Intelligent Shophouse System

Chew Rui Ping, Aeizaal Azman A.Wahab, Nurul Farah Aina Bt Mohd Sabri, Syazwan Iman Bin Shairunizam, Mohamad Haikal Bin Mohamad Nazari, Syed Sahal Nazli Alhady, Wan Amir Fuad Wajdi Othman
School of Electrical and Electronic, Universiti Sains Malaysia, 14300 Nibong Tebal, Pulau Pinang, Malaysia

aeizaal@usm.my

Abstract. An Intelligent Shophouse System has been developed and built which can applied in most of the small-scale stores such as convenient store and retail pharmacy. By implementing IoT, efficient customer monitoring systems enables to limit the customers from enter to the store and practice hygiene environment within the store. Compromising of different sensors which capable to detect the customers that come into the stores and track for the number of customers inside the store. The information from sensor help to count on for the customers and display the available spaces at outside the premise. An ESP32 is used to allow bidirectional communication between sensors and MIT application. The data from sensors will always updated into the IoT Cloud and users able to view the number of customers inside the premise in real time, while the users able to adjust the limitation of customers at anytime. Contactless hand sanitizer implemented to ensure hygienic of the customers and reduce spreading of virus. This is beneficial for users especially for shop owners which would like to limit and monitor number of the customer inside the store without being in contact with them and help to reduce the virus in their surroundings.

1. Introduction
According to the latest news report, the basic reproduction number (R0) of Covid-19 infections in Malaysia has increased back to 1.1 and R0 is necessary to bring it down to below than 1.0 to prevent the growth of new infections [1]. In addition, Malaysia’s public hospitals and Covid-19 Low-Risk Patient Quarantine and Treatment Centers have almost reached full capacity as high numbers of infections continue to be reported every day [2]. Thus, it is important for practicing physical distancing and only allow a certain number of customers enter the premise to make sure that the premise is not crowded with people. However, limit the number of customers manually in particular place is not efficient due to lack of staffs. In order to better practicing the physical distancing inside the store, a monitoring system is introduced to apply within the stores especially convenient store to limit the number of customers in automatic way. Besides, the system is embedded with IoT system, a platform where embedded devices are connected to Internet, so they can collect and exchange data with each other. In past few years, IoT solution are focused to help the organization measure people traffic and flow which allowing for them to plan operations better with real data without the needs of manpower. Also, contactless hand sanitizer could create a hygienic environment inside the store as an infected person may press the bottle trigger and virus can spread through hand sanitizer bottle. Consequently, the system able to reduce spreading of virus among people.
Intelligent shophouse system is a complete system designed to monitor and limit the number of customers in the store. Our proposed system utilizes a mobile phone to connect using Wi-Fi/Internet to an ESP32 which connects via serial communication to IR sensors, servo motors, LCD display and LEDs [3]. Shop manager has a hard time to make sure that the number of customers in the stores has exceed the limitation at all the times which may result the stores is crowded with people. Therefore, it is important to use this kind of system. If a customer has been detected by IR sensor, then IR sensor will send the data to ESP32 which will then process the data and send the signal to the LCD display, LEDs and servo motor. The data is collected and send to the IoT cloud which enable the store manager to view the number of customers inside the store and adjust the maximum limit at anytimes by using MIT application and it will send updated data to IoT cloud. The data is then sent to the ESP32 for processing purpose. In addition, whenever there is a situation where the sensors failure in detecting customer and results inaccurate displaying number of customers hence it also can be adjusted by using MIT application as well. Besides, when the customer approach their hand to the ultrasonic sensor, the sensor will send the signal to the Arduino UNO and trigger the servo motor to dispense out the sanitizer. Whenever the hand sanitizer level reached a certain limit, water sensor will send a signal to Arduino UNO and LED will been triggered. The motivation for this research come from the current situation Covid-19 pandemic where all people must be aware their surrounding and follow the SOPs that has been provided by government. When this pandemic happened, all the premises must implement the SOPs to protect the staffs and the customers from being infected by the virus. However, it is hard to implement the given SOPs because there are crowded people in the store without knowing number of customers inside it. Besides, from the study mostly of the premise still manually limit the number of customers to enter the stores and especially for the store that lack of manpower they are hardly to control the crowded situation within the store. In addition, some of store still utilize manual pump hand sanitizer dispenser which cause virus transmitted through hand sanitizer bottle.

Coronavirus Disease 2019 (COVID-19), a novel Wuhan-born pneumonia disease which is a deadly infectious disease, was confirmed by the World Health Organization (WHO) on 12 January 2020 before an outbreak in all countries. These viruses are transferrable through touch and contact. WHO provided the people around the world with several guideline to avoid from this hazardous virus. Unfortunately, the guides that have been given are slightly hard to implement in several circumstances. Therefore, technology is become the powerful method to overcome this issue.

