Hostel Power Switching Card System

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Abstract— In this world, it consists of a lot of people who do not know how to use the power wisely. For example, especially hostel area, the students will keep turning on the phones or laptop charger and keep turning on the air-conditioner to keep their room as their desired temperature even there is nobody in their room. This is a big issue, and it will cause the students to pay high electrical fees and cause the wastage of natural resources. To overcome this problem, the hostel power switching card system is implemented. In the hostel power switching card system, the students need to insert the student ID card into the energy saving card switch to turn on the power. Without the card, the student will not be able to turn on the power of their room. After inserting the card, the power will straight turn on and the energy meter will start measuring the unit consumption. The energy meter will transfer the data to the ESP12E NodeMcu V3 which is the microcontroller in this system by optocoupler. The optocoupler will measure the pulses from the energy meter. The ESP12E NodeMcu V3 will upload the data to the Blynk cloud. The students can check the unit consumption and electrical fees used through Blynk mobile application.

Keywords— Power switching, card system, Iot, student ID, energy saving, ESP12E NodeMcu V3

I. INTRODUCTION

Nowadays, electricity is an essential resource in everyone's life. Most of the appliances in this world are using electricity to work. Based on the statistics introduced by the (Energy Commission, 2017), the electricity consumption in Malaysia is rapidly increasing from the year 1978 to the year 2017. In 2017, the electricity consumption for residential in Malaysia is 2610 ktoe (Energy Commission, 2017). In this case, most of the residences are wasting unnecessary electrical power. For example, some residences are not turn off the power of some electrical appliances and causing the power wastage. Power wastage will waste a lot of natural resources such as coal, oil and gas because most of the power plant in Malaysia are thermal power plant which is using the natural resources to produce the power. To save the electrical power, the power switching card system is implemented. The power switching card system is a system that insert a card into a keycard switch to power up the electrical power. In other word, the electricity is turned on when the clients are inserting the card into the keycard switch while the electricity is delayed turn off when the clients are taking out the card from the keycard switch. This system will help the user to save a lot of electricity by 20% to 30% if compared to the old traditional hostel (Hotel Energy Solutions, 2020). For old traditional hostel, the clients must switch on or switch off the power by using normal switch only. If the students forget to switch off the power of electrical appliances in the traditional hostel, it will cause a lot of power wastage. For using the power switching card system, it will not cause more electrical power wastage than the traditional hostel due to the system can delayed turn off once the card is being taken out from the keycard switch.

In this era, a lot of people in this world keep wasting the electrical power instead of using them wisely. For example, especially hostel area, the students will keep turning on the phones or laptops charger instead of turning off them because they need to charge their phones or laptops every single day. Most of students are lazy to turn off the charger even it is a very easy action. For another example, the students will keep switching on the air-conditioner to keep the room as their desired room temperature. When students are coming back from class, the students can have a desired room temperature when they are entering their room. This will cause a lot of power wastage due to the students' laziness and selfishness. Other than that, this will cause the students to pay a high cost in the electricity aspect. To solve this problem, the hostel power switching card system is implemented. In this case, the card used to switch on or off the power in hostel is student ID card. The students are required to bring out the student ID card when the students are going out their room. This is because the room locker is using the smart locker system which can only use the student ID card to open the room door. Besides, the payment in university is using the student ID card instead of using the cash. In other word, the students must use the student ID card to make every single transaction in the university. Thus, the student ID card is most suitable to be used in this hostel power switching card system. Therefore , the aim of this research is to design a hostel power switching card system by using student ID card.

Nowadays, the hostel is using conventional switch to turn on the power. Since Malaysia is a high temperature country, most of students will rather turn on the air conditioner by whole day. Of course, students will not stay whole day in their hostel because the students need to attend the class or need to eat their meals. Although there are no people in the hostel, some students will still turn on the air conditioner in their room in order to have a desired temperature. This will cause a lot of power wastage. Thus, this project is to implement student ID card as a key to switch on the power of the hostel. As introduction written, the key card switch can save the power consumption by 20% to 30% (Hotel Energy Solutions, 2020). Other than that, the power consumption can be sent to students' email and students' phone by monthly. Without this system, the manpower is needed to go to each hostel to record the power consumption. This will waste a lot of time. Thus, this system is implemented in the hostel contains a lot of advantages.

