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A Secure Parking System for Residential Area using IoT

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Abstract: Reasonable and affordable prices increase the sale of apartments in Malaysia. The same goes for vehicles. The ability to own apartments and vehicles has indirectly led to an increase in the use of parking lot in apartments, where parking lot become fully occupied. Therefore, A Secure Parking System for Residential Area using IoT has been developed to overcome this issue. The term secures used in this project refers to how the project can guarantee a parking space for each resident from being taken over by others. In this project, the Arduino NANO 33 IoT with Wi-Fi Module is used to facilitate the connection to the Arduino IoT platform. This project is implemented as a prototype in a residential area where the prototype's size is determined by using a 1:64 scale car. The dashboard was built to make it easier for users to access their parking space. Each dashboard will be handed over to the owner of the parking space and directly to the apartment occupant by including the apartment occupant's email. The project achieved all the objectives where the system successful to secure the parking space of residents by applying a private dashboard that contains virtual switch and provide RFID Module to open the barrier by controlling the servo motor.

Keywords: Secure Parking System, IoT, Arduino IoT Cloud

1. Introduction

Apartments have become standard residential buildings in urban areas because the price is reasonable and affordable. A total of 47,178 units of residential buildings were launched in 2020, compared to almost 60,000 units in 2019. The total unsold units under construction and unsold units' construction decreased to 71,735 units, and 12,975 units showed a good effect as decreases by 1.3% and 22.6%, respectively [1]. Every apartment or condominium in Malaysia has provided parking for each occupant and some apartment only provide parking spaces without supervision from security officers. This situation gives rise to such cases as non-residents of apartments taking away the rights of occupants of apartments. This problem will make it difficult for residents to find parking spaces when

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needed. Thus, A Secure Parking System for Residential Areas using IoT is proposed to address the issue. This project improves the parking system for residential areas such as apartments or flat. The term secures applied in this project is how this project can protect the parking space for each resident from being seized by others.

2. Methodology

Methodology is a method and process of determining, designate, review and analysis of the workflow process for the project. This part will describe the details of every process related in designing A Secure Parking System for Residential Areas using IoT.

a. Project Block Diagram

A block diagram was constructed to illustrate the relation and brief function of all related components for the project. Figure 1 depicts a specific block diagram of the project system. The designed block diagram helps to give a better view on the project operation and complimentary work that required for the project methodology.

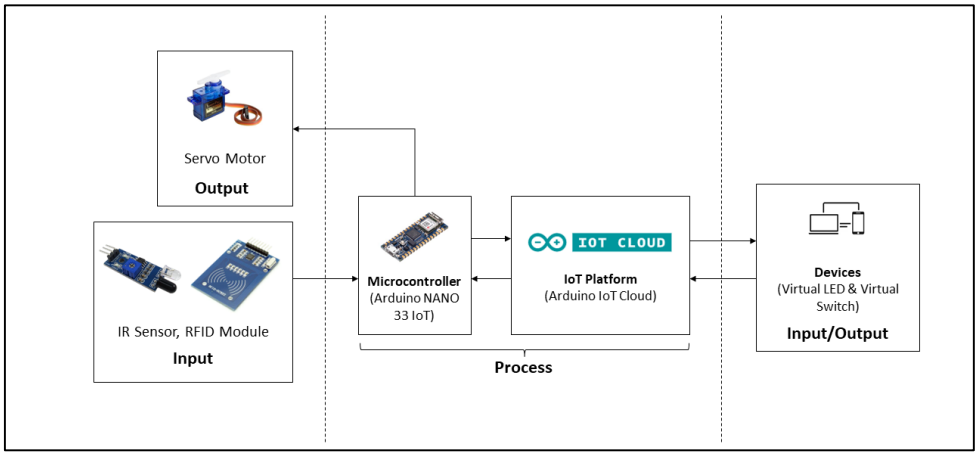


Figure 1: Block diagram of A Secure Parking System for Residential Areas using IoT

Figure 1 shows how each major unit connects and interacts with each other. All operations will begin with the code construction of all project functions in the Arduino IoT Cloud and be uploaded to the Arduino NANO 33 IoT to run the system. Each input or output obtained and received from the electronic devices will be stored in the IoT platform and displayed on the user's device through IoT Cloud Dashboard.

