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Designing of Lighting Automation System Based on Arduino Bluetooth Interface using Android Smartphone as Platform

NARCISA T. MORALLO
http://orcid.org 0000-0002-5468-9179
narcisamorallo@gmail.com
Negros Oriental State University
Dumaguete City, Philippines

ABSTRACT

Bluetooth is now mainstream that it has become synonymous with the 21st century. The wireless technology allows exchanging data over short distance using short wavelength radio transmission, providing convenience, intelligence and controllability. In this paper, a home lighting control system using arduino bluetooth interface with android smartphone as platform is proposed and prototyped. Technology in arduino, android smartphone and bluetooth are reviewed. HC-05 bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup is being used in the design. Android application is downloaded to android smartphone to monitor and control the operation of the lighting system remotely. The application facilitates in controlling the operating pins of Arduino. Design shows that arduino bluetooth interfacing can control a house lighting using an android smartphone as a platform. In future lighting home automation, timer will be included to be more energy- efficient and highly scalable. For secured, ubiquitously accessible and remotely controlled lighting system, GSM module will be incorporated in future designs. It would be extended to the large-scale environment such as colleges, offices and factories, among others.

Keywords – Science and Technology, lighting automation, Bluetooth module, Arduino, Philippines

INTRODUCTION

Smartphones provoke a true revolution to our society. Apps are available to smartphone users for more type of connections, such as communication platforms. Bluetooth technology makes it possible for electronic devices to be linked over short distance, without needing to be connected by wires. Generally, Bluetooth has a range of up to 30 ft., or greater, depending on the Bluetooth core. This technology offered better opportunity in convenience, comfort and security in home lighting. With dramatic increase in smartphone users, smartphones have gradually turned into an all-purpose portable device and provided people for their daily use.

In recent years, an open-source platform Android has been widely used in smartphones. Android is a mobile operating system developed by Google, based on the Linux kernel and designed primarily for touchscreen mobile devices such as smartphones and tablets. Android platform has support for Bluetooth network stack, which allows Bluetooth-enabled devices to communicate wirelessly with each other in a short distance .Bluetooth uses short-wavelength UHF radio waves in the ISM band from 2.4 to 2.485 GHz from fixed and mobile devices. It can connect up to seven devices.

Figure 1 .Bluetooth Symbol

Table 1. Bluetooth Specification

Bluetooth version	Maximum speed	Maximum range
3.0	25 Mbit/s	
4.0	25 Mbit/s	200 feet (60 m)
5	50 Mbit/s	800 feet (240 m)

Smart lighting is a lighting technology designed for energy efficiency. This technology enables to minimize and save light by allowing the householder to control remotely lighting. This ability saves energy and provides a level of comfort and convenience. With bluetooth based design, lights can be turned on and out automatically if within the portal's range.

In the study of Yan and Shi (2013), a system has been developed to monitor and control the lighting status using an Android Bluetooth-enabled phone and Bluetooth modules via BF10-A. This design utilizes a microchip in gathering status of the lighting and provides interface to control the lighting.

The study of David, Chirna, Ugochukwu and Obinna (2015) presented a home control and environmental monitoring system. This uses an Arduino microcontroller for accessing and controlling devices remotely. This uses a smartphone as platform. Saini, Singh, Sharma, Wattanawisuth and Leeprechanon also presented a system that monitors and controls the home electric appliances in the real-time environment with the potential benefits in terms of flexibility, scalability, security in the sense of data protection through cloud-based data storage protocol, and energy efficiency.

About 150 billion kWh, which is 11 % of the total commercial sector electricity consumption is utilized for lighting in 2016. In 2010, manufacturing facilities consumed about 52 billion kWh for lighting, which is 1.3% of total U.S. electricity consumption (Annual Energy Outlook, 2017).

In the Philippines, 2011 Household Energy Consumption Survey (HECS) shows that electricity was mostly used for lighting purposes with 74% of households reporting the use of electricity for such purpose. According to the International Energy Statistics (IES), in terms of energy consumption, Philippines is positioned at the median of countries in Southeast Asia. With the country's 1.260 quadrillion British thermal units (Btu) energy consumption, Philippines is way down below Asia and Oceania.