(ShanEn et al., 2015)introduces the intelligent energy-saving system for classroom by using the campus card. The system is based on the campus card to turn on or turn off the power. If there is nobody in the traditional classroom and the lightings of the classroom are turned on, this will cause a lot of power wastage and cause the higher unnecessary energy consumption of the school. The researchers introduce this system which consists of information center, base station and sub control nodes. The information center acts as an important part which consists of data of the campus card. The data of the campus card can be transmitted through the network to the base station. Meanwhile, the communication between the base station and control nodes is using wireless communication. The campus card is required to insert into the card holder in the classroom when the students enter the classroom. The data in the campus card will read by the control nodes to check whether it is available. If it is available, the student can turn on the power in the classroom. When the student removes the campus card, the warning will be produced to remind the student to insert again. If there is no campus card to insert, the control nodes will close the power automatically.

Radio frequency identification (RFID) and wireless sensor networks (WSNs) are complementary technologies that reduce power consumption (Abdulla, 2014; Abdulla & Ismail, 2011, 2013; Abdulla & Selvaperumal, 2018a, 2018b) .(Lakshmi & Deepika, 2017) emphasize on the classroom with the light is turned on while there is nobody in the classroom. With the problem of this, the researchers introduce a cost effective energy saving system based on RFID. With this system, the school can save a lot of power instead of paying unnecessary electricity costs. This system is using the campus card system to perform. If there is no campus card in the card holder, the power in the classroom cannot be turned on. In this journal, the researchers mainly focused on the components used in this system and the function of every components. For the control section, there are a lot of sensors used such as temperature and humidity sensor, light sensor and RFID reader. With the presence of sensors, the devices can be turned on and turned off automatically instead of wasting the power. The ARM is used to transmit the signal that produced by the sensors and transmit to the output devices. The microcontroller can be used immediately with the aid of the Zigbee in this system. The LCD display is used to display the students or staffs' name who used the classroom. For the server section, it works same as the control section. The PC is used to store the students or staffs' details and send them through the ARM. The ARM sends the details to the Zigbee and Zigbee will send them to the control section. In this journal, it stated that this system has been used widely in most of the university. The system has helped the university to reduce the electricity cost. The limitation of this journal is this system is not work with the human body detection. The system should work with the human body detection due to the irresponsible student can insert the campus card into the card holder without using the classroom. This will cause a lot of power wastage.

(VARMA & REDDY, 2017) are implemented the identity cards to create a power saving system in classroom. The researchers introduce this system by separating into two section which are transmission section and receiving section. The transmission section functions to transfer the student data through Ethernet from the information center. The receiver section is used to check the availability of inputs and make the decision to give the output. The microcontroller in the both sections acts as a brain of this section. It mainly functions to detect the inputs and make the decision to provide the outputs. The RF module in transmission section acts as a transmitter to transfer the data to the receiving section while RF module in receiving section acts as a receiver to receive the data from the transmission section. The card reader is used to read the data which stored inside the card (Varma & Reddy, 2017). The sensor module is used to detect most of the external inputs that affect the lighting of the classroom. The switch is used to turn on or off the lighting in the classroom. The flash memory acts as a backup which used to store the student's data. The voice module is to warn the student to insert the card again when the student removing the card from the card reader. For this system, it is useful in most of the university to minimize the power wastage. The limitation of this journal is this system cannot save the power when consisting of multiple students in the classroom. The irresponsible students can insert one of their cards into the card reader and walk away from the classroom due to this system works if the card present.

