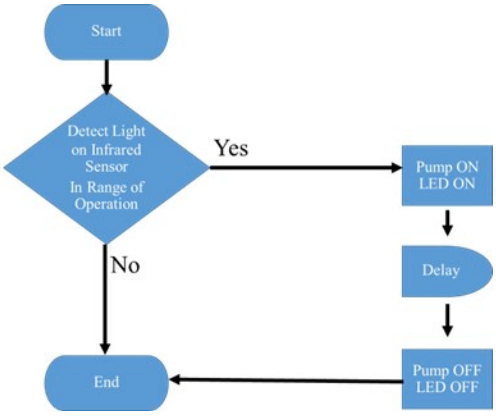


Fig. 4: *Flow Chart of Arduino Coding in AAHSDWM.*

the pump will be turned on. Then, the amount of delay in coding depends on the amount of alcohol liquid to dispense. After that, the pump will be turned off.

2.2.2.2 Programmable Arduino in AAHSDWM

```
int ledPin = 2;
int sensor = A7;
int val = 0;
int state; void setup ( )
{
pinMode(ledPin, OUTPUT
Serial.begin(9600);//Serial.println(”Arduino All TEST”);
}
void loop ( )
{
val = analogRead(sensor); //Read from sensor.
Serial.println(val); // Display value from sensor.
if (val > 500)
{
if (state == 1)
{
digitalWrite(ledPin, HIGH); // LED lighted
delay(100);
    digitalWrite(ledPin, LOW); // LED unlighted
state = 0;
}
}
else
{
digitalWrite(ledPin, LOW);// LED unlighted
state=1;
}
delay(100);
}
```

TheAAHSDWM works as the following. The infrared sensor of the AAHSDWM detected infrared energy emitted from hand heat. When hands are placed in the operating range of the sensor. The infrared energy quickly fluctuated to trigger the pump to activate and dispense the amount of sanitizer as it settled in the code.

2.2.2 Implementing for AAHSDWoM

The automatic alcohol hand sanitizer dispenser of prototype II works like the following:

The infrared sensor of the automatic alcohol hand sanitizer dispenser detected infrared energy emitted from

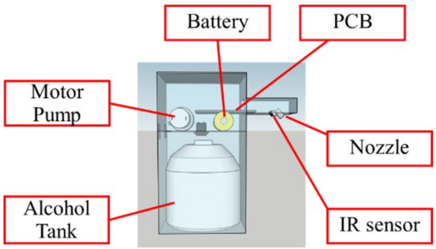


***Fig. 5**: Hardware installing diagram for AAHSDWoM.*

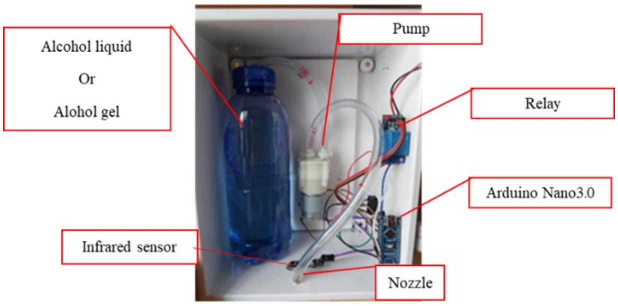


***Fig. 6**: AAHSDWM without cover.*

***Fig. 7**: AHSDWM with cover.*

hand heat. After placing hands in the operating range of the sensor, the infrared energy will fluctuate to trigger, and the pump activates and dispenses the amount of sanitizer.

2.2.3 Inside the schematic of the Automatic Alcohol Hand Sanitizer Dispenser

2.2.3.1 Inside schematic of AAHSDWM

The component of this system is shown in Fig. 6. A completed set of the system is shown in Fig. 7.