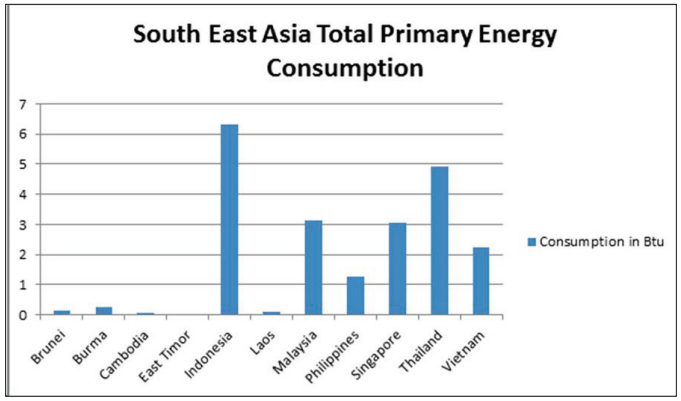

Figure 2. South East Asia Total Primary Energy Consumption

Electricity, which is usually used for lighting, is consumed at 58.33 billion kilowatt-hours. Electricity was most commonly used for lighting purposes with about 74 percent of the households reporting its use (Jane Moraleda, February 6, 2015).

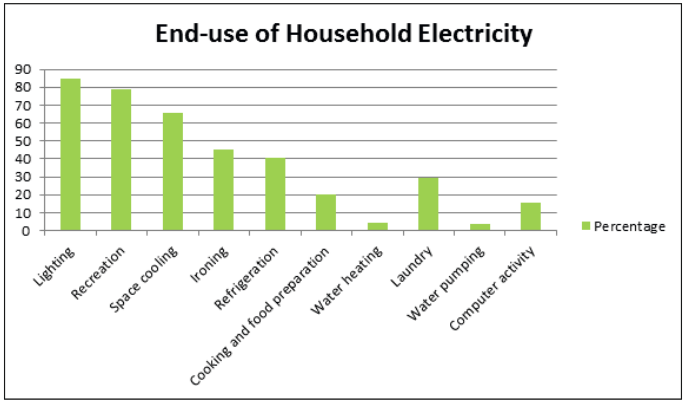

Figure 3. Philippines' End- Use of Household Electricity

Smart lighting market is growing exponentially from 2016 to 2022 and expected to be valued at almost 20 billion by 2022. It is expected to witness a shipment of 1.27 billion units by 2022, at a compound annual growth rate (CAGR) of 27.1% and 71.3%, respectively, between 2016 and 2022 (Smart Lighting Market by Product Type, Light Source, Communication Technology, Software & Service, Application, and Geography - Global Forecast to 2022, 2016).

OBJECTIVE OF THE STUDY

The purpose of this study is to design a home lighting control system using Arduino bluetooth interface with android smartphone as platform.

MATERIALS AND METHODS

Bluetooth Based Home Automation

Bluetooth-based home lighting automation makes use of a cell phone and Bluetooth technology. Bluetooth technology is secured and low cost. It is password protected for secured system. Android app in the smartphone provides the user interface. Bluetooth module and relays are used as interface for the bulbs. The Bluetooth has a range of 10-100 meters, 2.4 GHz bandwidth and 3Mbps speed. The android app on the phone is portable. It is also fast and cost effective system.

System Architecture

In this study, a design in lighting automation system based on Arduino bluetooth interface using android smartphone as platform is presented. This system is composed of hardware interface module and software communication module. Being the heart of the system, all communication and control pass through the arduino microcontroller.

The hardware required materials in this design are Arduino and battery (with cable), bluetooth module HC 05/06, relay, bulbs, connecting wires and android device. Android version use in this study are android 7 nougat, marshmallow version 6.x, lollipop version 5.x, kitKat version 4.4.x, and 4.3, 4.2 and 4.1 version all jelly bean. Figure 4 shows an Arduino microcontroller and a Bluetooth module HC 05/06. While the software requirement are Arduino Integrated Development Environment (**IDE)** and android studio.