In the recent years, advancement of technology has led to an increase in research and development of Internet of Things (IoT) devices (Abdulla et al., 2020; Al-Gumaei et al., 2018; Eldemerdash et al., 2020; Haziq et al., 2022; Hon et al., 2020; Kalilani et al., 2021; Katemboh et al., 2020; Lakshmanan et al., 2020; Murugiah et al., 2021; Rasheed et al., 2021; Samson et al., 2020; Singh et al., 2021; Zainudin et al., 2022). Internet of Things (IoT) has become one of the essential items in our reality (He et al., 2016)found out that the resources management is very challenging. To solve this problem, the researchers apply the IoT techniques to a smart resources management by performing the case study of intelligent chair system. The intelligent chair system is using the Arduino Yun as the microcontroller to work. In this system, the Arduino Yun is connected with the RF reader, pressure sensor and -Fi module. The RFID reader is used to read the information in the user ID. The pressure sensor is used to detect whether the chair is occupied or not. The Wi-Fi module is used to upload the collected data to the cloud server and the authorized user can retrieve the collected data from the cloud server. the system is divided into three parts which are Arduino Yun, ThingSpeak and Android application. The Arduino is used to receive the user's information from the RFID Reader when the pressure point has reached the reference data. Then, the Arduino transmit the user's information and timestamp to the AR9331 microcontroller through bridge (He et al., 2016). After that, once the ThingSpeak API receives the HTTP POST request, the user's information and timestamp will be stored inside the cloud server. When the authorized user wants to retrieve the data from the cloud server, the HTTP GET request will be send to ThingSpeak API. In this case, the API key is needed in this process to avoid unauthorised user to retrieve the data. In this journal, the researchers are using ThingSpeak as their IoT software instead of using Web 2.0. This is because ThingSpeak is easier to implement and it is free. In this case, ThingSpeak can store the collected data in its cloud system and can retrieve the data anytime. In this case, the limitation of this journal is the system cannot notify the user if there is error in the system and there is no specific cost of this system shown.

(Pasha, 2016) introduces an IoT sensing and monitoring system with MATLAB analysis by using ThingSpeak. In this system, the ThingSpeak acts as an IoT cloud system which store the sensed data. Meanwhile, MATLAB is used to track back the sensed data from the cloud system by using the channel ID and API key (Pasha, 2016). Other than that, this system also includes some important components which are Arduino Uno and Arduino ESP8266. The Arduino Uno acts as the microcontroller which functions to control the sensor while the Arduino ESP8266 acts as the Wi-Fi module which functions to transmit the sensed data to the ThingSpeak cloud system. Arduino transmit the sensed data to the Wi-Fi module and Wi-Fi module transmit the sensed data to the ThingSpeak cloud. If the user wants to retrieve the sensed data from the cloud system, the user can use the MATLAB to retrieve.

Most of the companies has taken the action to do some research on the machine-to-machine communication with IoT. IoT has implemented on the sensors by joining them to the machines or the objects. The sensed data is needed to read and analyse by using manpower and it will cause the higher cost in retrieve the data by using manpower. By solving this problem, the cloud system can be used to store and retrieve the sensed data. Thus,(Abdul-Rahman & Graves, 2016) introduces an IoT system by using MSP430 and ThingSpeak cloud system. In this system, MSP430 acts as a microcontroller to perform transmission of the sensed values produced by the sensor. In this system, the researchers use the educational booster pack of MSP430. the data captured by the sensor is the input of the system. The IoT system includes various modules which are the sensor reading and transmit system (MSP430), PC app and ThingSpeak online app. All the sensed data will be exchange between the modules. All these three modules will be worked together in order to perform the output. The output of this system will be displayed on the LCD screen which is located at the educational booster pack of MSP430. Other than that, the data captured by the sensor will be stored to the ThingSpeak cloud.