When the IR sensor or the RFID module receive input from the user, the devices will send the input to microcontroller to be process and be display on the virtual LED to determine the status of parking space. When the virtual switch on the user devices triggered which are ON or OFF, the data will send to microcontroller and be processed and controlled the servo motor to operate whether to open or close the barrier. Thus, users can secure their parking space by simply using their devices.

b. Project Flowchart

The flowchart in Figure 2 shows the system operations on user's view. The IR sensor reads the car presence and sends the data to the Arduino to process and upload to the IoT Cloud platform. Then, the user can determine the system technique for accessing the parking space, either the IoT Remote technique or the On-site technique. The IoT Remote technique involves the user's device to control the barrier in a parking lot. From the user devices, users can control the barrier by turning ON the virtual switch. On the other hand, the On-site technique involves the RFID module to control the barrier by using the given RFID card from the apartment management and tap the card on the RFID reader to open

the barrier. The two methods show that apartment dwellers can secure their parking space with the presence of a servo motor that controls the barrier in the parking space.

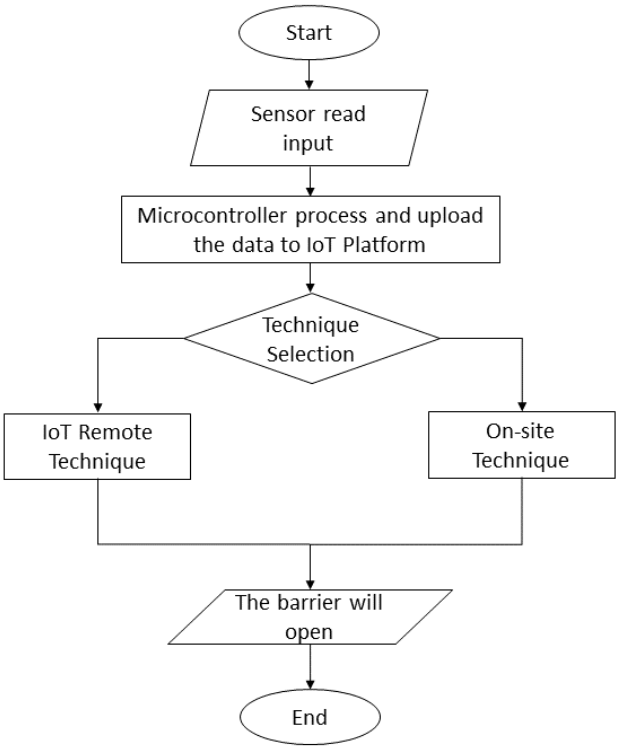


Figure 2: Flowchart of the smart streetlight system

c. Prototype and Circuit Sketching

There were major items in developing the prototype which is parking areas sketch up and circuit of A Secure Parking System for Residential Areas using IoT.

i. Prototype Parking Areas

Various parking spaces on the internet have been used as examples in producing prototype parking areas. The prototype sketch was created by hand sketching and re-sketched in the computer using Paint software as shown in Figure 3. At the same time, the size of each parking space and route in the prototype parking area has been determined to accommodate a 1:64 scaled car. As shown in Figure 4, the completed prototype parking space for residential areas.

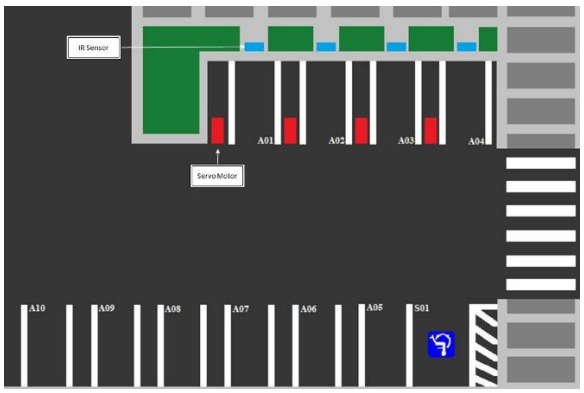


Figure 3: Sketch Up of Prototype Parking Space for Residential Areas

Figure 4: Complete Prototype Parking Space for Residential Areas

ii. Circuit of the Project

The number of electronic devices has been determined and listed by referring to the sketch of the parking space. The number of electronic devices that has been determined can provide four secure parking systems. The sketch of secure parking system circuit was sketched using Fritzing software. Fritzing is one of the most useful open-source Arduino software. Users can efficiently perform wiring connections among electrical components in an electrical breadboard [2]. Figure 5 shows a sketch of the secure parking system circuit.

