SMART LIGHTING SYSTEM

HENRIETTA HETTY HENRY
Universiti Teknologi Malaysia
henrietta@graduate.utm.my

MUHAMMAD 'ADLAN BIN ANUAR
Universiti Teknologi Malaysia
madlan7@graduate.utm.my

AHMAD NAJWAN BIN AHMAD RIZAM
Universiti Teknologi Malaysia
ahmadnajwan@graduate.utm.my

AHMAD ZIDAN FIRMANSYAH
Universiti Teknologi Malaysia
zidanfirmansyah@graduate.utm.my

Abstract:

Smart lighting system is one of the technologically practical systems that can be applied in your home. In order to save energy, this system is introduced because it can be achieved by implementing energy-efficient technologies, using renewable energy sources, and implementing energy conservation measures. The use of advanced technology, such as IoT, AI, and machine learning, can help to optimize energy consumption and production. This can improve the reliability and resiliency of the energy systems and minimize the energy costs. Based on the findings through surveys, the respondents choose the light to be automatically turned off when not in use and the implementation of solar energy for their home. In this modern era, the use of renewable energy resources is common in order to conserve energy. They prefer a system that can control lighting from afar and can receive notifications from phones. This is because the integration of Internet Of Things(IOT) will overcome simple problems that will occur in daily life. Most of our target users are family people and paying their own electricity bills. In the end, we hope that our prototype system will help people save cost and time, lessen burden, and have more pleasant conditions to increase their efficiency of life.

Keywords: Smart Lighting, Energy Conservation, Internet Of Things, Solar energy, Control Lighting

1.0. Introduction

Smart lighting system refers to a type of lighting system that utilizes solar power to run and is connected to a network allowing for remote control and automation. This system has been controlled by Arduino Uno. There are three features that users will get from this project, first is motion detection. For this part, a PIR motion sensor has been used and placed beside the light. The light has been programmed to automatically turn on and off based on movement detection. Next, there will be no interruptions occurs for this system because it consists of two power supplies which are a battery-powered by solar and a direct dc supply. Finally, Blynk application have been integrated into this system as IoT technology that offers automation, energy efficiency, and convenience for users. Users will get alert notifications and be able to control their lighting from their smartphones.

1.1 Data collection clustering.

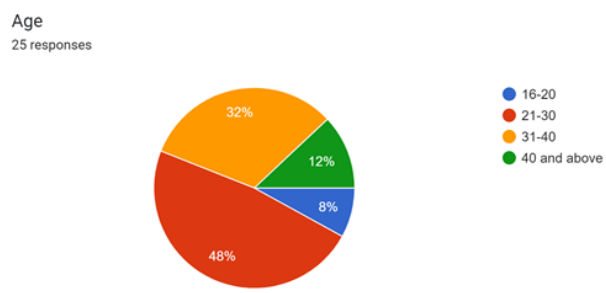


Figure 1.1: Gender.

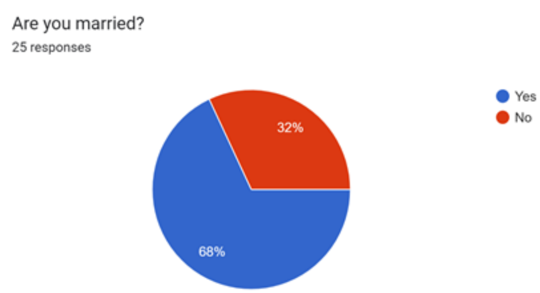


Figure 1.2: Age.

