Solar Powered Light Automation System Using Wireless Multi-controlled Switches

Noli Mark A. Paala, Rich Jorald M. Sabar, Mary Antonete D. Mortel, Couline A. Fadriquelan, and Klyssa F. Saulong
John Paul College, Philippines
Email: nolimark_paala@yahoo.com

***Abstract*—The study was developed to minimize the time consumed in turning on/off and in monitoring light bulbs in the school through the use of Android phone, LDR and Computer. It also aimed to minimize the power consumption through the use of solar energy. In this paper, it also focused on the collaboration of Bluetooth technology and Computer-Based System as tools in creating automation. It used hardware such as Arduino Mega microcontroller, HC-06 Bluetooth Module, Light Dependent Resistor, solar panel, Solar Charge Controller (SCC), DC-AC Inverter, 12V 60 Ampere-hour lead acid rechargeable battery, 24 light bulbs, relay module, manual switch buttons, Android phone and a computer. Using an Android phone, the light bulbs can be controlled using Android Light Saver App made from MIT App Inventor. This app requires an username and password before use. It can be used by tapping the on and off command in each light or using voice command. The Light Controller System installed in the computer was made from Microsoft Visual Studio with C# programming language. It has light switching control, timer, voice control, scheduler and alarm. Using Light Dependent Resistor, the light bulbs can automatically turned on or off when it is already night and day time. Light bulbs can also operated manually.**

***Index Terms*—Arduino, light automation, Android App, solar powered lights, LDR**

I. Introduction

Solar Powered Light Automation System Using Multi-Controlled Communication Switches was developed to give an easier way of accessing the lighting system with the use of solar power energy and Arduino Mega. The above mentioned project used Light Dependent Resistor to let the lights turn on and off at night time and daytime. The study of A. Jalan *et al.* (2017) [1] and R. Dunning *et al.* (2017) [2] in using LDR and PIR sensor was considered. Hard times of going back and forth to monitor and do the lightings will no longer be a problem. This project can be operated manually if desired by turning on and off the switches of the lights. It also has Light Controller System, a real time system that was developed in Visual Studio C# that can be set in desired time but the best of all is it has a voice command or a speech recognition system that can access the light system. Moreover, it has database in monitoring the switching of lights. Users can also set a scheduled time and date of operation. The researchers also created an Android application that can control and access the lights via Bluetooth connection. Therefore, it can easily communicate to the lighting system with no efforts and just one click at a time. The project provides mobility options and remote command executions to create a better access and efficient control to the system. This lighting system using C#, Bluetooth and LDR based will centralized the lights operation.

II. Materials

The project was developed using software and hardware requirements. The software requirements were the following: Arduino Integrated Development Environment (IDE), Google Sketch Up, Visual Studio 2013, Virtual Serial Port Emulator, App Inventor and Processing IDE. Hardware requirements were the following: Arduino Mega microcontroller, Light Bulbs, Relay Modules, Lead Acid Battery, Solar Panel, Solar Charge Controller, 2-way Switches, DC-AC Inverter, Light Dependent Resistor (LDR), Computer, HC-06 Bluetooth Module and Android phone. Arduino Mega microcontroller was used to control the hardware connected to it. Solar panel with 1000 volts maximum system voltage was used to accumulate solar energy to be converted to electricity. 12v Lead acid battery with 60Ah stored the electricity came from solar panel. Relay modules switched the light bulbs when the switch is triggered. DC-AC Inverter converted the Direct Current (DC) from the battery to Alternating Current (AC). Solar charge controller used to control the power going into the battery from the solar panel. According to Galita, W.M. (2015) [3], solar energy can be used in various different ways, making it very versatile. It can be used for both domestic and the industrial purposes. Light Dependent Resistor detected the dimness and brightness of the environment. The value of dimness or brightness is programmed according to the response of the light bulbs. Bluetooth module was implemented to have wireless serial communication between the Android phone and Arduino Mega. It was used to switch the light bulbs using the Android phone with installed Android Light Saver app. The application is protected by a password. Computer or laptop with installed Light System made from C# language controlled the light bulbs through voice

Manuscript received April 28, 2019; revised October 25, 2019.

doi: 10.18178/ijeee.7.4.83-86

command, scheduler and button switching. The system is also protected by a password to ensure the light and power usage security. The position of light bulbs in the schools were indicated as shown in Fig. 1.