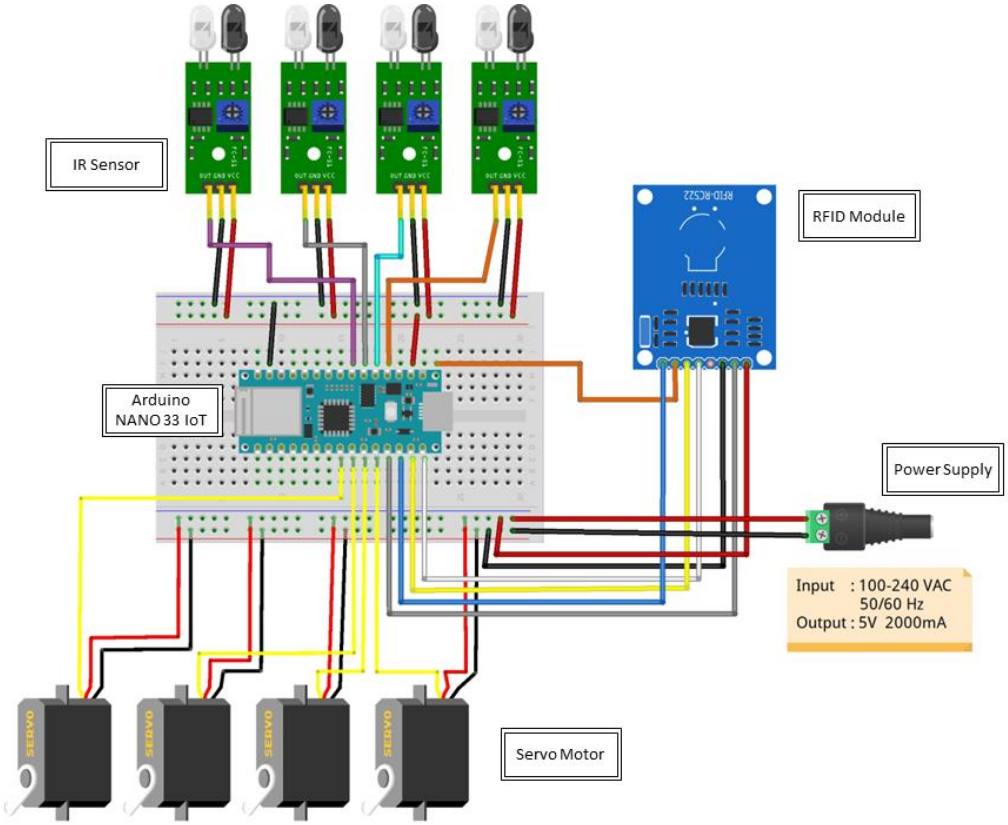


Figure 5: Sketch Diagram of Projects' Circuit

As shown in Figure 6, the complete circuit of A Secure Parking System for Residential Areas using IoT. Arduino NANO 33 IoT used as the microcontroller because it comes with a Wi-Fi Module to simplify the connection the microcontroller to the cloud server. There were four parking space applied with the secure parking system due to the lack of pinout on the microcontroller. There were four IR

sensors, four servo motors and RFID module were used in the project. The function of the IR sensor was to detect the presence of vehicles in the parking space. Besides, the function of the servo motor was to control the barrier in parking space. Lastly, the RFID module was used to control the servo motor using on-site technique.