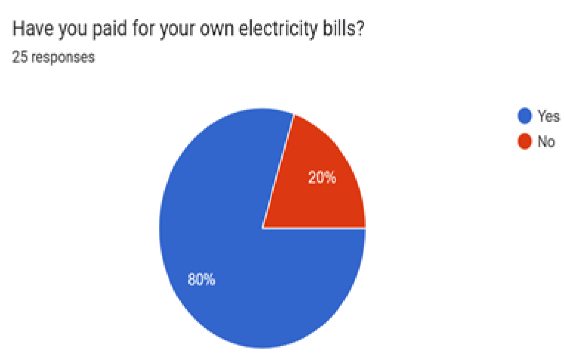


Figure 1.3: Paid electricity bills

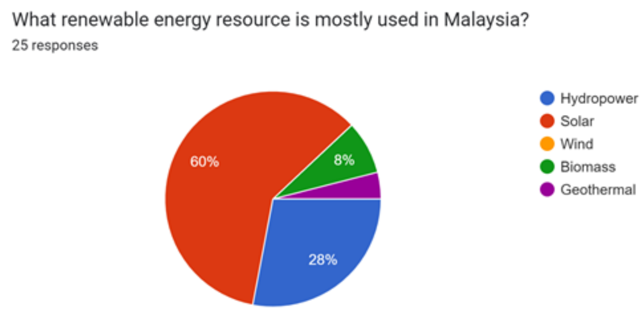


Figure 1.4: Renewable energy resources in Malaysia

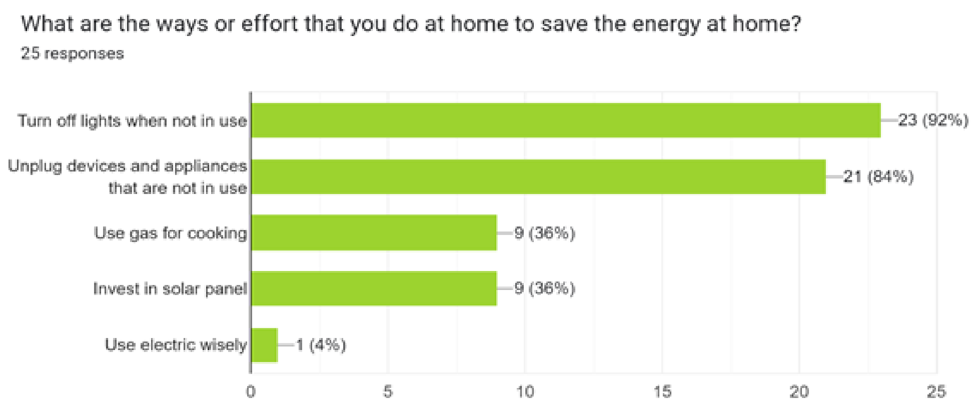


Figure 1.5: Ways to conserve energy at home.

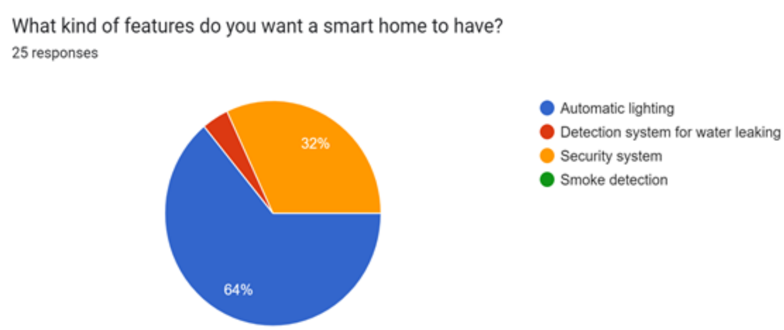


Figure 1.6: Features of the smart home.

The data collection was conducted through a google form that has been distributed among the people that are interested in having a smart home in the future with a total of 10 questionnaires. These questionnaires are divided into 3 parts: personal life, general knowledge of energy resources, and general knowledge of solar energy and smart home. Based on the pie chart above, the majority of people range between 21 to 40, they are family people and pay the electricity bills as a perspective for personal life. Moreover, for the knowledge of energy resources, we can see that about 60% answered solar as the energy source that is mostly used in Malaysia, and in order to save energy, most of them will turn off lights when not in use. The last part is about smart homes and solar energy. For this part, most of the respondents choose to have automatic lighting as a feature if they own a smart home which is about 64%.