III. Methods and Results

The methods used in the development of the project were: project design, project construction and project testing. In project design, the position of light bulbs in the school were determined. The light bulbs outside in the room were drawn using Google Sketch up software. The project construction were divided into two: 1) hardware and electrical construction 2) System development. In project testing, all the installed components and program made were tested. The physical view of the project was observed in Fig. 2.

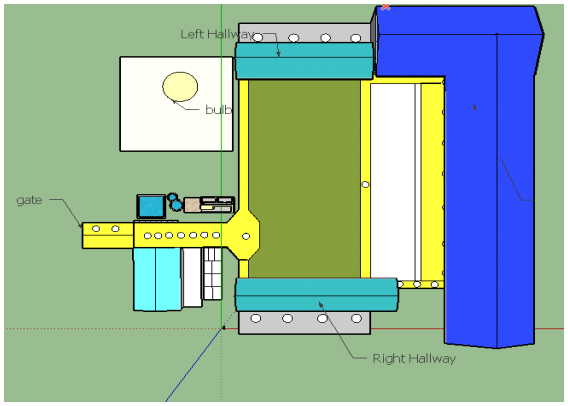

Figure 1. Position of outdoor light bulbs in the schools indicated by white circle.

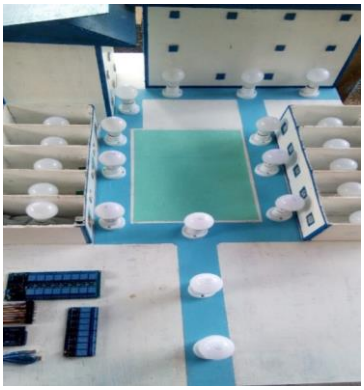

Figure 2. Physical view of the project.

A. Bluetooth Test

The maximum range of HC-06 Bluetooth module connection were tested. By using tape measure, the Android Application has run/launch and started measuring the wireless range connection from 1m up to 5m while controlling the light bulbs. If it is still responded to the command from Android phone, then the measuring process will add another 5m. If the project and the App are not responding, then the connection has exceeded its limit and it means that it reaches the maximum range of Bluetooth wireless Connection. Then the wireless range of Bluetooth module is limited only in 10 meters.

B. Battery Test

The power supply of the project by using a 12 volts lead acid rechargeable battery was tested. Before testing, the battery charge is full. The project were continuously used for one hour. After one hour, the capacity or voltage reduction of the battery was tested using solar charge controller display. If DC to AC inverter trigger a long sound and the solar charge controller battery bar is empty and the battery value is 9.04 volts, it means that it reaches the critical level of the battery or the battery is already low. The connection of solar power supply was observed in the study of A. B. Abdullah (2008) [4].

C. Solar Panel and Solar Charge Controller Test

Solar panel is tested at 1 hour with the devices Solar Panel, Solar Charge Controller, Battery. The actual connection was shown in Fig. 3. Due to Solar Charge Controller has a display on its LCD, it shows when the solar panel is giving power to the battery. If the arrow of the Solar Panel logo going to the Battery Logo has stop blinking, then the charging process is completed. Therefore, the researchers conclude that the solar panel is working.