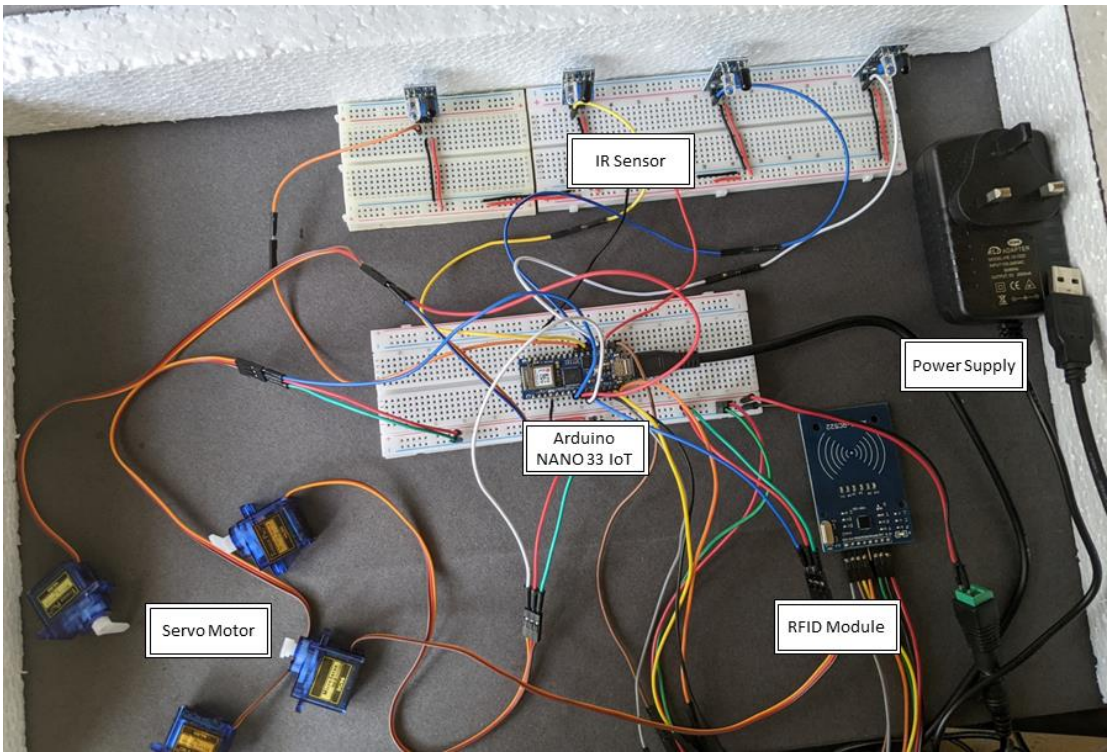


Figure 6: Complete Circuit of the Project

d. The IoT Configurations

Arduino IoT Cloud provides features like Things, Dashboards, and Devices used in the project. The function of the Devices to register the Arduino NANO 33 IoT to the IoT platform. The function of the Things is to declare the real and virtual devices. Meanwhile, the function of the Dashboards is to be a display space to display the current output. As this project uses products from Arduino, the microcontroller (Arduino NANO 33 IoT) configuration is easier than a third-party device. The cloud variables will be declared for this project in the Things and the cloud variables will be the button that controls the barrier and the LED that will be the indicator that shows the status of the parking space. Both buttons and LED will be Boolean data types.

The IoT Cloud platform auto generated the code in a sketch file based on the declared variable. The sketch file with the completed code is uploaded to Arduino NANO 33 IoT. Each Button and LED cloud variable is linked to Widgets on the Dashboard. The selection of widgets is determined based on data types of cloud variables which are Boolean. The procedure is repeated until all cloud variables have been linked to widgets. The button cloud variables will be using Switch widgets as shown in Figure 7 and the LED cloud variables will be using the green and red LED widgets to be an indicator to show the status of parking space as shown in Figure 8. The green LED indicate that the parking is unoccupied, meanwhile the red LED indicate that the parking is occupied.

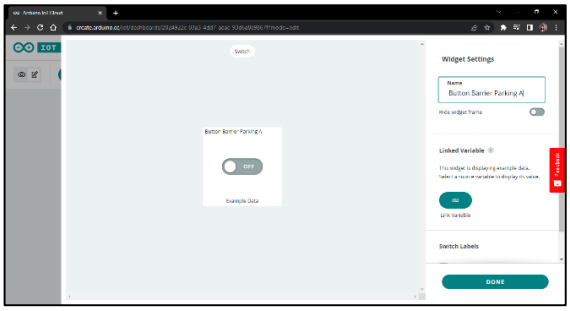


Figure 7: Button Widget Settings

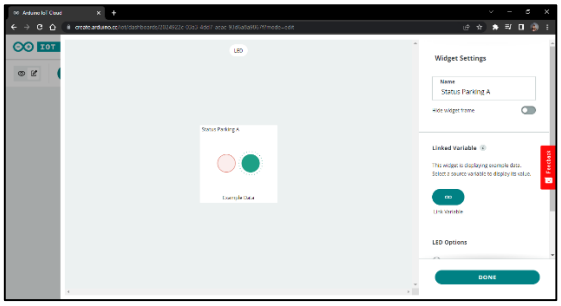


Figure 8: LED Widget Settings

After the widgets are linked to all cloud variables, the widgets will be arranged according to the parking space as shown in Figure 9.