1.2 Needs.

- The system is able to conserve energy, especially for lighting.
- Lights are able to automatically turn on and off.
- Systems that can control the lighting through smartphones & receive alert notifications.

1.3 Design statements.

How can we help BigHero to save electricity bills while utilizing the energy resources without affecting their family's well-being?

2.0 Project Planning.

The initial task of this project is to make a survey with the 10 questionnaires provided. We did this survey through google Forms among the people who are interested in the smart home. Based on their responses, we can see what are their desired features that they want if they own a smart home in the future. After we finished collecting data, we brainstormed to generate some ideas that related to the survey. From this, we combine all of our ideas and make an analysis to get a good output or good product that we are going to create. Next, we distributed tasks to the four of us and divided them into two parts which are coding and hardware. For this project, finding the right components is difficult because of the budget that was given to us only RM300. Based on the bill of the material in Figure 2.2, the total for all components already exceeds RM300 due to the delivery charge for some components that we bought through Shoppee. Last but not least, the project flow or schedule for this project is presented in the Gantt Chart above.

2.1 Conceptual design prototype.

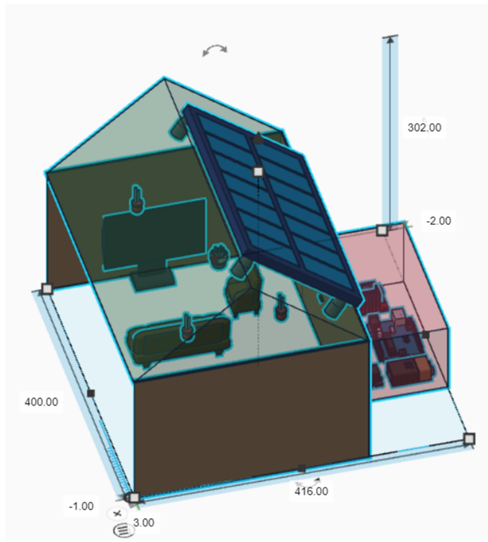


Figure 2.1: Conceptual design prototype.

2.2 Bill of Material.

NO	COMPONENT	Estimated Cost		
		Unit Price (RM)	**Qty.**	**Subtotal (RM)**
1	Arduino UNO Wi-Fi based (ESP8266)	25.00	1	25.00
2	USB Micro B	4.00	1	4.00
3	PIR Motion Sensor (HC SR 501)	5.90	2	Total =16.70 (Delivery = 4.90)
4	Relay Module 12V (1 way)	4.90	2	Total = 30.50 (Delivery = 4.90)
	Relay Module 12V (2 way)	7.90	2	
5	Wire Jumper • Male to female • Female to male	4.50 2.00	4	13.00
6	Plastic Board	8.90	2	17.80
7	Power Led 3W	7.90	3	Total = 28.60 (Delivery = 4.90)
8	Solar Charge Controller 30A	29.90	1	Total = 74.30 (Delivery = 4.90)
9	Solar Panel 12V 420Ma 5W	39.50	1	
10	Power Supply 12V 1A	46.90	1	Total = 51.80 (Delivery = 4.90)
11	Cable 1.0mm	3.00	4	12.00
12	Cable leg	0.40	2	0.80
13	Connector battery	0.40	4	2.00
14	Cable lug	0.40	4	0.40
15	Wi-Fi Module ESP8266	13.50	1	13.50
TOTAL			1. Buy by ourselves 267.33 2. Cytron 38.00	= 308.13

Table 2.1: Table bill of materials.