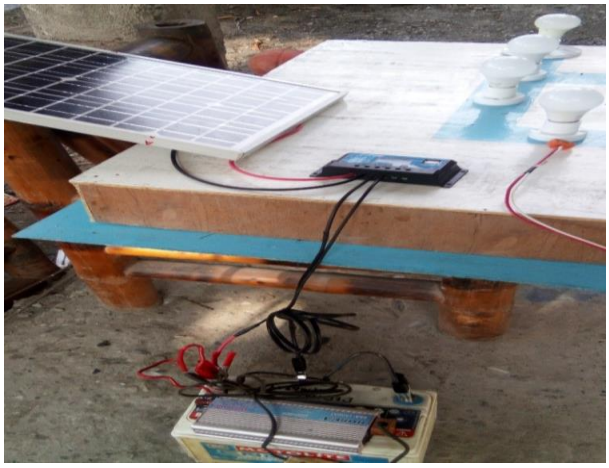

Figure 3. Solar panel and solar charge controller test.

D. Power Consumption Test

Using the 24 light bulbs of the project, the researchers test the amount of energy used and remain the lights turn on until it reaches the 1 kilowatt/hour of the electric meter in a typical residential house. After the test, the result it is when after 27 mins. The light bulbs used is *17 pcs of 7 watts and 7pcs. of 5 watts*. Calculating the wattage of the mention bulbs is total of 154 watts.

Convert to watt per hour

(1) Wattage of bulbs x one hour usage = watts per hour

Multiplying 154 watts' x 1 hour = 154 watts per hour

Electricity is measure in kilowatt hours on electricity bill. Since that 1 kilowatt is equal to 1000 watts, calculating how many kWh a particular device uses is as easy as dividing by 1000.

Convert to watt per kilowatt hour

(2) 154 watts per hour / 1000 watts = 0.154 kWh

Figuring out the cost

(3) 0.154 kWh x 13.00 Pesos per kilo watt hour (given by electricity provider) = 2.00 pesos per kWh

Using the project, it was cost free in terms of Electrical bill. Using one lead acid battery while turning on of 24 light bulbs, the discharging time process takes up to 8 hours to become the battery at low charge corresponding to solar panel is not so much expose to the sun. The study of A. Jalan *et al.* (2017) [1] in calculating the power consumption was considered. The circuit diagram of the project was indicated in the Fig. 4.

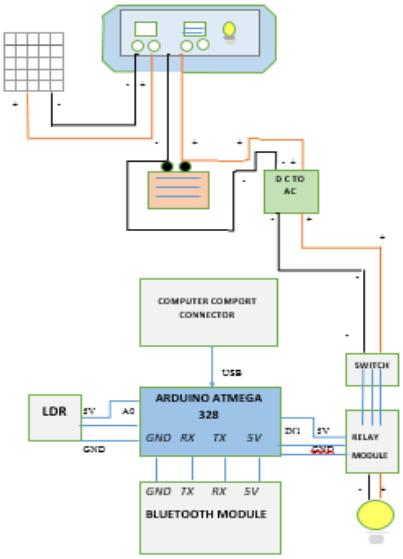

Figure 4. Circuit diagram.

IV. Discussion

The project has wireless multi-controlled switches because the light bulbs can be switched on and off by tapping the command buttons and voice commands on Android phone, setting a timer on the Light Controller System, Light Scheduler, Voice Control and clicking the command buttons. The process flow chart was shown in Fig. 5. Android phone and computer are required to connect in Bluetooth to control the light bulbs wirelessly. Each incoming and outgoing command is stored in the database and can generate a printable form for the record and monitoring system. The application in the Android phone was shown in Fig. 6. It has Voice control and control buttons.

In Light Controller System, Home Form shows the title of the system and it has the button to connect the serial port communication settings that enables the application to connect into the hardware. The Light Form shows the real time buttons that is used to switch on/off the lights. The Voice Control Form shows enable and disable of voice command which can directly control the lights with the exact control of command to turn on/off the light. The Timer Form shows to set the desired time of the user and when the timer is equal to the present time, the light bulb will automatically turn on/off. The Calendar Form shows the current date. The Alarm Form shows the alarm system that will trigger and inform the user. The Scheduler Form shows the time, day, and the room to be set. The Settings Form shows the layout that can set the existing name of room when the user set new name it will automatically set the entire room name. All forms were shown in Fig. 7. It can also be used using manual buttons. Using LDR, it turned on or off the light bulbs automatically when it was already night time or daytime. This concept was observed in the study of M. Revathy *et al.* (2017) [5].

