Research Article

Design and Development of Room Limit Counter for The Use of Social-Physical Distancing

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Abstract: Counter system is one of the revolutionary systems created nowadays that has multiple uses in our daily lives. One of it is the Parking Guidance System and it uses a counter system that counts the number of cars entering and exiting a parking basement or spaces which makes it easier for other customers to look for other parking spaces when the counter system notifies other customers that the space is full. Following the concept of a counter system, we came up with an invention of a Room Limit Counter. It is a prototype using an Arduino to create a counter system at a cheap price. The reason that we created this project is because of the pandemic that is still in play throughout our daily lives which causes us in need of physical distancing and becomes one of the compulsory etiquettes when we are in a crowded and confined place with crowded people. Therefore, the needs of this product are beneficial as it is the new norm for our daily lives.

Keywords: Room Limit Counter, Arduino, counter system, physical distancing, COVID-19

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1. Introduction

According to the Ministry of Health Malaysia, the spread of Coronavirus outbreak that found in China i.e. Novel Coronavirus 2019 (COVID -19) can cause respiratory tract infections [1]. The World Health Organization (WHO) classifies the nature of an infectious diseaseCOVID-19 is a pandemic as it is a contagious disease that spreads to people and worldwide. This virus can be spread through droplets from the nose or mouth when someone infected with COVID-19 coughs or sneezes.Others will become infected with COVID-19 by touching the object or area, and then touching their eyes, nose, or mouth [1],[2].

All sector especially in economy sector has been affected by pandemic COVID-19. The movement control order needs to be followed by all societies. Government also introduced new norms as ways to avoid the spread of virus. Due to COVID-19, all people need to practice new norm in their life. Physical distancing, not staying in crowded places and close chat need to be done to make sure the contagion can be reduced [2]. Physical distancing helps limit the spread of the virus. To make sure the limitation in one room or place is important and this will avoid physical contact and close chat between the visitors [2]. Moreover, a place that is small which can only occupy a small amount of people such as a toilet, small office, or a small shop space will require a device that limits the amount of people entering and exiting such places. Besides, a place that has insufficient workers and staff to guide the number of visitors need this device.

Below is the infographics of new norms that need to be practiced by every society, especially in Malaysia. In the infographic shows three things to avoid which are crowded, confined and narrow places, and close conversation. Besides, every people need to practice wash hands, warn COVID-19, and wear face mask. These norms are important in behalf to control COVID-19 from continuing to spread.

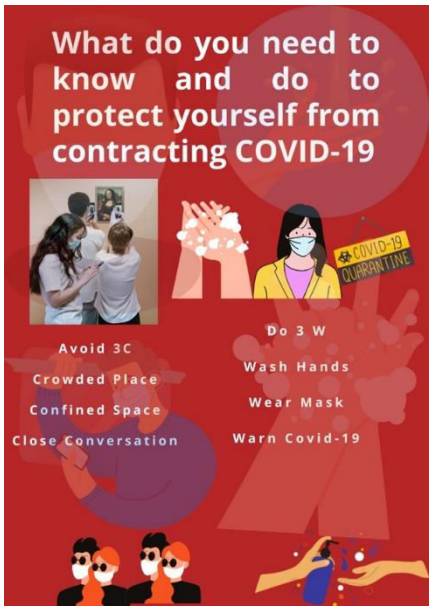


Figure.1. The figure above shows the new norms that need to be practiced by every society This innovation is focused on avoided crowded place and confined space in order to practiced physical-social distancing.

This paper is focused on how the development of the innovation that will help to reduce the spread of COVID-19. The Room Limit Counter or RomLIC is an innovation that used to monitor the limitation of visitor in one room to make sure the physical distancing will be done in societies.