(Rahman et al., 2015) introduce a smart meter system by using Arduino and GSM for advanced metering and billing system. The traditional metering and billing system is slow compared to the system proposed by researchers. Basically, Arduino acts as a microcontroller which is the brain of this system. The function of Arduino is used to perform the appropriate outcome based on the code in the Arduino. The GSM can allow the Arduino to connect with the internet. Other than that, messages sending or receiving can be done by using GSM as well. The software used in this system is Proteus 8.0. Other than Arduino and GSM, there are a lot of components used such as energy meter which is digital, relay and buzzer. The energy meter is used to measure voltage and current to calculate the energy. In this system, when the Arduino and GSM Modem is turned on, the relay will be turned on to make the connection with the load and energy meter. The current data will be displayed by reading the EEPROM. At the same time, the Arduino will read the signal from the energy meter. Once receiving the signal, the Arduino will increase and display the current data. In this case, the GSM Modem is used to check the SMS. The data will be sent to the specific number if the SMS is "DATA". The relay will be turned on and turned off if the SMS is "LINE OK" and "LINE CUT" respectively. Other than these three formats, the SMS will be deleted. The Arduino can detect whether tampering attempt occur or not. If it is detected, the Arduino will turn off the relay to cut off the connection with the load. After that, the buzzer will be turned on and the service provider will receive the SMS to alert them.

In this 21st century, there have a person who stand in front of our house's electrical meter once a month to record the electrical bills. The disadvantages of using manpower to record is human error which is extra changes for bills. To solve this problem (Sahani et al., 2017), propose an IoT based smart energy meter. In this system, there are some components used which are energy meter, signal conditioner, Arduino Uno, Max 232, GSM, Wi-Fi module, webpage, driver circuit and switching device(Sahani et al., 2017). switch device used in this system is Solid State Relay (SSR). It is used to turn on or off the meter. The signal conditioner is used to increase the voltage of the LED in the meter to allow the Arduino to read. The AC load can be cut off by using the driver circuit. MAX 232 is used as communication for the GSM and Wi-Fi module. The webpage is created with the aid of HTML.

Nowadays, all the people cannot live without electricity. Due to selfishness of some people, they are keep using the electricity by not paying the money which is power theft. (Preethi & Harish, 2016) introduces the smart energy meter to solve the problem of power theft. the communication between home section and base station section is using network. The power consumed and energy consumed will be calculated in this system. The energy used will be displayed on the LCD screen and it will send to consumer by monthly in the form of SMS. The power theft also can be checked by using this system. The software used for this system is keil IDE. there are two types of smart energy meter in this journal which are prepaid mode or post-paid mode. The result will be shown at two places which are LCD screen and SMS.

The conventional way to collect the meter data is through one way communication which is collected by human being. This will cause a lot of trouble because the human will make some error when collecting the meter data. To overcome this problem, (Joshi et al., 2016) introduces the IoT Based Smart Energy Meter. With this IoT based smart energy meter, the system can conduct two ways communication for billing and meter data collection. The IoT based smart energy meter can save a lot of time and save the usage of the electrical energy. Other than that, this system can collect accurate data compared to the conventional way. In the block diagram of this system, there contains pulse which produces by the energy meter. Based on the researchers, the energy meter will rotate and the researchers connect the LDR sensor to sense the rotations of the meter and the Arduino will convert the rotations to the pulse. Once the Arduino receive the pulse, the algorithm will compute the units and calculating bills. The data will be saved to the server. The user can access easily to the server and monitor the electrical consumption. If the consumption above the limit set by the user, the alert message will send to user's mobile. With this system, it will reduce the power consumption. This system can be used effectively in a lot of related sectors. The limitation of this system is the initial cost is higher compared to conventional way.

In this era, the electricity plays the main role in every house. However, most of the people are not responsible when they are using the electricity. They mostly waste the power when they are not using the electricity. Moreover, the conventional meter is time consuming because it needs manpower to record the meter data. In this case, the human also will make some error in taking the meter data. Thus, (Barman et al., 2018) introduces the IoT Based Smart Energy Meter for Efficient Energy Utilization in Smart Grid. The energy smart energy meter proposed by the researchers can use to control and monitor the power consumption of the user.

Other than that, with this smart energy meter can solve the power theft as well. Fig 1. shows the block diagram of this system.