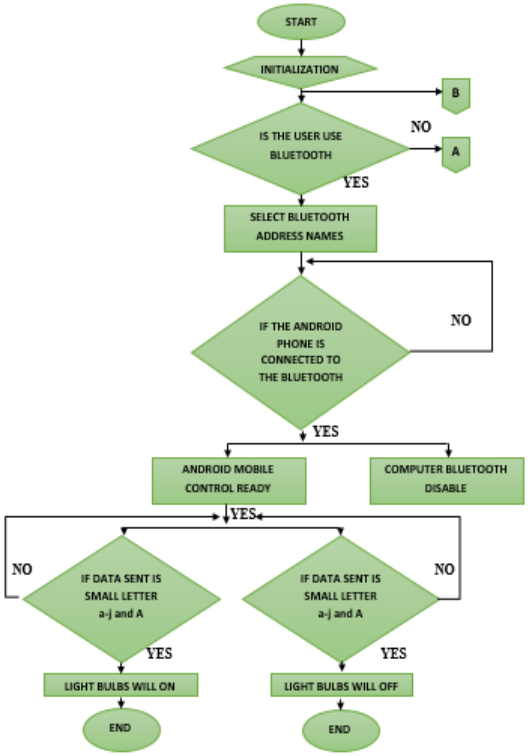

Figure 5. Process flow chart of Bluetooth connection.

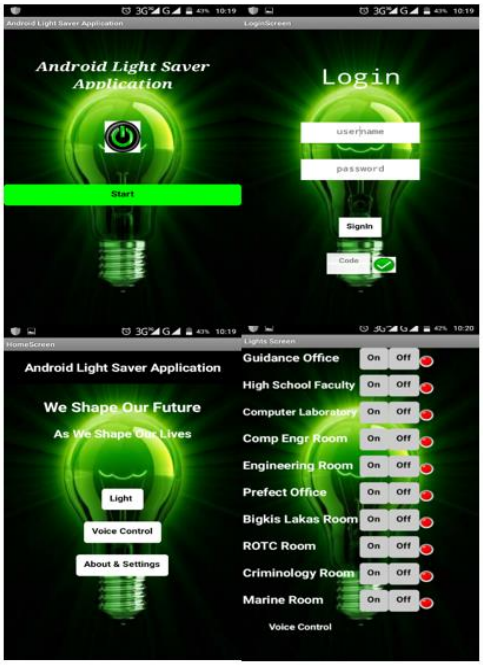

Figure 6. Android light saver app developed in MIT app inventor.

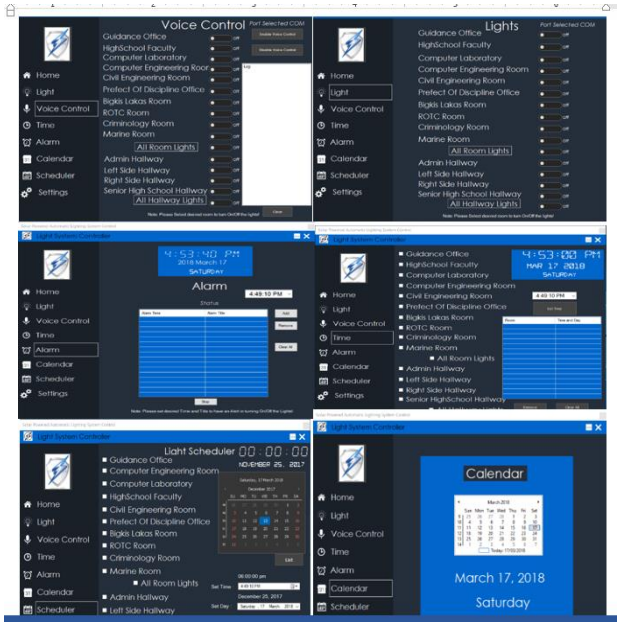

Figure 7. Light controller system made in Microsoft visual studio.