2.Significance Of The Study

Prospective teachers are at risk for making poor dietary choices that can cause significant health problems. They are unaware of the nutritional requirements to maintain a healthy body weight, they make poor nutritional decision, which can cause poor weight management and health problems. Prospective teachers select food according to convenience, taste, time, and price rather than nutritional values. Poor nutrition due to unhealthy eating habits may lead to delayed puberty, nutrient deficiencies and dehydration, menstrual irregularities, poor bone health, increased risk of injuries, poor academic performance and increased risk of eating disorders. The student teachers who are nutrition under eaters may be affected by anorexia or bulimia. Prospective teachers who do not eat breakfast, or eat an insufficient breakfast, are more likely to have behavioral, emotional and academic problems at college. Prospective teachers who consume unhealthy foods can have trouble concentrating, become easily fatigued, listless or irritable and are likely to face difficulties in learning, which can lead to behavioral and social problems. Teaching prospective teachers about the importance of good nutrition lay the foundation for a healthier and more fulfilling life. Poor eating habits and nutritional knowledge deficits may affect health of the youngsters. Healthy eating habits may help to eliminate carbonated soft drinks and unhealthy junk foods from their routine diets. The high intake of sugar rich and white flour foods such as cookies and cakes will increase the risk of obesity among college students. The significance of this research is to enlighten the prospective teachers about the importance of healthy dietary habits.

3.Review Of Related Studies

Technological advancement is one of the reasons the creation of this prototype is possible. The concept for these prototypes was sparked by recent events, which have resulted in physical separation due to pandemic Covid-19. 'Automatic Door' and 'Counter Prototype' are examples of inspiration and related work that has ideas that are like RomLIC which act as an automatic door opener for a company, then counts the number of customers who entered and exited [3].

In a large emporium or mall, it is already and continues to be commonly used. The one that is used in a mall uses motion detection sensors or optical sensors, which are installed on the sides of the door, to trigger the

opening/closing of doors. RomLIC which is in a similar area but on a much smaller scale uses Arduino as its component. Furthermore, more recent projects developed during pandemics include a 'Pushup Counter' [4], prototype, which was invented by the project founder during the coronavirus pandemic to be used as a counter for his training and held as a journal because the gym was closed during the lockdown period. Any push-up that is done is recorded (every second that you come into 10 centimeter of the ultrasonic sensor). The components used in 'Pushup Counter' are an LCD that displays the pushup count, a buzzer that sounds every ten pushups, and RGB that shows how far away the user is from performing a pushup.

Another prototype with similar ideas is the 'Car Counter' [5], a smaller scale for counting the number of cars entering and leaving the parking basement orspaces. The general purpose of the sensors is to count the number of cars that pass through them on a regular basis. For this prototype to function properly, the sensors must be mounted at the parking lot's entry and exit points. When a car comes in, the count is increased, and when it leaves, the count is decreased. Since it uses the same sensor as the sensor that will be used in RomLIC, this system has served as a model for this project. For a larger scale of use, the concept has been applied as a "Parking Guidance System" in a mall or an emporium. It is used to figure out the issue and assist the driver in quickly locating a parking space when the driver needs to park. Most of the prototypes or projects that have been listed have used motion sensors to make their projects successful; as a result, the use of motion sensors will be incorporated in RomLIC prototype as well.

To begin, PIR motion sensor and ultrasonic motion sensor are two types of sensors that have been debated for use in RomLIC. Each sensor's features and benefits have been listed. PIR motion sensors, for example, have a 170-degree field of view. To prevent the sensor from picking up movement at the edges of its field of view, users must cover a portion of the sensor.

Furthermore, the PIR Motion Sensor is suitable for sensing motion, especially that of people in and out, as well as day and night. Finally, the PIR Motion Sensor has the advantages of being lightweight, compact, and inexpensive. Ultrasonic Sensors, on the other hand, have a small range; 8 feet may be the maximum, but it may function. Furthermore, the Ultrasonic Sensor can detect all forms of materials, including static which is not suitable for this project. As a result, the PIR motion sensor is a better option for the sensor in RomLIC [6].

Apart from the sensor, Arduino is one of the other components that has been inspired by similar projects. After doing more research into what kind of processor is ideal for a small project or prototype, one of the main reasons for using Arduino is that it is relatively inexpensive and easy to acquire. Furthermore, according to Louis, Leo [7], the operating system is fast, and the user interface is simple to use for someone new to developing a project or prototype. It is also a reliable component, despite the fact that it's based on open-source software. Other components that go into making RomLIC a reality include an LED that displays the premise's minimum and maximum capacity, a buzzer that alerts the premise that the number of customers in the premise has reached its maximum capacity and requires amendment or action from the premise owner to reduce the number of customers entering the premise. Some connecting wires and a breadboard are also required to complete the prototype.