2.2 : Gannt Chart

No	Tasks	Start Slot	End Slot	Capstone Slot 5	6	7	8	9	10	11	12	13	14
1	Build conceptual prototype	5	5	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
2	Presentation of conceptual prototype	5	5	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
3	Individual Report 1	5	5	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
4	Survey component needed	6	6	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐
5	Finalised and purchased materials	6	6	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐
6	Start doing software	6	9	☐	☑	☑	☑	☑	☐	☐	☐	☐	☐
7	Troubleshoot and modify the code	9	12	☐	☐	☐	☐	☑	☑	☑	☑	☐	☐
8	Individual Report 2	8	8	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐
9	Build prototype	12	13	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐
10	Presentation of prototype	13	13	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐
11	Individual Report 3	13	13	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐
12	Technical Report submission	13	14	☐	☐	☐	☐	☐	☐	☐	☐	☑	☑

Table 2.2: Gantt Chart for the whole project flow.

3.0 Engineering Design

a) Block diagram

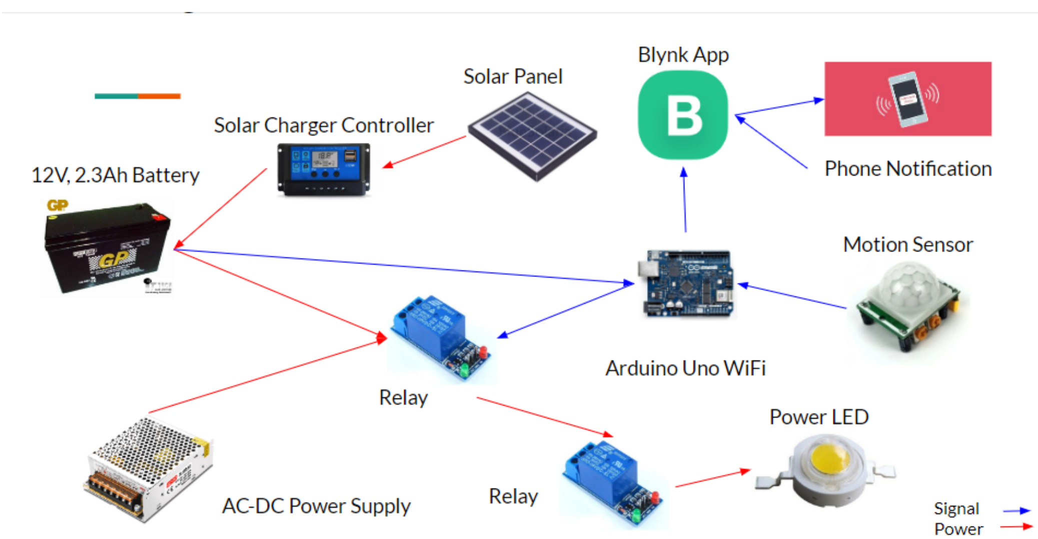


Figure 3.1: Block diagram of overall system.