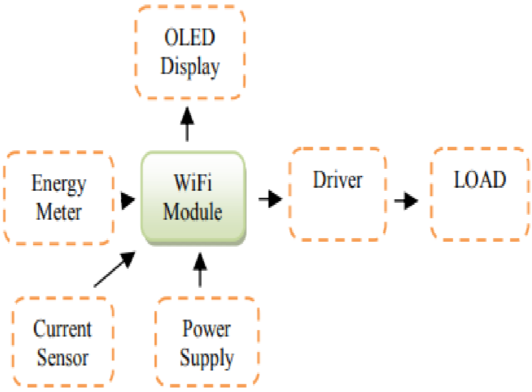

Fig. 1. Block diagram (Barman et al., 2018)

Based on Fig 1., the ESP8266 12E is act as the Wi-Fi module in this project. The energy meter is connected with the 4N35 optocoupler in order to allow the optocoupler to sense the pulse produced by the LED. The output will be sent to the Wi-Fi Module. The OLED Display is to display the results. The current sensor is used to measure the power theft in this system. In this case, the LED calibrated in the energy meter blinks 3200 times for 1 unit kWh. Once the data received from the energy meter, the data will be sent to IoT platform which is called "ThingSpeak". The ThingSpeak is used to store the data for supplier and consumer. Both can monitor the power usage by log in this IoT platform.

II. Overall Block Diagram

In this project, energy meter is used to record the power consumption of the student as shown in Fig 2. The optocoupler 4N35 is used to capture the pulse produced by the energy meter and transfer the pulse to the ESP12E NodeMcu V3. The RFID RC522 works with the energy saving card switch. The energy saving card switch is used to allow the student to insert the student ID card into it and turn on the power. The energy saving card switch will delay 15s when the student removes the student ID card from the switch. This is to protect the electrical appliances. The RFID RC522 is used to identify the user. The ESP12E NodeMcu V3 is used to process the data captured and upload to the Blynk cloud. The data included name, TP, unit consumption and electrical fees. The student can log into the Blynk account to monitor the power usage pattern. Once the students insert the card into the energy saving card switch, the RFID will receive some student information from the student ID card and transfer to the ESP12E NodeMcu V3.

The power will turn on once the student ID card is inserted. Once the power is turned on, the energy meter will run as normally and send the pulse to optocoupler. The optocoupler will capture the pulse and transfer it to the microcontroller. The microcontroller will process the data and calculate the fees and send it to the Blynk cloud. The student will receive the notification from the Blynk about the unit consumption and the electrical fees need to pay. Once the student ID card removed, all the electrical appliances will turn off within 15s time.

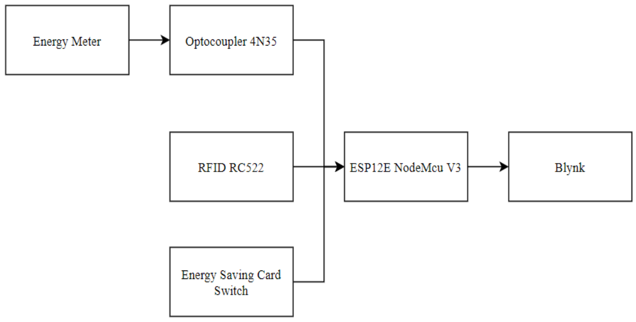

Fig. 2. Overall block diagram of this system

III. Constructional Details

Fig 3. shows the wiring diagram of the entire system. First, the electrical meter is connected with the optocoupler 4N35. The optocoupler 4N35 will receive the pulse from the LED calibrated in the electrical meter. The electrical meter used is 1600imp/kwh which means the LED blinks 1600 times and it will increase 1kWh. The optocoupler pin 1 is connected with the anode of the LED while optocoupler pin 2 is connected with the cathode of the LED. When the LED blinks one times, the optocoupler will receive one pulse and transfer to the microcontroller. The electrical meter is also connected with the main switch which consists of ELCB, isolator and MCB. The main switch is used to protect the electrical appliances from the short circuit. All the wires are connected tightly and correctly to each circuit breakers. On the upper part of the circuit breakers, they are connected with the input power while bottom of the circuit breakers are output power. When it is detected short circuit, the circuit breakers tripped automatically by themselves. The connection must be correct or else there will have electricity when circuit breakers tripped and cause danger. The output of the MCB will connect to the energy saving switch. The energy saving switch can save the electricity if there is no card inserted into the slot. When the card is present in the slot, the power will automatically turn on. All the loads' power must connect after the energy saving switch or else the power of the load cannot be controlled by the card. The optocoupler pin 1 must connect one resistor in order to step down the voltage from the pulse and it will protect the LED inside the optocoupler. The optocoupler pin 4 is connected to the ground while pin 5 will connect to the pin D0 on the ESP12E NodeMcu V3. This is to transfer the data to the ESP12E NodeMcu V3.