The methodology for the RomLIC project is ADDIE models, which is appropriate for this project since ADDIE is widely used in product or content development [8]. The first phase in the ADDIE model is research, which involves analyzing recent events or scope to generate new ideas. The prototypes are then designed based on the initial concept, and some research into similar projects is needed to generate some ideas.

To suit the concepts and inventions, some ingenuity was used in the development of the RomLIC prototype. Once the prototype has been designed, the next stage is the construction process, which involves acquiring components and assembling them according to the design.After obtaining all the components, put all the concepts and components into action. During the evaluation stage, a survey and an interview will be performed to elicit input or suggestions from the trial experiments. Below shows an example process for ADDIE Model:

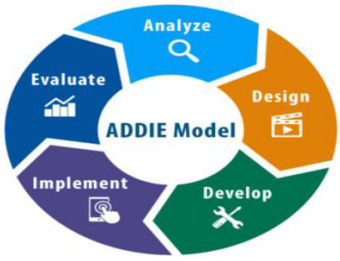


Figure.2. The figure above shows the ADDIE Model Design by https://www.edapp.com/blog/the-addie-model/ which we choose to use for the development of our prototype.

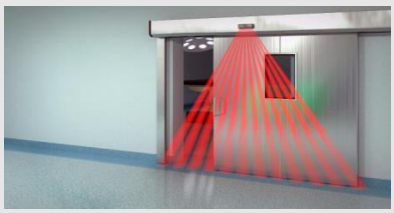
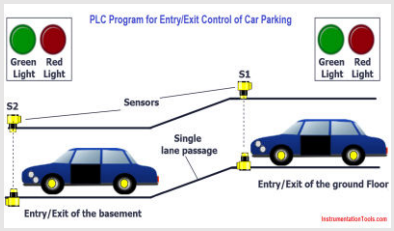
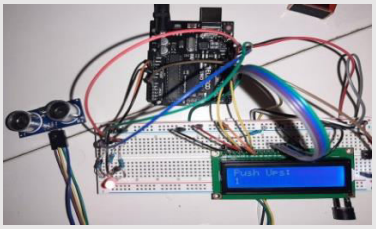
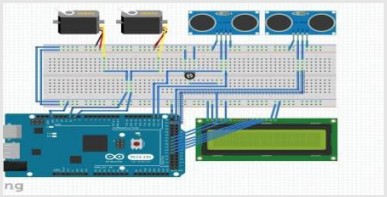
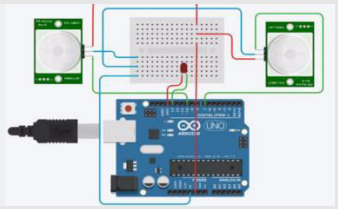
No	Device
1.	*Automatic Door* *Sensor used:* • *Motion Detection or* • *Optical or Infrared* 
2.	*Parking Guidance System* *Sensor used: Ultrasonic* 
3.	*Pushup Counter* *Sensor used: Ultrasonic*
	
4.	*Automatic Door and Counter Prototype* *Sensor used: Ultrasonic* 
5.	*Car Counter* *Sensor used: PIR Motion Sensor* 

Table.1. Shows few similar innovations that used same concept as the one that we are doing for our project or prototype. The explanation regarding the innovations have been explained in literature review.

4.Design of RomLIC

"Room Limit Counter" or RomLIC is a device that can be used to limit the amount of people entering and exiting the premises at one time. Thus, the components used in this product will be divided into two functions: input and output.