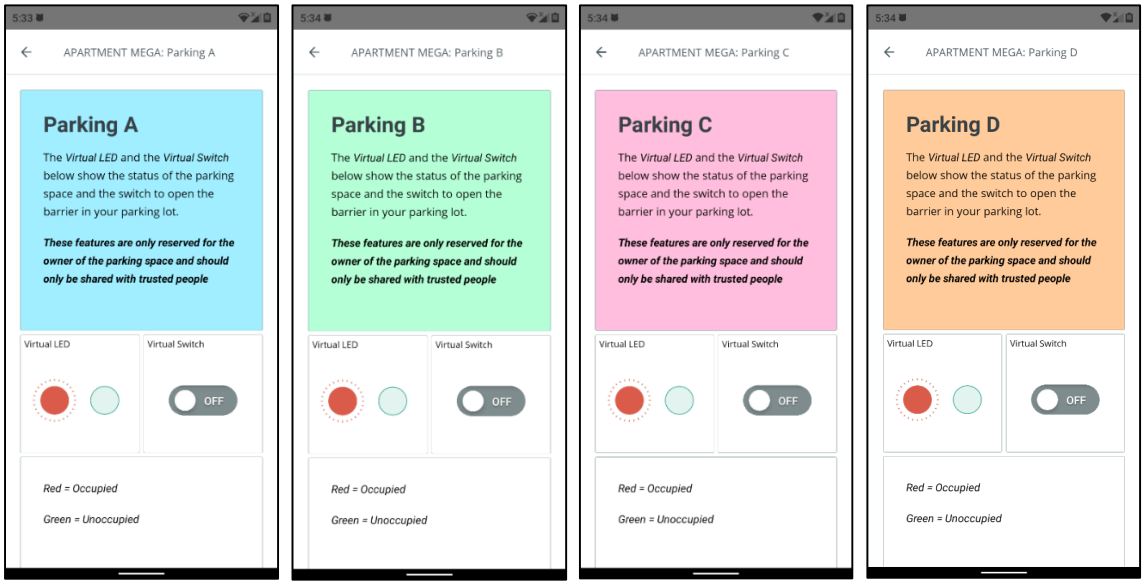


Figure 9: Complete Dashboard of A Secure Parking System for Residential Areas using IoT

Each parking lot has its own dashboard that provides virtual LEDs and virtual switches that apartment residents use. The dashboard interface also includes a label for each virtual device and how to use the system, as well as a reminder not to share the dashboard with strangers. Each dashboard will be handed over to the owner of the parking space and directly to the apartment occupant by including the apartment occupant's email, as shown in Figure 10.

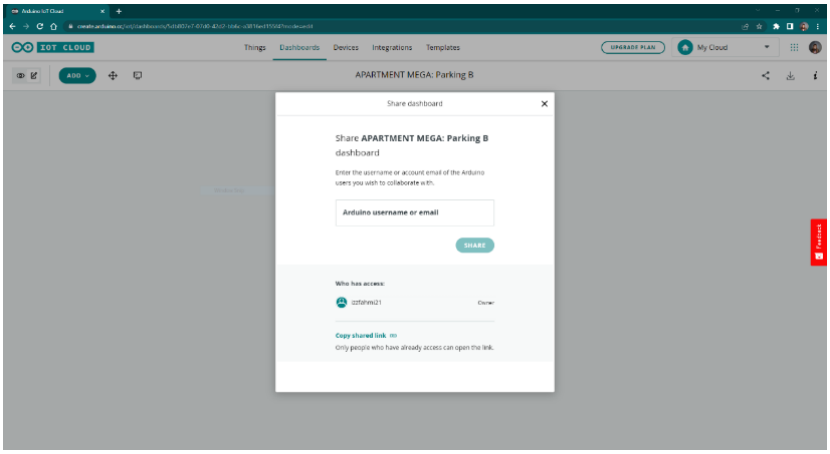


Figure 10: Sharing the Dashboard to Other Users (Resident)

3. Results and Discussion

a. A Secure Parking System for Residential Areas using IoT

The project's first objective is to develop A Secure Parking System for Residential Area using IoT. Figure 11 shows the complete prototype parking area in residential area that contains the completed circuit.