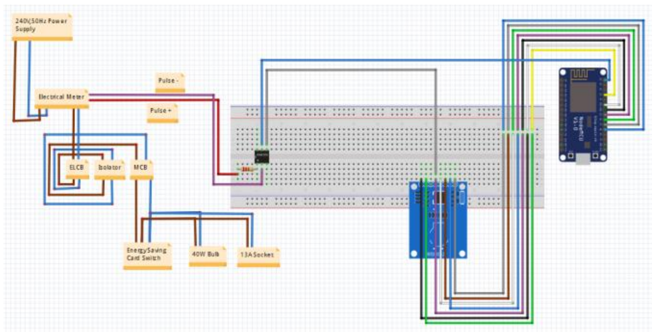

Fig. 3. Wiring diagram of the entire system

IV. Working Principle

Fig 4. shows the flowchart of the entire system. In the beginning, the student ID cards verification is keep repeating until the student ID card is being inserted. Once the student ID card is inserted into the slot, the power will be turned on and ESP12E NodeMcu V3 will measure the pulse of the electrical meter. If the card is not student ID, the Blynk will send a warning message to the student's mobile phone in order to change the card to student ID card.

As before mentioned, the pulse of the LED is the measurement of the unit consumption for microcontroller. The optocoupler is connected to the electrical meter and transfer the pulse to the ESP12E NodeMcu V3. In this case, the microcontroller will calculate the power consumption and electric fees that used by the students. At the same time, the network criteria are needed to verify. If the network criteria are wrong, it is needed to check the Wi-Fi connection. Once it is correct, ESP12E NodeMcu V3 is connected to the internet. The unit consumption and electric fees that used by the students will be send to IoT platform, Blynk. The students can log in to monitor the unit consumption by time. The Blynk will notify the students the power consumption and it will send an email to allow the students to know their power consumption.

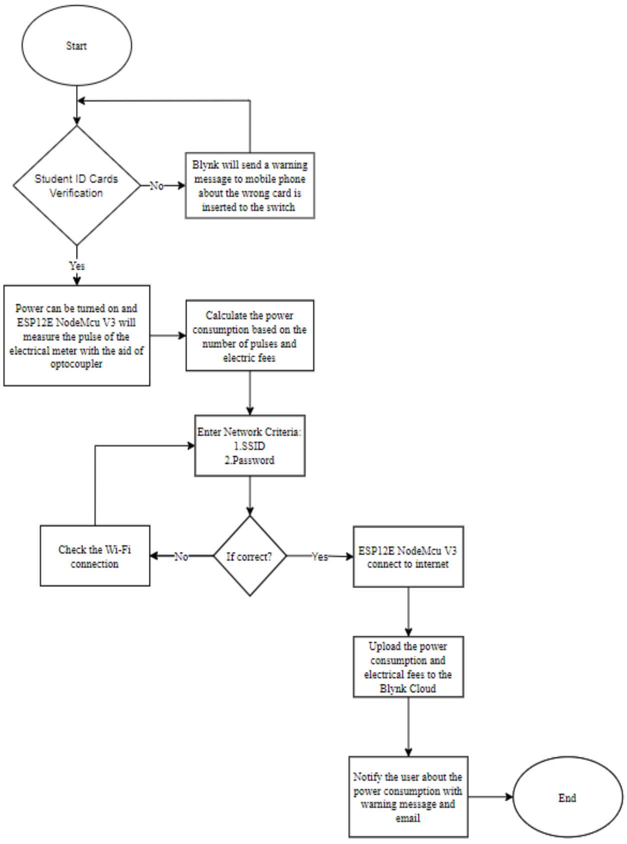

Fig. 4. Flowchart of the entire system

V. HARDWARE AND SIMULATION RESULTS

In this result, the results will be displayed for the hardware and simulation. Fig 5. and 6., show the hardware for this system before and after inserting the card.