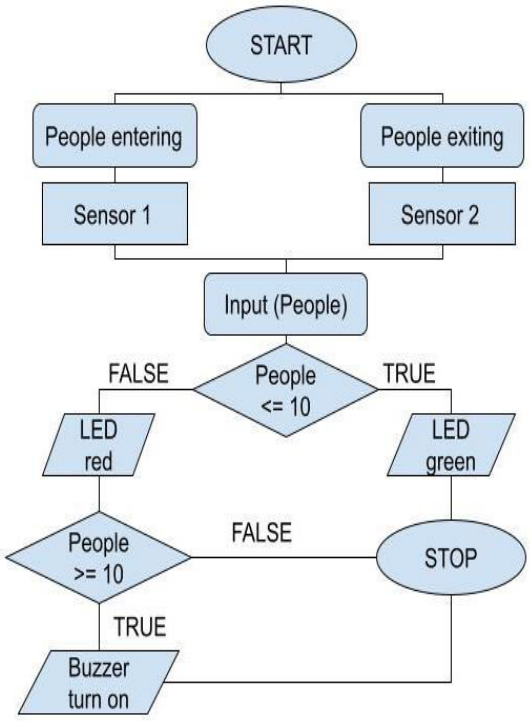


Figure.3. This is the flowchart of the process of RomLIC. The process starts when people enter and exit and stops when the LED changes color.

In RomLIC design, a PIR motion sensor is used as an input. The RomLIC is equipped with two PIR motion sensors that detect movement of people entering or leaving the premises [6]. The PIR motion sensor was chosen as an input compared to other sensors because it only detects heat signatures and is not normally triggered by inanimate objects blowing across their field of view, such as a leaf blowing across a path or a branch moving in the wind [9]. There are many advantages when using this sensor such as small, wide lens range, easy to use and inexpensive.

The LED lights and buzzer are the outputs for RomLIC. The LED bulb will light on according to the number of the people in the room. If the number of people is less than 10, the LED light will turn to green but if the number of people exceeds to 10 people at one time, the red LED light will turn on. The 'beep' sound will come out when people enter the place and loud danger sounds will come out when they reach the limit number of visitors (5-10 visitors at one time). This will make the visitor alert on the number of people that

already enter the room. The feature of the buzzer for this product will mimic the feature of a protection alarm in homes or shops. It will trigger the warning signals to the store proprietors or people that the wide variety of the traffic at one time has exceeded [9].

The Arduino UNO board will be connected to PIR motion sensors, LED, and buzzer. The breadboard is used in this design to avoid soldering the connecting wires to the components [12]. Thus, the design will be neat and well designed.

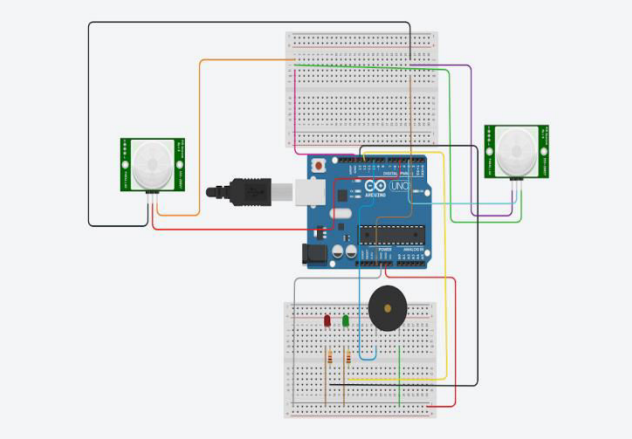


Figure.4. Circuit diagram of the final design.After doing some research and discussion, we come to a conclusion using PIR sensors.

As shown in Figure 4, the design's input will be connected to one breadboard, while the design's outputs will be connected to the other breadboard. It is to ensure that the design is simple to construct and that the connecting wires do not get entangled.

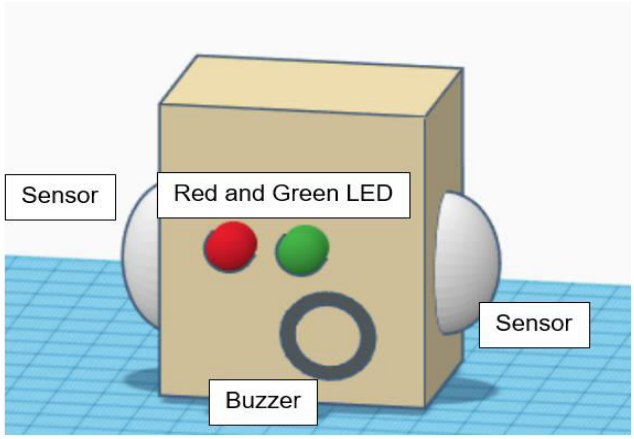


Figure.5. 3D diagram of the product design. After, we discuss between the members of the project and consultation with senior IEEE for a guide and advice.