b) Flowchart

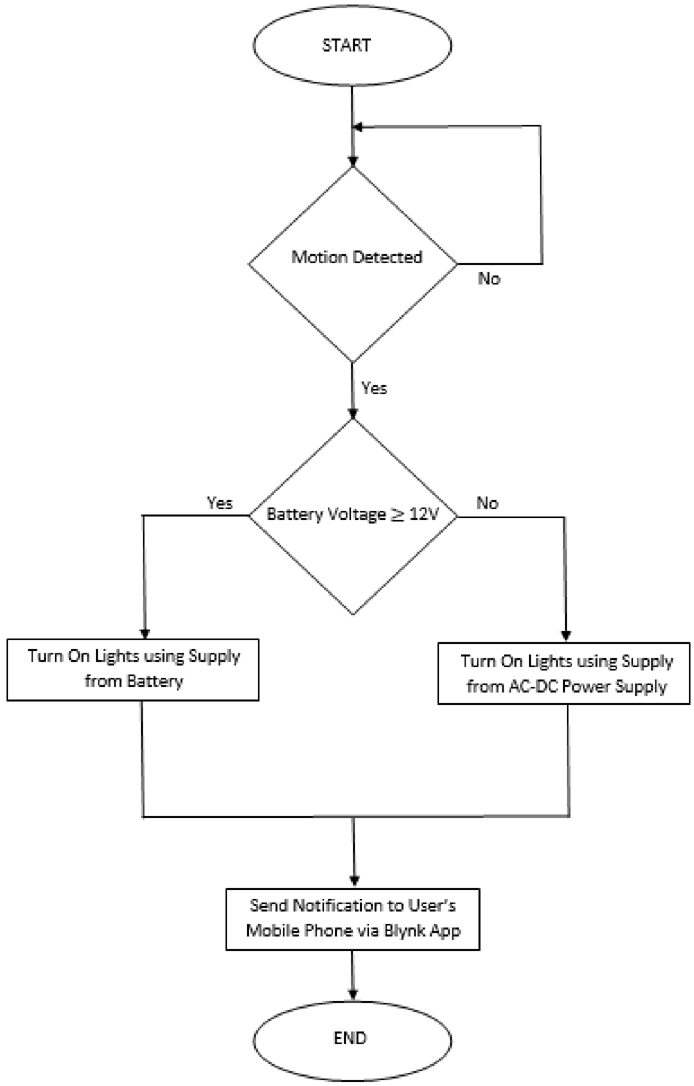


Figure 3.2: Flowchart of overall system

c) Programming

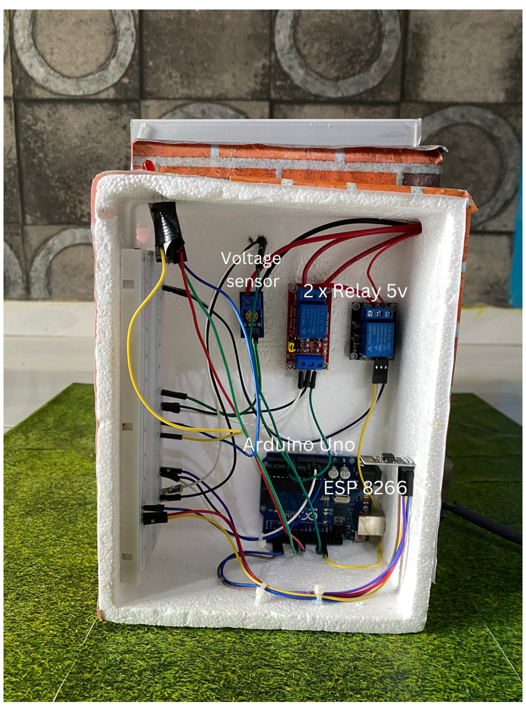
```
#define BLYNK_TEMPLATE_ID "TMPLvXLStkl_"
#define BLYNK_DEVICE_NAME "Lighting"
#define BLYNK_AUTH_TOKEN "tKFe3ZUn_-x9NiJiJAoCeiJVJaSizSoy"

#define BLYNK_PRINT Serial
#include <ESP8266_Lib.h>
#include <BlynkSimpleShieldEsp8266.h>

char auth[] = BLYNK_AUTH_TOKEN;
char ssid[] = "henrie.xo"; //hotspot name
char pass[] = "7175henriexo"; //hotspot password

#include <SoftwareSerial.h> //Software Serial on Uno
SoftwareSerial EspSerial(3, 2); // RX, TX pin

#define ESP8266_BAUD 9600 //ESP8266 baud rate

ESP8266 wifi(&EspSerial);

const int RELAY_PIN_1 = A1; //Relay Pin
const int RELAY_PIN_2 = 13;
const int analogPin = A0; //Battery Pin
int offset =20;
const int PIN_TO_SENSOR = 12;   // the pin that OUTPUT pin of sensor is connected to
const int led_1 = 7;
const int led_2 = 8;
int pinStateCurrent   = LOW; // current state of pin
int pinStatePrevious  = LOW; // previous state of pin
float analogValue;
float input_voltage;

BLYNK_WRITE(V13)
{
 int pinvalue=param.asInt();
```

```
 digitalWrite(13, pinvalue);
 }

void setup() {
  Serial.begin(115200);    // initialize serial
  EspSerial.begin(ESP8266_BAUD);
  delay(10);

  Blynk.begin(auth, wifi, ssid, pass, "blynk.cloud", 80);

  pinMode(PIN_TO_SENSOR, INPUT);
  pinMode(RELAY_PIN_1, OUTPUT);
  pinMode(RELAY_PIN_2, OUTPUT);
  pinMode(led_1, OUTPUT);
  pinMode(led_2, OUTPUT);
}

void loop() {
  Blynk.run();
  pinStatePrevious = pinStateCurrent; // store old state
  pinStateCurrent = digitalRead(PIN_TO_SENSOR);   // read new state
  int volt = analogRead(A0); //read the A0 pin value
  double voltage = map(volt,0,1023, 0, 2500) + offset;
  voltage /=100;
  if (pinStatePrevious == LOW && pinStateCurrent == HIGH) {   // pin state change: LOW -> HIGH
    Serial.println("Motion detected!");
    if (voltage > 12.3) {
      digitalWrite(RELAY_PIN_1, HIGH);
      Serial.print("Using Battery");
      digitalWrite(RELAY_PIN_2, HIGH);
      digitalWrite(led_2, HIGH);
      Blynk.logEvent ("motion_alert", "Living room lights are turned on!");
    }
    else {
      digitalWrite(RELAY_PIN_1, LOW);
```