According to K.Intawong, D.Olson, and S. Chariyalertsak, the authorities in Thailand were requested to reduce the demand for health resources to meet people's health needs by successfully implementing application technology, resulting in people taking greater control of their own health and improving the effectiveness of medical and public health staff [4]. This statement show that technology can help to reduce the spread of this hazardous virus towards environment. There are many technologies that can prevent COVID-19 from being spread towards environment. One of technologies that can be applied is Intelligent Shophouse System. This system is to limit the number of customers inside the stores to practice social distancing and physical distancing and create hygienic environment among them. This system has two sub system which are limitation customer system and contactless hand sanitizer. Limitation customer system is the most crucial system to prevent this virus from spreading. Based on this article, they design bidirectional digital visitor counter to count the number of visitor and limit number of visitors inside the room [5]. They use infrared sensor to detect the customer. When customer pass through the IR receiver’s then the IR Rays falling on the receivers are blocked and then the obstruction is sensed by microcontroller and display number of visitors in the room on the LCD (Liquid Crystal Display). If number of visitors exceed the capacity limitation, the alarm will beep. However, this system does not send the information to the manager to know the number of customers inside the shop. The solution of this problem is to implement Internet of Things (IoT) by adding a Bluetooth to the microcontroller. Therefore, the owner can know the number of customers and set the capacity limit inside the store easily. Finally, contactless hand sanitizer is one of the subsystems in Intelligent Shophouse System. According to the project [6], the system can detect proximity with the help of an ultrasonic sensor and send a signal to the microcontroller. The controller
will then process the data of the sensor and operates the pump and the solenoid valve. The sanitizer liquid is dispensed by a mist nozzle. This can reduce the risk of infection due to contact and create hygienic environment. This project also can be used in contactless hand sanitizer but instead of using pump and solenoid valve, this can be replaced by servo motor to dispense the sanitizer. This can reduce cost and energy consumption. The advantages of this project are that it requires less maintenance, less manpower and easily installed. In addition, this project aims to improve the limitation of customer system in general. The use of the IoT platform will enhance the capabilities of current remote monitoring equipment and at the same time log data for analysis and reference purposes.

2. Design Specification
For intelligent shop house system, ESP32 and Arduino Uno was chosen as main processors to interface with all devices and components. This project is mainly focusing on three features. The first feature is the setup of maximum number of customers allowed to enter the premise through Android application and updated into the processor. Next, automated customer monitoring system to activate or deactivated the entrance of the stores, displaying the information in LCD screen as well as number of customers inside the store on the smart phone application. In addition, contactless hand sanitizer dispenser which allow sanitizer to be dispense out without any contact to the hand of sanitizer bottle and generate a warning signal to users when the sanitizer is almost run out.

![Figure 1. Circuit connection for Customer Limitation System](image1)

![Figure 2. Circuit connection for Contactless Hand Sanitizer Dispenser](image2)

3. Block Diagram

![Figure 3. Block diagram of customer limitation system](image3)
Fig. 3 show the block diagram for customer limitation system, where ESP32 Wi-Fi module is main controller which will receive input reading from infrared sensors and upload the data into Firebase database via Wi-Fi network. The setup of limit for number of customers enters the store is set through MIT App and the data is upload to Firebase database. Subsequently, the microcontroller will get the data from database and process the data as well as send the signal to the LCD display, LEDs and servo motor. All the output components will send its status into database via Wi-Fi network. Besides, to make sure the system is only limit for several customers and not the staffs for the premise, hence the shop manager or staffs can update the number of staff work via the MIT App and data will be uploaded into database and lastly transfer into the ESP32 microcontroller. The microcontroller will then process the data and send the signal to the output components such as activate the entrance door to allow the staff enter the store. In addition, a condition is considered where the infrared sensor may damage or fail to detect customers that enter or exit from the store at certain time which will result the system unable to track current number of customers in proper way. Hence, additional feature is added into MIT App where the users can self-adjust for number of customers in the store and the data is upload into database as well as microcontroller to work in its manner. Fig. 4 show the block diagram for contactless hand sanitizer dispenser, where Arduino UNO is the main controller to receive input reading from ultrasonic sensor and water level sensor. When the ultrasonic sensor senses the object within the range of 5cm, then it will send the signal to servo motor and carry out relevant action such as activate the servo motor to dispense the sanitizer. Besides, when water level sensor detect the level of sanitizer and LEDs will triggered or blinking based on the level of sanitizer such as when sanitizer is used up, then white LED will be blinking.

4. Viability
This product has been considered in economic because this product has come out with affordable cost for user. This product is considerable high in demand by owner of convenient shop and this high in market value since the pandemic has spread among Malaysians. This product can be considered as a good investment in social distancing to reduce spread virus among customers. This product provide safety from the limitation customer. This limitation design provide safety from the spreading of corona virus by social distancing among people. Even though the product has debug in system, it will be harmless to people also because of the product only effect the system. This product is priority to health as it is reducing from spreading the virus. As the product is limitation to customer, they can buy grocery without contact another person. This product can increase productivity since the product can increase efficiency of the workers by saving their time doing the SOP instruction and let the system do it itself. Quality of production are improved greatly with the help of automatic hand sanitizer that gives more hygiene to the store and workers. This helps to improve the quality of production because the system satisfies and optimize the need of customer.