The figure 5 above shows the sketching of the expected final design. All the components and wires are kept in a box. The design is the result from many reviews and discussions between teammates.

5.Development of RomLIC

5.1 Selection of Components

1) Pir Motion Sensor

PIR motion sensors are sensors that detect the movement of infrared-emitting objects, such as human bodies. It detects whether the bodies are going into or out of the ranges by tracking their movement. It's commonly used in security systems to detect human activity. It can not only detect the movement of human bodies, but it can also detect the movement of a vehicle in a parking space. A PIR sensor is used to determine whether a parking space is accessible. It will take about 10 to 60 seconds to calibrate the sensors before using it for the first time [10].

Not only that, but PIR sensors are also efficient, cheap, and easily customizable when it comes to detecting motion in each area. Since it is tiny, it is simple and straightforward to integrate into the project [11].

Two PIR motion sensors are used in the RomLIC design to detect people entering the premises and exiting the premises. Thus, both PIR sensors have their own function.

Figure.6. PIR motion sensor that is being used as an input in RomLIC design.

2) LED

Light-Emitting Diodes or known as LED is a small light that is made of silicon. There are many types of LED light which have different colours, brightness and sizes. LEDs have a positive/ anode (+) and negative/ cathode (-) leg, and its electricity can flow in one direction only. The longer leg of LED indicates the positive side [15]. There are many products that use LEDs. For instance, car mirrors, garden lights, camera phone and Christmas lights [16].

RomLIC uses two types of LED which are green LED and red LED. Both LEDs indicate whether people are permitted to access the premises at that time. People can enter the premises if the green LED is turned on; if the red LED is turned on, people cannot enter the premises for the time being and must wait outside before the green LED is turned on again.

3) Buzzer

The buzzer vibrates a metal disc inside a plastic housing with the aid of a small magnetic coil. Different pitches of buzzer can be produced depending on the different rates of pulse of the electricity through the coil [17]. The example of products that use buzzers are telephones, toys, security alarms and others [18]. RomLIC uses a buzzer to trigger the warning that the number of the people inside the premises has exceeded its limit. Thus, the workers can be alerted and will not allow people entering the premises for a while.

4) Arduino Uno

Arduino UNO is a microcontroller, and it has 14 digital input/output pins, 6 analogue inputs, a 16 MHz ceramic resonator, a USB link, a power jack, an ICSP header, and a reset button. To get started, simply connect it to a device with a USB cable or power it with an AC-to-DC adapter or battery. If the user is making some errors while trying to use it, they do not need to feel anxious because they can push the reset button and fix their mistake [19].

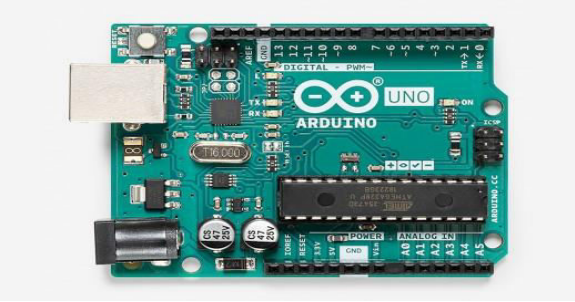


Figure.7. Arduino UNO board that is typical being used in projects.

5) Connecting Wires

Connecting wires or jumper wires are being used to connect the components in breadboard and Arduino Uno's header pins together without soldering [20]. Several wires are often needed to ensure that components such as LEDs and buzzers work properly. Jumper wires are typically used with breadboards and other prototyping tools to make it easy to change a circuit if needed.