***Fig. 8**: Implementation AAHSDWM.*

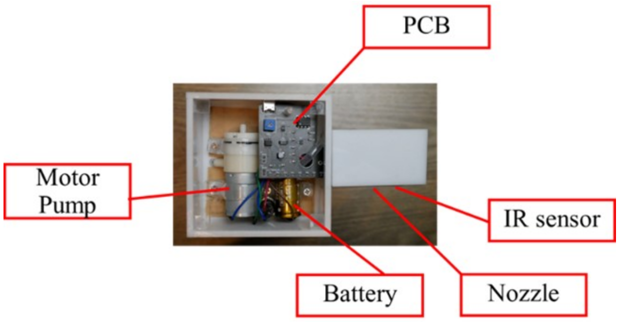


***Fig. 9**: AAHSDWoM without cover.*

***Fig. 10**: AHSDWoM with cover.*

***Table 2**: Measurement the range of operation for AAHSDWM.*

	Operation				
Distance between and sensor / **No.**	0.5 cm	1 cm	1.5 cm	2 cm	2.5 cm
1	Working	Working	Working	Working	Not Working
2	Working	Working	Working	Working	Not Working
3	Working	Working	Working	Working	Not Working
4	Working	Working	Working	Working	Not Working
5	Working	Working	Working	Working	Not Working
6	Working	Working	Working	Working	Not Working
7	Working	Working	Working	Working	Not Working
8	Working	Working	Working	Working	Not Working
9	Working	Working	Working	Working	Not Working
10	Working	Working	Working	Working	Not Working
11	Working	Working	Working	Working	Not Working
12	Working	Working	Working	Working	Not Working
13	Working	Working	Working	Working	Not Working
14	Working	Working	Working	Working	Not Working
15	Working	Working	Working	Working	Not Working
Average Percentage of working	100%	100%	100%	100%	0%

***Table 3**: Measurement the range of operation for AAHSDWoM.*

	Operation										
Distance between hand and sensor / **No.**	1cm	2cm	6cm	10cm	14cm	18cm	22cm	26cm	30cm	32cm	33cm
1	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
2	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
3	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
4	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
5	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
6	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
7	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
8	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
9	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
10	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
Average Percentage of working	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	0%

Y: Yes working
N: No working

3. RESULT

This section presents the results of the range of operation, time of sanitizer, settle-in delay, and user satisfaction of 40 users.

3.1 Range of Operation

Figure 12 highlights the range of operations. This measurement shows the precise distance of this system.

From Table 2, these 100% working results proved the range of operation that the distance between hand and sensor should be at 0.5 cm, 1 cm, 1.5 cm, and 2 cm. The machine was not working at 2.5 cm of the distance between hand and sensor.

From Table 3, these 100% working results proved the range of operation that the distance between hand and sensor should be at 2 cm, 6 cm, 10 cm, 14 cm, 18 cm, 22 cm, 26 cm, 30 cm, and 32 cm. The machine was not working at 1cm and more than 33cm of the distance between hand and sensor.

From Table 4, ten tests were performed to set the program time. From delay values of 100, 600, 1100, and

Table 4*: Time of dispensing the amount of sanitizer as settle time in delay in AAHSDWM.*

	Operation				
Settling time in delay / **No.**	100	600	1,100	1,600	2,100
1	1.35s	3.67 s	6.84 s	8.27 s	10.41 s
2	1.11s	4.23 s	6.65 s	8.09 s	10.38 s
3	1.05s	3.79 s	7.16 s	8.78 s	11.25 s
4	1.90 s	3.94 s	6.34 s	8.12 s	11.23 s
5	1.96 s	4.12 s	6.45 s	9.16 s	11.34 s
6	1.07 s	4.11 s	6.03 s	8.95 s	10.76 s
7	1.09 s	4.51 s	7.30 s	9.12 s	12.08 s
8	1.96 s	3.87 s	7.21 s	9.29 s	11.44 s
9	1.28 s	4.05 s	6.08 s	8.80 s	11.68 s
10	1.27 s	4.37 s	6.12 s	8.66 s	12.38 s
Average time to dispenser	1.404 s	4.066 s	6.618 s	8.724 s	11.295 s

Table 5*: The users' satisfactions from 40 persons in AAHSDWM.*

No	Topic	Average Score (Min1, Max5)
1	How much score do you think about easy to use and comfortable of this device?	4.43
2	How much score do you think this device can reduce infection comparing with having to touch the device?	4.40
3	How much score do you think this device had a high precision alcohol dispensing in each time using?	4.10
4	How much score do you like about the appearance of this device ?	3.95
5	How much do you think the responsiveness of this device comparing with another device that you used before?	4.15
6	How much score do you think of overall satisfaction in this device?	4.08

Table 6*: The users' satisfactions from 40 persons in AAHSDWoM.*

No	Topic	Average Score (Min1, Max5)
1	How much score do you think about easy to use and comfortable of this device?	4.4
2	How much score do you think this device can reduce infection comparing with having to touch the device?	4.7
3	How much score do you think this device had a high precision alcohol dispensing in each time using?	4.62
4	How much score do you like about the appearance of this device ?	4.25
5	How much do you think the responsiveness of this device comparing with another device that you used before?	4.27
6	How much score do you think of overall satisfaction in this device?	4.6

2100, this machine proves that the alcohol dispensing time can be set as desired through a delay variable in the driver of this system.