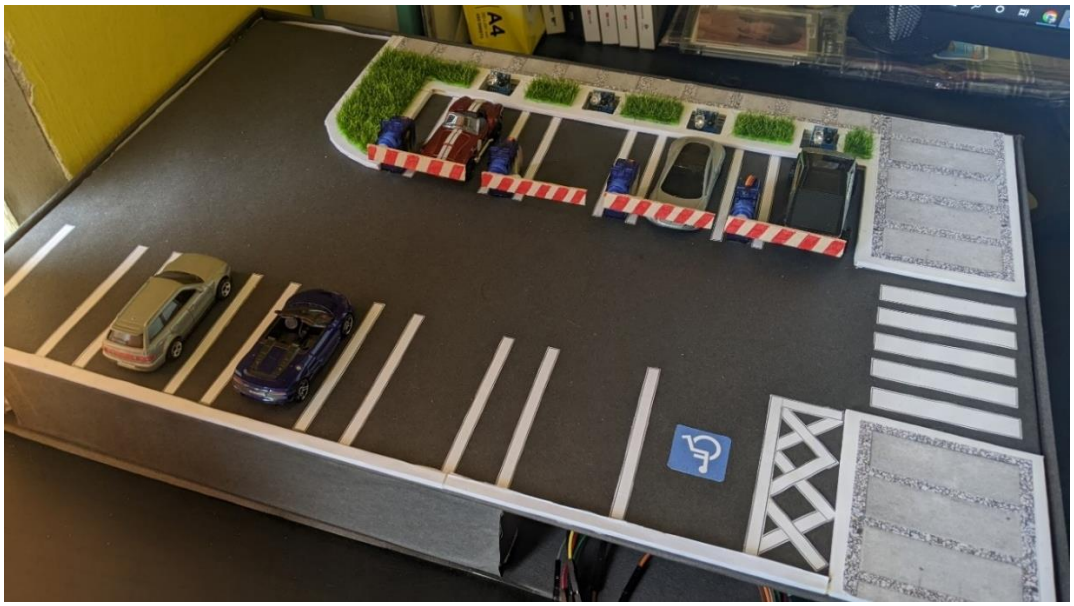


Figure 11: Complete A Secure Parking System for Residential Areas using IoT

b. Integrating with Internet of Things (IoT) Platform

The second objective of the project is to use the Arduino IoT Cloud as the IoT platform medium to monitor the parking space status (through the virtual LED) and control the servo motor to open or close the barrier (through the virtual switch). Therefore, this section comprises two elements: observation the IR sensor on the parking space status and observation the virtual switch control of the servo motor based on the situation in Table 1.

Table 1: Integrating with Internet of Things (IoT) Platform

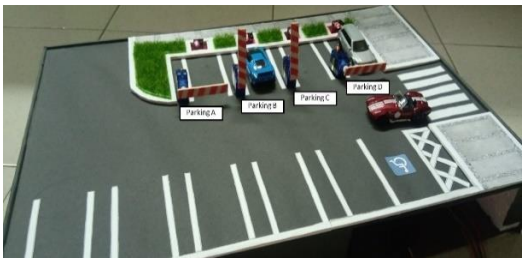
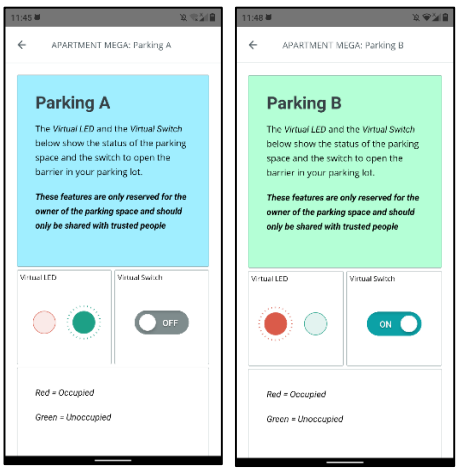
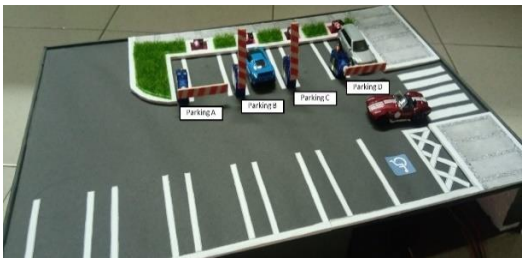
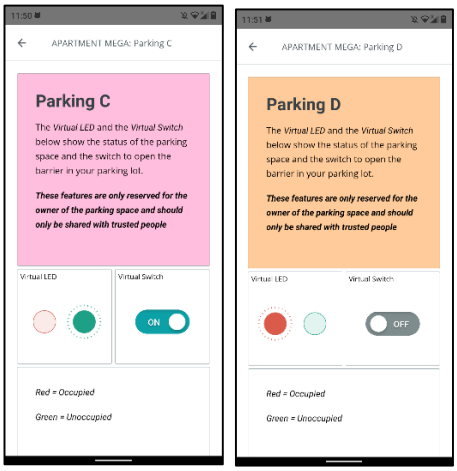
Situation	IoT Cloud Dashboard
Observation the IR Sensor on the Parking Space Status 	Based on the situation, there are no resident's car on Parking A and Parking C, meanwhile, there are resident's car on Parking B and Parking D. 