6) Breadboard

A breadboard is a solderless board that allows you to build electronics circuits and wiring for projects like Arduino [12]. Components are inserted into breadboard sockets, and connections are made with additional 'jumper' wires. There are many types of breadboards such as full-sized, full+, half-sized, half+ and mini.

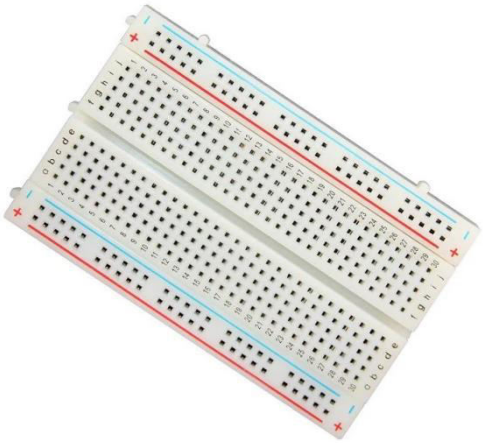


Figure.8. Breadboard that is being used in RomLIC design to connect the components to the Arduino's pin.

The design of RomLIC uses two breadboards; one is for connecting the input components to the Arduino UNO and another one is used to connect the output components to the Arduino pin.

7) Arduino IDE

The Arduino Integrated Development Environment (IDE) is software/ application that can be used in a cross-platform framework such as Windows, macOS and Linux written in C and C++ functions. It is used to write and upload the code to Arduino-compatible boards [19]. Arduino IDE is open source; thus, it is easy to write code and upload it to the board even for the beginner [20].

5.2Design Enhancement and Optimization

There are several enhancements made to improve the final design of RomLIC. It is because the final design of the products should attract the customers and convince them to buy the products.

All the components will be put in a small box to make the product more presentable. The small box was chosen so that users can conveniently transport the product and change its location at any time. A plastic box was selected so that the finished product would be lightweight, allowing consumers to carry the product without fear of damaging it. If the user puts the device outside the building, the plastic box will protect it from water.The most suitable color for this design is white box because it allows people to see the color of the LED. The color of the product plays a big role in attracting the customers and convinces them to buy the product [21]. A small LED light is used in this product. People might not notice the output of LEDs if a brightly colored box is used, regardless of whether green or red LEDs are switched on.

Even though RomLIC used two sensors, the weight is still light and able to carry. Coinciding with the RomLIC that needs to be light and easy to detect human motion, this sensor is suitable for this device. Both sensors are placed on opposite sides of the box so that they can better detect people according to their functions; one sensor detects people entering the premises, while the other detects people leaving the premises. If sensors are installed in the package, they may not be able to detect people properly.

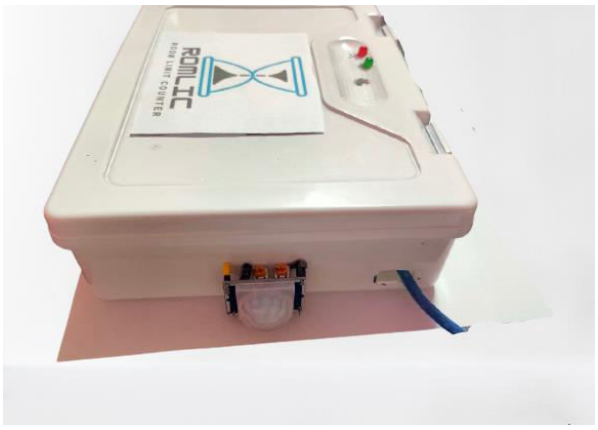


Figure.9. This is the RomLIC left view for our prototype and how it is designed.

The chosen color of LED is intended to resemble the feature of a traffic light. Green indicates that people will enter the premises, while red indicates that people must stop and cannot enter the premises [21]. Besides, the color of RomLIC that is white will help the user be able to focus on the LED light. The white color can make the red and green LED light stand out more. Below is the figure of RomLIC last design after many enhancements.

Figure.10. This is the RomLIC last design.