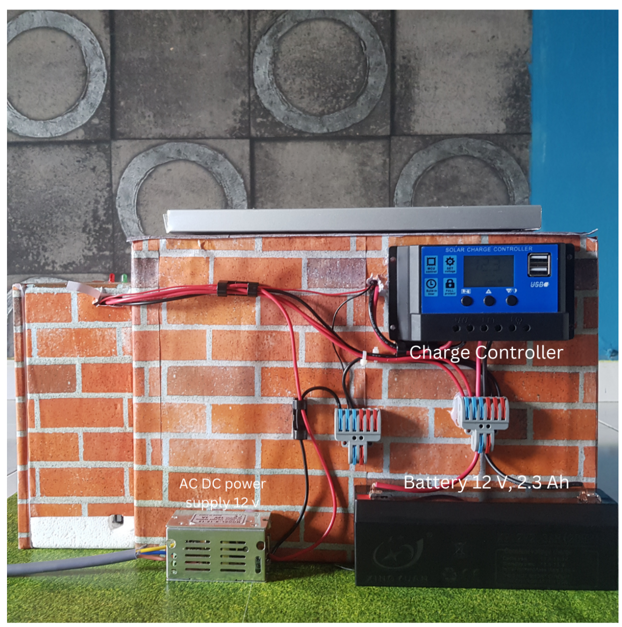
```
      Serial.print("Using Power Supply");
      digitalWrite(RELAY_PIN_2, HIGH);
      digitalWrite(led_1, HIGH);
      Blynk.logEvent ("motion_alert", "Living room lights are turned on!");
    }
  }
  else
  if (pinStatePrevious == HIGH && pinStateCurrent == LOW) {   // pin state change: HIGH -> LOW
    Serial.println("Motion stopped!");
    digitalWrite(RELAY_PIN_1, LOW);
    digitalWrite(RELAY_PIN_2, LOW);
    digitalWrite(led_1, LOW);
    digitalWrite(led_2, LOW);
  }
}
```

4.0 Product Realisation

a) Hardware



(a)



(b)

(c) (d)

Figure 4.1 (a) Inside the control room, (b) Backside the house, (c) Upside the house, (d) Frontside the house

The hardware component listed in Figure 4.1 is further discussed in this section.

1. Solar Panel

Allows the device to charge using solar energy.

2. Voltage sensor

Allows the system to read the capacity of the battery periodically by measuring the voltage level of the battery.