Table 1: Integrating with Internet of Things (IoT) Platform (continue)

	Figure above displays the status of each parking space and shows that the virtual LED for parking A is green. It indicates that the parking space is unoccupied. Meanwhile, the virtual LED for parking B is red. It indicates that the parking space is occupied.
Observation on Virtual Switch in Control the Servo Motor 	Based on the situation, the barrier in Parking A and Parking D are close, meanwhile the barrier at Parking B and Parking C are open.  Figure above displays the dashboard of Parking C and Parking D. The virtual switch on the dashboard of Parking C is in turn ON mode. Meanwhile, the virtual switch on the dashboard of Parking D is in turn OFF mode.

From the observation, it is proving the IR sensor changes the status of the parking space through the virtual LED and the virtual switch on the dashboard can control the servo motor to open and close the barrier through the resident's mobile phone. In summary, the second objective of the project has been achieved.

c. Verification on the Developed System

The third project objective is to verify the system functionality in securing the parking space for apartment resident. Thus, this section includes the verification on the dashboard, the observation of the time taken for hardware and software to update the output and the verification of the system functionality when there is no internet connection or mobile phone.

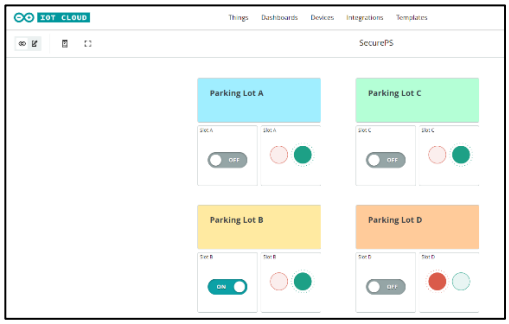
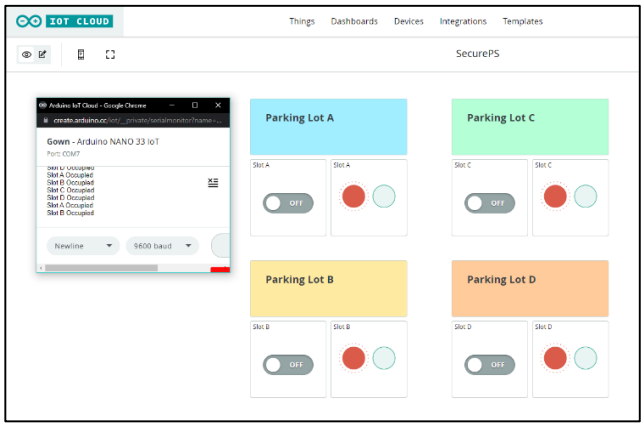
i. Verification on the Dashboard

Figure 9 shows the dashboard of each parking of A Secure Parking System for Residential Area using IoT. Apartment owners and apartment residents can only access the dashboard. In most agreements between the apartment owner and the apartment occupants, the occupants will have a minimum of one parking space in the apartment area. Thus, in this project, the apartment owner will hand over the parking space and the dashboard (to access the parking space) to the apartment occupants using the method, as shown in Figure 10. Thus, residents can share the dashboard with their household members via a shared email. This proves that strangers cannot use the parking space because they need the dashboard to access it.

ii. Observation of Time Taken for Hardware and Software to Operate the Instruction

Both hardware and software will send input to each other to evaluate the time taken (for both hardware and software) to operate the instruction. Table 2 discuss the time taken for both hardware and software to operate the given instruction.