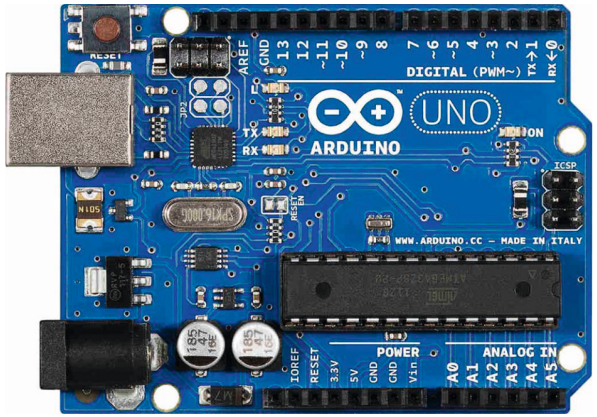

Figure 4.Arduino microcontroller

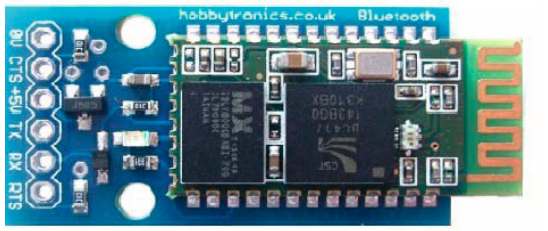

Figure 5. Bluetooth module

Figure 6. Relay

The four main parts of this project are android smartphone, a bluetooth transceiver, an arduino and relay as shown in Figure 7.

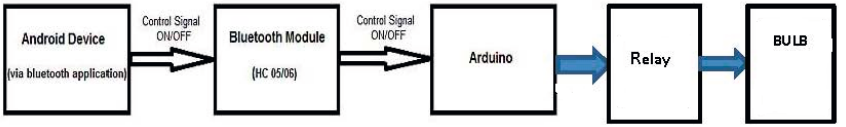

Figure 7. Block diagram

Bluetooth module HC 05/06 works on serial communication. As shown in figure 7, the Android app is designed to send serial data to the bluetooth module. The bluetooth module will communicate with the arduino microcontroller through the transmitter and receiver pins of the module. The arduino activates the relay connected to it by passing 5V through it. The bulb will turn on once the relay is triggered.

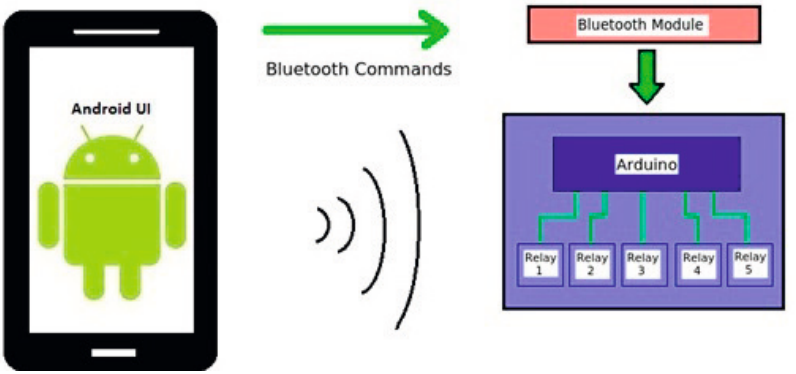

Figure 8. Automatic Lighting System Block diagram

The following are the steps in making this design:

Step 1. Setting up the hardware connections

For setting up this system, wiring connections have to be made between the arduino and bluetooth module and also with the relays. Figure 9 shows the hardware connection of arduino and the bluetooth module. There are only four connections to be made between the Arduino and Bluetooth module.. Here, the bluetooth module's Tx is connected to arduino Rx (digital pin 0) and the module's Rx to arduinoTx (digital pin 1). VCC and GND of the module is connected to the arduino's 5V and GND.

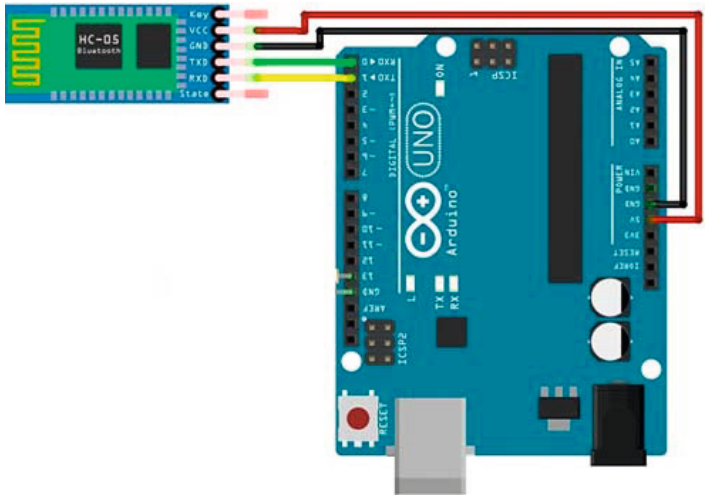

Figure 9. Arduino Bluetooth hardware Connection

Figure 10 shows the schematic diagram of the lighting system with switching functionalities to control lighting using arduino through the relay system. The corresponding bluetooth module pin connection is indicated in the figure.