3. LED indication

LED indicators for indicating if the system is using the battery when turning red and turning to green when using an AC-DC power supply.

4. ESP 8266

Allows the system to connect to Wi-Fi.

5. 5v Relay

The connector between two power supplies, and able to switch when receiving the signal from Arduino UNO.

6. 12v Lithium battery

Store power from the solar panel.

7. AC-DC Power supply

Converts power from AC 220v into DC 12v and then acts as a power supply.

8. Arduino UNO

The main controller of the system, and able to store programs from the users.

9. PIR Motion Sensor

Sensing the motion of the users.

10. 12v LED Bulb

Act as a load of our system.

b) Software

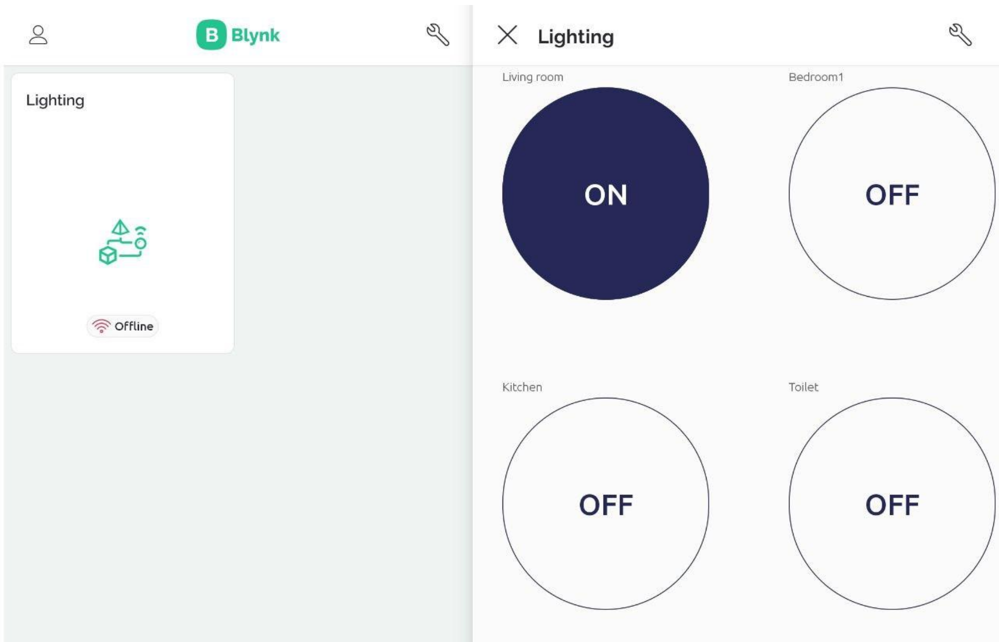


Figure 4.2 Interface of the *Blynk* app

From figure 4.2 we are able to see the full interface of our IOT enablement application, by using *Blynk*. There are several buttons that are able to control the load, just by pushing on/off from the app.