Table 2: Observation of Hardware and Software to Operate the Instruction

Situation	Observation
Hardware Observation  Figure above shows the virtual switch on Parking B is in turn ON mode.	Figure below shows the barrier for parking B is open. From the observation, it was taken around 1 to 2 seconds for the barrier to open. 
Software Observation  Figure above shows the car is placed in front of all the IR sensors.	Figure below shows that the virtual LED on the dashboard takes 1 to 3 seconds (using stopwatch) compared to the Serial Monitor.  On a different note, the virtual LED on the dashboard using a mobile phone, it takes 5 to 7 seconds (using stopwatch) to update the output.

iii. System Functionality when no Internet Connection or Mobile Phone

In the condition of no internet connection or mobile phone, the apartment management will hand over an RFID card to apartment residents. This is to ensure the residents can access the parking space without using the internet or mobile phone. Figure 12 shows that the barriers at parking A, B, and D have been opened by using the RFID system. Figure 13 shows the observations that have been made on the Serial Monitor to show the ID (on each card) and which barrier is accessed.

Figure 12: Parking A, B and D are Open

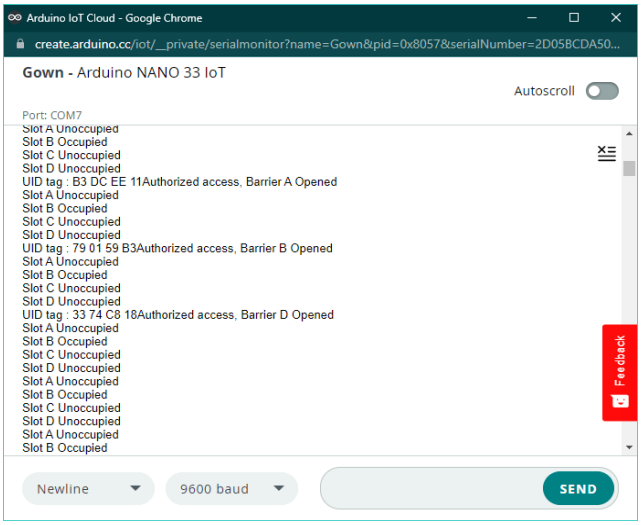


Figure 13: Serial Monitor of the RFID Systems Output

4. Conclusion

A Secure Parking System for Residential Area using IoT was assembled by using several essential components: Arduino NANO 33 IoT, Arduino IoT Cloud, IR Sensor, RFID Module, and Servo Motor. The combination of Secure Parking System and Arduino IoT Cloud in IoT has helped the project to achieve the first objective. Arduino IoT Cloud has been made as a medium between users and devices. Arduino IoT Cloud provides simple interface and easy steps for users to connect the devices to the cloud server. The benefit has helped to achieve the second and third objective. Various verification was performed to determine whether the system can achieve the third objective. After several trials, this system was able to secure parking space by using servo motor control as a barrier through IoT Cloud Remote. Thus, the third objective was successfully achieved.

The first recommendation is to use a microcontroller with a multi-core processor such as Raspberry Pi, STM32 Nucleo-144 MCU Board, and others. This is to expand the functionality of the system. The use of the IoT platform that was newly created in February 2019 compared to other IoT platforms is a challenge in this study. Few references and learning resources cause difficulties to study on how the devices can connect to the cloud server. Thus, the use of other platforms such as Blynk is recommended to be used. Blynk is flexible in connecting devices to the IoT platform and it has a service update. The reference sources also are easier to obtain. With many reference sources, the project can be improved by connecting the cloud server to the mobile app developer to display the system outcome with a friendly interface.

Acknowledgement

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References

[1] Property Market Report. Valuation And Property Services Department. Retrieved from https://rehda.com/wp-content/uploads/2021/07/JPPH-Property-Market-Report-2020.pdf, 2020

[2] Liao, P. S., & Lee, C. H., “Applying Open Source Softwares Fritzing and Arduino to Course Design of Embedded Systems,” International Journal of Automation and Control Engineering, 2015, 4(1), 40-44