Fig. 5. Hardware for this system before inserting the card

Fig. 6. Hardware for this system after inserting the card

Based on Fig 5. and 6., it can be observed the bulb has been turned on and the 13A socket contains electricity after inserting the student ID card. The electric meter contains a red light at the left side of the meter which used to indicate the pulse. The simulation result will be shown in Fig 7.

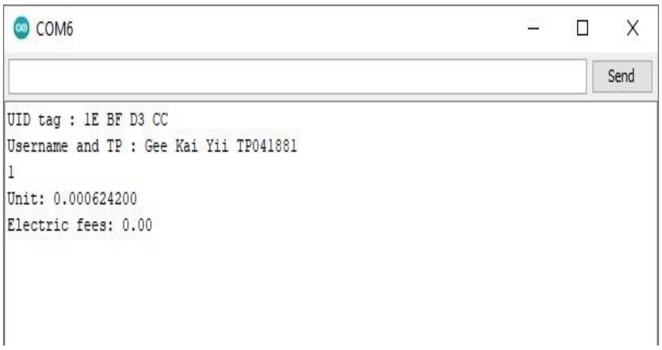

Fig. 7. Simulation result

Based on the Fig 7., the UID tag, consumer's username and TP number are displayed at the serial monitor. Once the power is turned on, the unit consumption and electric fees are calculated by itself. Fig 8. shows the Blynk's GUI which used to display the data to the consumer's mobile phone.

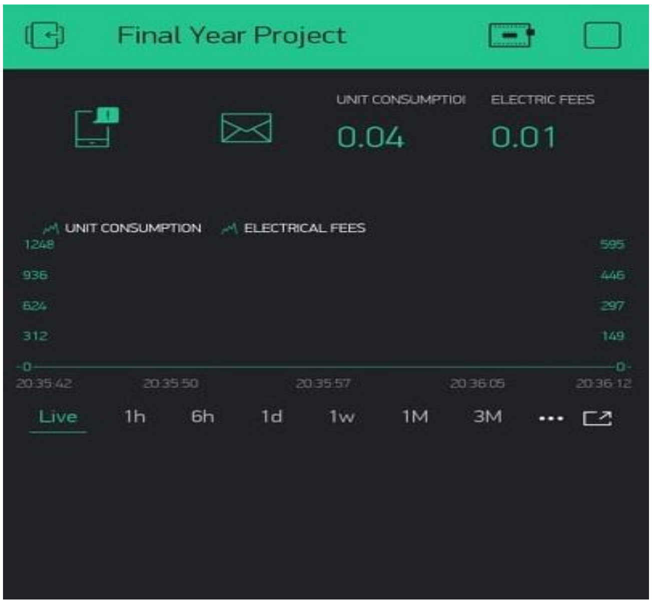

Fig. 8. Blynk's GUI

The graph is used to display the power usage pattern of a student. The right hand side of the top part is used to display the unit consumption and electric fees. However, the other side of the top part is used to notify the student about the unit consumption and electric fees used by student. The notification will be sent to the mobile phone and the email will be sent to the registered email as well.

VI. Testing of the Proposed Design

The testing of the proposed design for this system contains 3 sets. First set results are tested by using different students' ID card to test this system. For the students' ID cards, it will display the result at the serial monitor. Meanwhile, for the other cards, it will display another result at the serial monitor. In this test, it is using 3 students' ID cards and other card for this testing.

TABLE I. Different Cards for Testing Purpose

Students' ID cards	Other Card
Gee Kai Yii, TP041881	Normal Card with RFID chipset
Khor Qi Bin, TP042729	Debit Card
Allen Sia Shun Yang, TP041875	

In this testing, there are 5 cards used to check whether the system can work with other card or only work with the students' ID card. The testing results will be shown as Fig 9, 10, 11, 12 and 13.