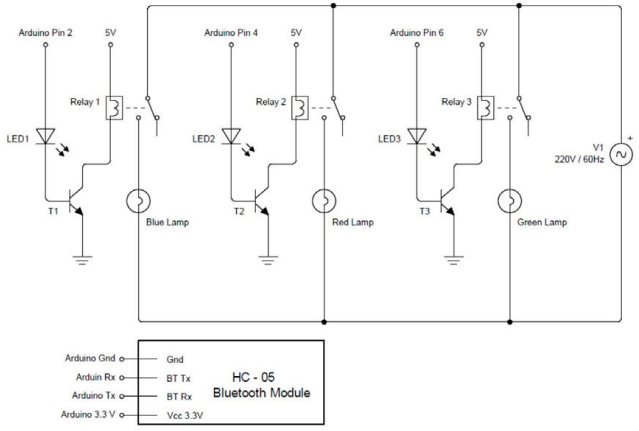

Figure 10. Lighting System Schematic Diagram

Step 2. Connecting the bulb to the relay

The relay used in this design is SPDT, it has 5 pins on the underside as shown in Figue 12. Pins 1 and 3 are the coil pins. Pin 1 is connected to the arduino digital pin and 3 is connected to arduinoGND . Pin 2 is the common contact in the relay.

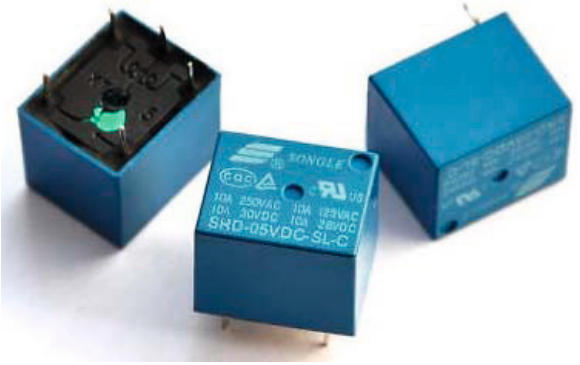

Figure 11. Single-pole double-throw (SPDT) 5V Relays

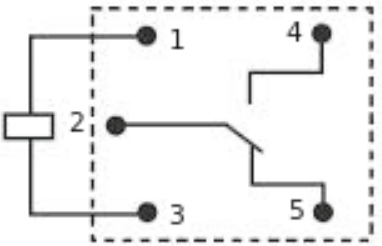

Figure 12. Relay pin-out

A relay pin–out, as shown in figure 12, pins 2 and 4 act identical to the two terminals of a switch. When a HIGH voltage is applied to the relay, switch turns ON, and switches OFF when a signal is withdrawn.

Step 3. Loading the Arduino Software

Aduino Integrated Development Environment can be downloaded from Arduino. The code checks the bluetooth signal and compares using and “if” statement with the pre-defined values. The relay is activated once the value matches, which passes 5V to the arduino digital pin.

Upload the code to the arduino board.

The Bluetooth module should be removed from the arduino board and connected once the upload is complete.

The code in this design is shown below:

```
char data = 0;
constintblueLamp = 2;
constintredLamp = 4;
constintgreenLamp = 6;

void setup()
{
Serial.begin(9600);
pinMode(blueLamp, OUTPUT);
pinMode(redLamp, OUTPUT);
pinMode(greenLamp, OUTPUT);
}
void loop()
 {
if(Serial.available() > 0)
 {
data = Serial.read();
Serial.print(data);
 }

if(data == ‘d’){digitalWrite(blueLamp, LOW);} //turn OFF blue lamp
if(data == ‘D’){digitalWrite(blueLamp, HIGH);} //turn ON blue lamp

if(data == ‘e’){digitalWrite(redLamp, LOW);} //turn OFF red lamp
if(data == ‘E’){digitalWrite(redLamp, HIGH);} //turn ON red lamp

if(data == ‘f’){digitalWrite(greenLamp, LOW);} //turn OFF green lamp
if(data == ‘F’){digitalWrite(greenLamp, HIGH);} //turn ON green lamp
}
```