In terms of power consumption, the project was more economical compared to the other electricity source because it can only consumed 0.154 kWh with 24 light bulbs continuously turned on. Assumed that means that using the electricity that can lasts up to 8 hours without so much expose to the sun, the electric bill computed to 16 pesos. It can lessen the expense in electric bill.

Further studies and test should be done to expand the functions and capabilities of the project so as to further add additional features to the existing prototype.

V. Conclusion

The prototype project minimized the time consume in turning on/off and monitoring of light bulbs in the school through the use of Android phone and Light Controller System.

It can reduce the electrical wastage of the school in light operations using solar power. This project implemented the wireless multi-controlled switches depending to the demand or need of the user.

Acknowledgment

The authors gratefully acknowledge the contributions of Sir O. Galicia, S.M. Dino Lainez and Dr. M. Cantos for the financial support for this work and providing all the facilities to finish this project.

References

[1] A. Jalan, G. Hoge, S. Banaitkar, and S. Adam, "Campus automation using arduino," *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering*, vol. 6, no. 6, June 2017.

[2] R. Dunning, *et al.*, "Automated lighting system for park pathways," in *Proc. Systems and Information Engineering Design Symposium*, June 2017.

[3] W. M. Galita, "Development of a smart solar-powered LED street lighting system for greener community," *Open Access Library Journal*, vol. 2, p. e1291, 2015.

[4] A. B. Abdullah. (November 2008). Portable Solar Street Lamp. Universiti Malaysia Pahang. [Online]. Available: http://umpir.ump.edu.my/100/1/cd3185.pdf

[5] M. Revathy, S. Ramya, R. Sathiyavathi, B. Bharathi, and V. M. Anu, "Automation of street light for smart city," in *Proc. International Conference on Communication and Signal Processing*, Chennai, 2017, pp. 0918-0922.

Noli Mark A. Paala was born in Labasan, Bongabong, Oriental Mindoro on November 21, 1992. He graduated Bachelor of Science in Computer Engineering at Mindoro State College of Agriculture and Technology Bongabong Campus, Philippines on 2014.
Currently, he is a professor in John Paul College at Odiong, Roxas, Oriental Mindoro. He is also taking Master of Engineering in Computer Engineering at Technological Institute of the Philippines-Manila.
He was also the Champion in Science Investigatory Project-Robotics Research in National Science and Technology Fair 2015.

Rich Jorald M. Sabar was born in San Aquilino, Roxas, Oriental Mindoro on May 10, 1995. He graduated Bachelor of Science in Computer Engineering at John Paul College, Philippines on 2018.
Currently, he is a professor in John Paul College at Odiong, Roxas, Oriental Mindoro.

Mary Antonete D. Mortel was born in Bucana, El Nido Palawan on September 6, 1996. She graduated Bachelor of Science in Computer Engineering at John Paul College, Philippines on 2018.
Currently, she is a professor in John Paul College at Odiong, Roxas, Oriental Mindoro.

Couline A. Fadriquelan was born in Odiong Roxas Oriental Mindoro on July 24, 1996. She graduated Bachelor of Science in Computer Engineering at John Paul College, Philippines on 2018.
Currently, she is a professor in John Paul College at Odiong, Roxas, Oriental Mindoro.

Klyssa F. Saulong was born in Labonan, Bongabong, Oriental Mindoro on June 28, 1996. She graduated Bachelor of Science in Computer Engineering at John Paul College, Philippines on 2018. Currently, she is a professor in John Paul College at Odiong, Roxas, Oriental Mindoro.