6.Implementation

The phase of implementation has been done after the development phase is finished. Implementation is the phase where the product is implemented, and project work is done. It is important to maintain control and communication as needed during implementation [25]. Based on Webster's Collegiate Dictionary [25], the implementation is the process of moving an idea from concept to reality. This may be the basis of the drive before it is fully discharged.

In this part, the step by step of implementation and the manual how the user can use the RomLIC will be explained. There are three phases of implementation which are installation, initial implementation, and full implementation. These phases have been recommended by [27].

The installation phase has been done by the developer by installing the Arduino codes into the product. The purpose of the installation phase is to build a system capacity that will support the implementation of new

practices in selected areas. The construction of the power system requires testing and strengthening of system components and quality features also called startup drivers, which are needed to ensure success [29].

The initial implementation phase is the implementation with one PIR sensor. To test the PIR sensor, it should be tested individually to determine sensor correction. Once the sensitivity of the sensor is adjusted according to its functionality, another sensor will be tested out. After that, both sensors can be connected to the circuit and make a complete circuit of the product.

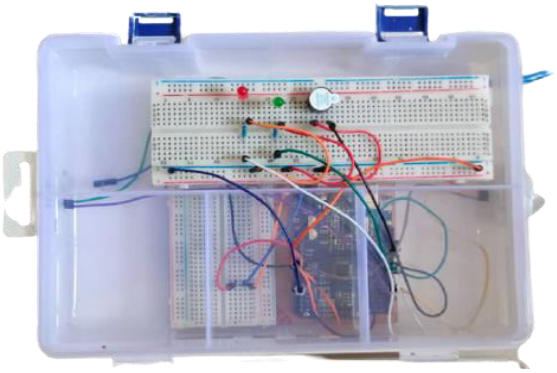


Figure.11. This is the view inside the RomLIC. The Arduino has been installed inside the product.

The implementation with the packaging also has been done to make sure the product can run well even in the box and at different places. The box that has been chosen is made of plastic and light. The size is also suitable forthese Arduino kits.

Figure.12. This is the RomLIC that can be placed on the table. RomLIC also can be hung between the exit and enter door.

Basically, RomLIC can be used at the entrance of a shop, cooperation, or office. Users can put RomLIC on the table, chair or hang it at the middle of the entrance or door. This has been adapted from the observation of shopping mall entrances to sense the goods from being stolen. The size of the product that small and light will make it easy to handle and able to bring it anywhere. Here, we attached with its coding as below.

(1) int pirPinIN = 3;

```
(2)  int pirPinOUT = 5;
(3)  int buzzer = 10;
(4)  int ledGREEN = 12;
(5)  int ledRED = 13;
(6)  static long i = 0;
(7)
(8)  void setup()
(9)  {
(10)pinMode(pirPinIN, INPUT);
(11)pinMode(pirPinOUT, INPUT);
(12)pinMode(ledGREEN, OUTPUT);
(13)pinMode(ledRED, OUTPUT);
(14)pinMode(buzzer, OUTPUT);
(15)digitalWrite(ledGREEN, LOW);
(16)digitalWrite(ledRED, LOW);
(17)Serial.begin(9600);
(18)}
(19)
(20)void loop()
(21){
(22)long now = millis();
(23)if (digitalRead(pirPinIN) == HIGH)
(24){
(25)i++;
(26)Serial.println(i);
(27)delay(500);
(28)}
(29)
(30)if (digitalRead(pirPinOUT) == HIGH)
(31){
(32)i--;
(33)Serial.println(i);
(34)delay(500);
(35)}
(36)
(37)if (i<10)
(38){
```

```
(39)digitalWrite(ledGREEN, HIGH);
(40)delay(500);
(41)digitalWrite(ledGREEN, LOW);
(42)}
(43)
(44)if (i>10)
(45){
(46)digitalWrite(ledRED, HIGH);
(47)delay(500);
(48)digitalWrite(ledRED,LOW);
(49)}
(50)
(51)if (i>10)
(52){
(53)digitalWrite(buzzer, HIGH);delay(200);(54) digitalWrite(buzzer,LOW);
(55)delay(200);
(56)}
(57)}
```