5. Results and Discussions
Fig. 5 show the opening page when user access into application. Once the app load to 100%, then the app will move into user login page as shown in Fig. 6 and request users to select the user ID and enter the password to login into system. However, if the users enter the wrong password, the app will notify
users that invalid login is performed due to inaccurate password is entered which shown in Fig. 7. Otherwise, the users will be allowed login into the system and “display” screen is appear as shown in Fig. 8. Once NODEMCU ESP32 is powered up and sketch is upload into the microcontroller, then it will try connecting with the Wi-Fi as set up in the code. The SSID Wi-Fi and its password can be adjusted by the programmer upon request from the user. The upper part of the application, it displays for number of customers in the store. Then, it follows by customer limit, number of customer adjustment and number of staffs which shop manager or staffs can manually set by manipulating the slider under each section. The check box for each section enables the users to update specific information rather than update all the information. Any changes in the data update via application will be store into Firebase Realtime database. Bottom part of the screen displays some information regarding the number of customers inside the store and current setting that made by user.

When the users manually set the customer limit and number of staffs for this section, after update button is pressed, the data will be update into the Firebase Realtime database which as shown in Fig. 10 and read by ESP32. In Fig. 9, it can be observed that the user set only 10 customers can enter the premise and there are currently 3 staffs working within the store. Thus, these data will be store into database. In previous section, it can observe that the sensor detected currently 5 customers enter the store. Hence, when there is an update for 3 staffs work in the store, then the system is eliminating count of staffs and display that currently there are only 2 customers in the store and the system will only limit for customer instead of customers and staffs. These feature gives huge impacts toward Intelligence Shophouse System as its control the limitation number of customers to enter the shop.
There are green LED and red LED available in the system to show the accessibility of customer toward the store as shown in Fig. 11. The green LED is triggered if the number of customers inside the shop are not exceed the customer limit that set by the users (staffs), otherwise the red LED will be triggered as the shop is crowded (number of customers inside the shop exceed the limit) which indicates that customer could not enter the shop until the green LED is triggered again.
Two infrared sensors are installed at entry and exit lane to detect customers enter and leave the shop. The count of customers will increase by one as a customer pass through the IR sensor that located at the entrance door, otherwise count of customers will decrease by one for each time when a customer pass through the IR sensor that located at the exit door. The servo motor 1 which control the movement of entrance door will be turn to 90o position (door open toward inside the shop) as customer entering the shop. The servo motor 1 will maintain its position (door opened) for 5s and it will be turn back to its original position (door closed) at 0o. While the servo motor 2 which control the movement of exit door will operates the same way as the servo motor 1 but this servo operates when the customer leaving the shop. As the servo motor facing each other, then servo motor 2 will open the door toward outside of the shop rather than toward inside the shop.

The I2C LCD Module in Figure above display the information to the customers. When a customer entering the shop, the LCD will be display “PEOPLE ENTERING”. While it will display “PEOPLE LEAVING” which indicate that a customer is leaving the shop. On the other hand, the LCD also set up to display a message “STORE IS CROWDED” and “PLEASE WAIT A PERSON TO LEAVE” for the customer if the number of customers inside the shop have exceed or equal with the customer limit that set by the user (staff). Else, the LCD will constantly display “WELCOME TO GROCERY STORE GROUP 15” message.
Every time system reset, the number of customers inside the store will reset to zero unless the button (turn on position) for update adjustment customer count is pressed. Let assume a condition where the infrared sensor located at entrance door is unable to detect customer enter the store for certain time, hence adjustment of customer count should be made. The “Customer Count Adjustment” information the application could be adjusted by manipulating the slider as show in Fig. 17 or turn on the reset feature (to reset the current count of customers to zero). When the button (turn on position) is pressed, the “Customer Count Adjustment” value is read from the Firebase to update the current number of customers inside the store. After the button (turn on position) pressed, it will need to be pressed again (let it in turn off position) to let the system counting run as normal. If the button in turn off position, the current number of customers count will be constant whether there are customers enter or leave the premise. When the object or our hand is approach to ultrasonic sensor and the distance is less than 5cm, then the servo motor will be activated to force the sanitizer dispense out for the customer. Besides, white, red and green LED is implemented in the prototype to show the status level of sanitizer in the bottle. When the sanitizer is fully used up, the white LED will be blinking between red and green colour to notify the staffs to fill up the sanitizer. When the level of sanitizer is medium or full, then red LED and green LED will be triggered respectively.

6. Conclusions

In conclusion, providing all the planning, it is believed that this project can complete within time frame with all the features being achieved such as customer limitation system and contactless hand sanitizer. However, considering several problems that could be faced by this system, the proposed design will fulfil the requirements by end-user. By using this Intelligent Shophouse System, the user can potentially reduce spreading the virus and able to practice physical distancing among people into the store. Lastly, it is hope that it can significantly help the users to move towards a smart, safety and public health of technology.

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