Fig. 9. Gee Kai Yii's student's ID card results

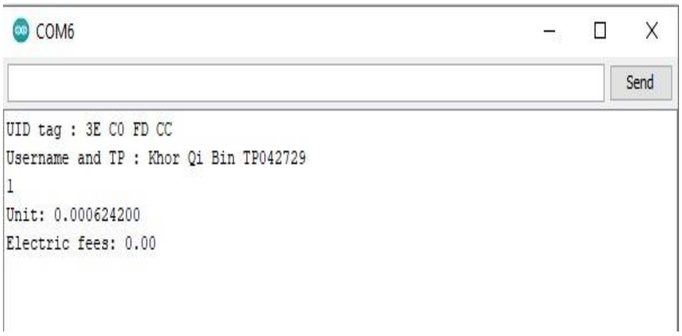

Fig. 10. Khor Qi Bin's student's ID card results

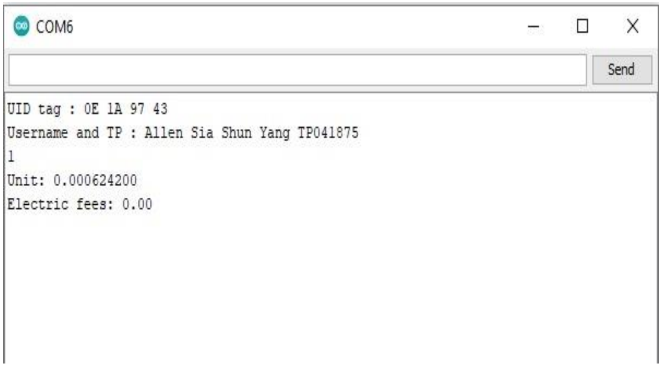

Fig. 11. Allen Sia Shun Yang's student's ID card results

Fig. 12. Debit card results

Fig. 13. Normal card results

For all the students' ID card is successfully turn on the system and execute the system when the students' ID card is inserted into the switch. This is because all the students have been registered and their student's ID card is activated in this system. For the other cards which are normal card and debit card, they unable to be used in this system and unable to turn on the power. For the debit card, it does not consist of RFID chipset inside the card. Thus, the RFID reader cannot read it and cause it unable to turn on the power.

Although the normal card consists of RFID chipset, the unauthorized person is detected by the RFID reader. The warning message keep popped out at the serial monitor.

The second testing is using the different types of load to test this system. The result of this testing will be compared with the calculated results and calculated the accuracy of the results. The table below shows the time consumed for the loads to have one pulse.

TABLE II. TIME FOR THE LOADS TO HAVE ONE PULSE

Types of Load	Time to have one pulse (s)
40W bulb	53
58W standing fan	51
40W bulb and 58W standing fan	27

The formula to calculate the time to achieve the 1000W is shown as below.

$$Time = (Time\ for\ one\ pulse \times pulse\ rate)/3600 \quad (1)$$

TABLE III. TIME FOR THE LOADS TO ACHIEVE 1000W

Types of Load	Time to achieve 1000W(h)
40W bulb	23.5
58W standing fan	22.67
40W bulb and 58W standing fan	12

The theoretical result and experimental result will be tabulated and calculated percentage error.

TABLE IV. COMPARISON BETWEEN THE THEORETICAL RESULT AND EXPERIMENTAL RESULT

Types of Load	Theoretical Result (h)	Experimental Result (h)	Percentage Error (%)
40W bulb	25	23.5	-6%
58W standing fan	17.24	22.67	31.5%
40W bulb and 58W standing fan	10.2	12	15%

Based on Table IV, the percentage error is much higher. This is because the result recording can be caused by human error. When the LED calibrated is light up, the person who record the reading needs some time to react and makes the time is not accurate.

VII. CONCLUSION

The energy saving card system is used to turn on the power by using the student ID card. The IoT is used to store the data and retrieve the data from IoT platform. The smart meter system is used to calculate the energy consumption used by students. The methodology includes how this works and some calculations which related to this project. Besides, the GUI for data retrieving has been built and proposed in this project.

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