Step 4 : Downloading the android application and setting up Bluetooth

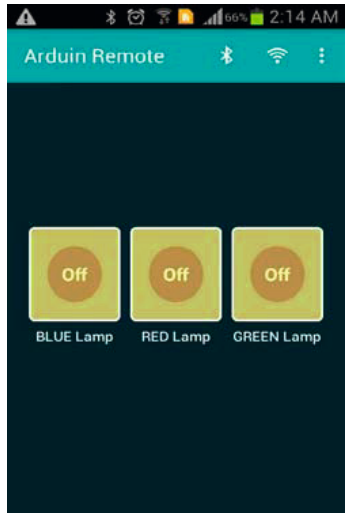

Figure 13.Graphical User Interface Application

Download the android application, Arduino Remote to the phone from PLAYSTORE as shown in figure 13. When application is installed, pair and connect with bluetooth module before opening the Arduino Remote app. Power the arduino and bluetooth module and then turn ON the bluetooth of the phone and make it visible to other devices. Then search for new devices in bluetooth, select the Bluetooth module from the list, enter the pairing code when prompted, it is usually '1234' or '0000'.

Note the name of the device, in this case it is "HC-06α. After pairing with the system, open the android application "Arduino Remote" and enter the name of bluetooth module (case-sensitive) and click "OK". After that, the phone will get connected to the system. By clicking the respective buttons on the app, the bulbs turn ON/OFF.

RESULTS AND DISCUSSION

Figure 14 shows the circuit connection of the design. The working module of the proposed system has been successfully built by harnessing the potential benefits of android phone and bluetooth together. The Bluetooth system can

function at real time with high speed of communication. The range of Bluetooth appliances is around 10- 100 meters. The system can be controlled within the Bluetooth range. This is a significant drawback of this system.

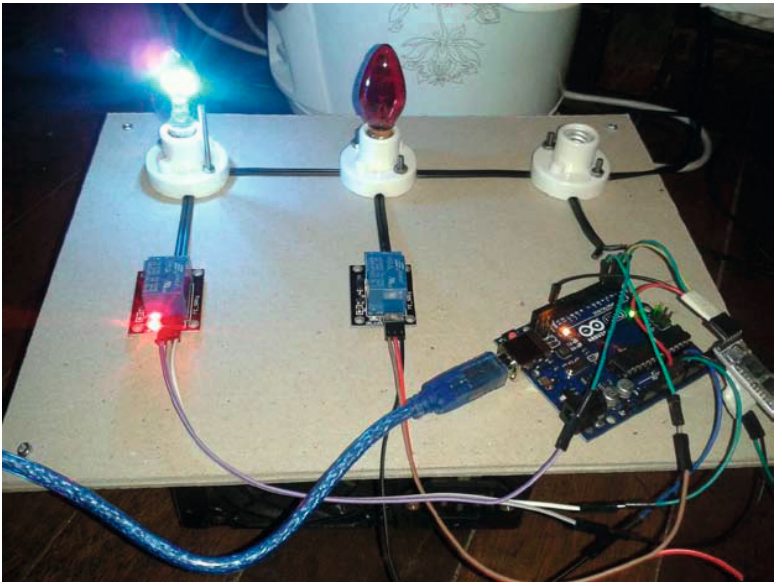

Figure 14. Circuit Connection

CONCLUSION

The primary aim of this paper is to design a home lighting system based on arduino Bluetooth interface using android smartphone as platform. A working designed has been developed to control the lighting status using android Bluetooth-enabled phone and Bluetooth modules through arduino. All communication pass through the microcontroller for lighting status and interface for the control of lighting. The bluetooth module transmits and receives commands from the bluetooth-enabled phone. Arduino Remote app communicates among Bluetooth devices. Android application, Arduino Remote, proved to be very efficient and convenient. It is concluded that the design of lighting system using arduino microcontroller and bluetooth module using android smartphone as platform can effectively control home lighting remotely and wirelessly.

RECOMMENDATION

For secured, ubiquitously accessible and remotely controlled lighting system, GSM module will be incorporated in the future designs since accessibility to the devices is limited within the Bluetooth range. Timer will be included to be more energy- efficient and highly scalable. It would be extended to the large-scale environment such as colleges, offices and factories etc.

TRANSLATIONAL RESEARCH

The circuit design can be introduced at homes, homes for Person with Disability (PWD) and home for the aged. The design concept can also be evaluated by stakeholders alike for acceptability and impact.

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