6.1User Manual

This user manual used to explain how users are able to handle and use RomLIC correctly. A user guide is a technical document with a narrow focus. Its aim is to assist non-technical people in identifying and solving problems without the need for expert assistance [26]. This also will help users be able to understand the functions well. Below is the list of steps to use the RomLIC:

a) Put RomLIC on the chair, table or hang it at the middle of the entrances. The sensor must face the way people can in and out.

b) Connect the cable with the power supply.

c) The sensor is at the right side of the device while the Out sensor is at the left side. When people walk into the entrance, the Green LED will light, and the counter will increase.

d) The Green LED will inform the visitor that they are able to go in.

e) If the last people walk in and the Red LED will light on and the buzzer will warn the next visitor to wait until the Green LED lights on.

f) When people walk out, and the Out Sensor plays its role to deduct the number.

7. Evaluation and Validation

The evaluation is the last phase after implementation of the product has been completed. Evaluation is critical to obtain feedback and recommendations regarding the method [27] [31]. There are three methods of evaluation that have been used to make sure this product meets the objectives and needs of innovation. RomLIC has been evaluated around early January. This process has been done by target people such as businessmen, shoppers, and customers. There are 3 respondents that have already tried and evaluated this product.

Method 1: Survey

Survey has been conducted by the subject matter experts to make sure the design and functionality of RomLIC meet the research objectives and real-world situations. The survey has been conducted after the respondent tried the product. This survey has been given using sharing the link of Google Form. There are five components that have been included into the survey which are the user experiences, usability, functionality, productivity, and effectiveness.

Based on the survey, all the respondents agree that they enjoy using this Room Limit Counter. Besides, all the respondents that tried this product agree that RomLIC is functioning well. Usability is the measure by which a user in a particular context can use a product to achieve a well-defined, effective, and satisfactory goal [28]. All respondents respond that this product is usable for them. According to the next question about productivity, only two of the respondents put the high scale on which the respondents work as businessmen. This show RomLIC will help in the business sector to help them handle the room limitation. Next, the respondents also agree that RomLIC can enhance their effectiveness on the guide room limit and can save their time and resources.

Method 2: Observation

Observation is the qualitative methodwhere researchers observe the participants' ongoing behavior in a natural situation [29].The evaluation based on observation has been made when the respondent tried the product. This method of evaluation is very important to look at how the respondent reacts towards the product and to know if they can easily handle this product [29]. The behavior and how the respondents reacted has been written by the observer. Based on the observation, at first respondents look wondering on how the RomLIC functions. After being given an explanation, the respondents can easily understand. They look excited and interested with the product. The respondents sometimes carry the product, and this shows it is portable to bring anywhere. They also looked impressed with the design and can easily understand the sign of LED light.

Method 3: Interview

The interview evaluation session has been made to get the information regarding the experience of the respondents when they try the products and their opinion on enhancing the product. The informal interview session has been held after the respondents tried the product.

According to the first respondents, she felt excited and said that this product is easy to handle. The white color of the body makes the user focus more on the LED light. Respondents said that for the next enhancements, maybe this product can be added other features such as voice alerts or reminders to take temperature.

The second respondents also said that this product is easy to handle. It is simple but the function is good for time-being. He said, as businessmen he sometimes needed to multitask during Covid-19. He needs to take care on the counter and he also needs to take care of the limitation people enter his room. He hopes that this product can be commercialized and help other businessmen. The 3rd respondent also gave the same opinions. The enhancement that has been suggested is to have LCD to show the number of people in and out. Besides, respondents also suggested to use a big LED light so that the user can easily see it.

8. Conclusion and Future Works

Recommendation was made based on the suggestions and opinion of respondents and lecturer. For next improvements, liquid crystal display (LCD) functions can be added to this product. The LCD used to show the number of the visitor. Besides, the improvement of the size of LED light needs to be done to make sure the visitor can see the light. Refer [1] and [30] for examples of LCD projects.

Doing the project during the pandemic is quite hard but we seem to manage and make the product to work. We from the RomLIC teams recommend and hope to add more usage in our products soon. Moreover, we will try to increase the capacity of our projects by enabling it to use more devices such as LCD and others.

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