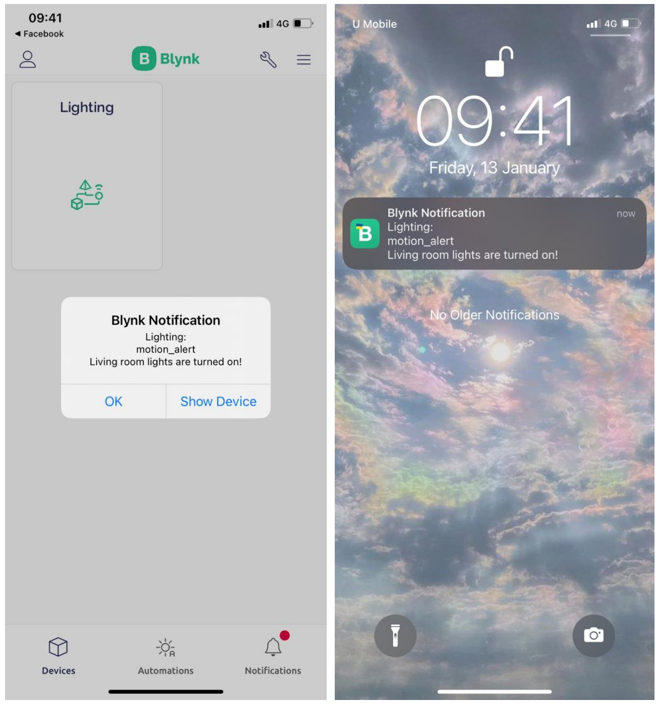


Figure 4.3 Notification from *Blynk* app

Figure 4.3 shows when the *Blynk* receives a push notification from the system through the connection between ESP 8266 and the user's device.

5.0. Results and Discussions

The features created for this project are successful in satisfying the needs of the user in a satisfactory way. The first end user's need is a system that is able to conserve energy and this is achieved by using renewable energy resources which is solar energy. In this project, we used a solar panel to absorb light energy which is converted to electrical energy and charge the battery. Besides that, we use two power sources in order to save energy and use that energy efficently. The light will use supply from the battery when the battery's voltage is above 12V, and a power supply from the utility company when it's below 12V. In addition, a voltage sensor and relay are used to switch between supplies from the battery or AC-DC power supply. Next, the end user's need is that they want the light that is able to automatically turn on and off. This is also achieved by using passive infrared sensors (PIR) where this sensor is able detect motion of everything that emits IR radiation, such as humans. This sensor is used to give a signal to the microcontroller to control the power LED. Hence, when a user enters their room or living room, the sensor will detect the motion and switch on the light. Moreover, the utilization of the energy will be efficient. Lastly, systems that are able to control lighting through smartphones and receive alert notifications is the last end user's need. This need is completed when users are able to turn on and off the lights from the Blynk application. From this, we will use a Wi-Fi module which is Internet of Things (IOT) integrated, enables us to control the switches from far using Blynk apps and receives notifications when the PIR sensor detects the motion.

This table show us the calculation on how long does it takes for battery to recharged and how long Power LEDs Turn on:

How Long Battery Recharged ?	How Long Power LEDs Turn on ?
Battery 12V, 2.3 AH : 12V x 2.3 AH = 27.6 VAH Solar Panel 12V,5W : 27.6VAH÷5W = 5.52 hours	Power LED 3W: 3W x 1 power Led = 3 W 27.6VAH÷3W = 9.2 hours

Table 5.0: Duration of the battery to fully charge and last.

From this table, we can conclude that it takes 5.52 hours of battery to fully charge and the power LED can stay on up until 9.2 hours long.

5.1. S.T.E.E.P Analysis

Social ● Improve awareness and understanding on energy usage ● It is reasonable, communities now able to choose to live off the grid ● Lifestyle changes
Technology ● Smart Home Automation is technologically simple but efficient ● New invention and development
Economic ● Lower your electricity bills ● Helping in emergency
Environmental ● Use far less electricity, therefore produce less waste ● Improve air quality by reducing greenhouse gas emissions
Politic/Legal ● Encourage the government to focus on issues related to technology that can save energy. ● Encourage government to adding innovative courses from low level education to high level.

Table 5.1 : S.T.E.E.P Analysis

Conclusion

In conclusion, our "Smart Lighting System" project has been a success in demonstrating the capabilities and benefits of integrating smart technology into lighting systems. The system we have developed allows for remote control through the implementation of the Internet of Things (IoT) via the Blynk application and improved convenience and safety through the use of motion sensors. Not only that, electricity bills will be reduced by utilizing solar energy and using power sources from the charged battery through a solar panel instead of the utility company. We believe that this technology has the potential to revolutionize the way we think about lighting and energy management in both residential and commercial settings. Overall, we are proud of the work we have accomplished and are excited to see the continued development and implementation of smart lighting systems in the future.

Acknowledgment

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