Throughout the entire survey satisfactions of the 40 persons from university. These surveys were performed to identify and evaluate the users satisfaction.

From Table 5, the results showed that the average score for easy to use and comfortable was 4.43.

The average score of devices that reduce inflection was 4.40.

The average score of this device with high-precision alcohol dispensing each time it was used was 4.10.

***Table 7**: Advantage and disadvantage between AAHSDWM and AAHSDWoM.*

Automatic Alcohol Hand Sanitizer Dispenser	Advantage	Disadvantage
AAHSDWM	1. Can adjust amount of alcohol liquid by changing delay in coding. 2. Speed of installation faster than because it need more time for circuit designed at the first stage.	1. Difficult to configure and maintain because using hardware & software. 2. Its cost is 690 Baht/device. Higher cost than. 3. Overview of user's satisfaction the average scores are lower than. 4. Difficult to move because using power supply by adapter. 5. Range of operation is shorter than because using IR (Can't adjust range of operation).
AAHSDWoM	1. Its cost is 480 Baht/device. Lower cost than. 2. Easy to configure & maintain because using only hardware. 3. Overview of user's satisfaction the average scores are higher than. 4. Easier to move anywhere because using power supply by recharged batteries. 5. Range of operation is longer than because using IR (Can adjust range of operation).	1. It is fix an amount of alcohol by hardware settle.

***Fig. 11**: Implementation AAHSDWoM.*

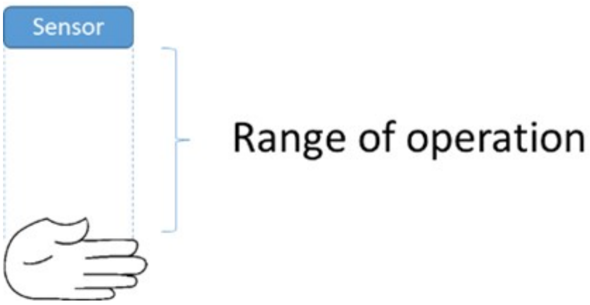


***Fig. 12**: Range of operation.*

The average score for liking the appearance of this device was 3.95.

The average score of this device's responsiveness compared with another device was 4.15.

The average score of overall satisfaction for this device was 4.08.

Throughout the entire survey satisfactions of the 40 persons from university. These surveys were performed to identify and evaluate the users satisfaction.

From Table 6, the results showed that the average score for easy to use and comfortable was 4.4.

The average score of devices that reduce inflection was 4.7.

The average score of this device with high-precision alcohol dispensing each time it was used was 4.62.

The average score for liking the appearance of this device was 4.25.

The average score of this device's responsiveness compared with another device was 4.27.

The average score of overall satisfaction for this device was 4.6.

From Table 7, the results depicted that AAHSDWM has two advantages to adjust the amount of alcohol liquid by coding and the speed of installation. AAHSDWoM has four advantages: it is less expensive, it is easier to configure and maintain because it uses only hardware, it has higher average user satisfaction scores, and it is easier to move around because it is powered by recharged batteries.

4. CONCLUSION

This research article indicated that the installation of these devices to use AAHSDWM and AAHSDWoM for more than a month helped researchers understand the operation of these devices. This is one way to develop and improve the quality of health-conscious devices from COVID-19. Studies have shown that these devices can function within the range in which the sensor can operate. AAHSDWoM has more advantages than AAHSDWM. especially in terms of cost and being easier to configure and maintain. In addition, this AAHSDWoM has a wider range of operations than AAHSDWM, and it is appropriate for mass production for commercial.

Further the future research

1) Using an ultrasonic sensor in the device because IR has a drawback in a public area with sunlight.
2) Designing the creative, modern shape of the device to get into business with the device.

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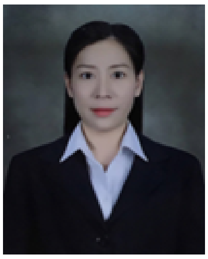

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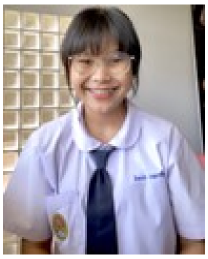

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