PWM and Bluetooth Based HomeAutomation Systems

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Abstract

Home automation system is an important issue now-a-days. Home automation involves several components such as microcontroller, Bluetooth module, android phone, Wi-Fi module etc. Its principle is to control the home-used devices and components based on electric power. In this project, a Bluetooth based home automation system has been designed and implemented with a microcontroller(PIC16C73B) and supporting components such as Bluetooth module(HC-06), transformer(220V-50Hz), relay(50/60 Hz), High voltage bridge rectifier, voltage regulator etc. This project is able to remote control the home appliances using android application. The system has been designed using Pulse Width Modulation (PWM) technique and relay for increasing/decreasing fan and on/off the bulbs. The PWM technique is relatively new concept in home automation system for proper control of rotating instruments. The home automation system based on PWM and Bluetooth with aid of the android application is well controlled and operated.

Keywords: Home Automation Systems (HAS), Pulse Width Modulation (PWM), Bluetooth, Microcontroller**.**

1. INTRODUCTION

Home automation system (HAS) is an emerging concept. Peoples want to automatically control the home appliances using remote devices. There are several technologies are used in home automation system some of them are Bluetooth and Wi-Fi. [1]The Bluetooth wireless technology is set to revolutionize the way people perceive digital devices in our homes and office environment . Wi-Fi is expensive technology and need to create a server and local area network with personal computer. For this reason, Wi-Fi technology is more expensive and not suitable for controlling home appliances. Bluetooth is well known and available Personal Area Network (PAN) technology which is highly affordable and low cost technology. Bluetooth technology is capable of transmitting data and voice at half-duplex rates of up to 1 Mbps without the use of cables between portable and fixed electronic devices. Home automation is one of the major applications of Bluetooth technology. The core technology of home automation is communicating and controlling automatically with each device and sensor in Bluetooth based on home network. By using Bluetooth wireless home network, a home network system can be installed with a low cost and it is simple to implement in an existing home. [1]Operating over unlicensed, universally available frequency of 2.4 GHz, it can link digitaldevices within a range of 10 m (expandable to 100 m, byincreasing the transmitted power) at the speed of 1 Mbps.The "smart house" technology is one

realization of home automation ideals using a specific set of technologies. [3] The terms "Smart Home", "Intelligent Home" followed and has been used to introduce the concept of networking appliances and devices in the house. Coded signals are sent through the home's wiring to switches and outlets that are programmed to operate appliances and electronic devices in every part of the house. [2]PWM technique on microcontroller is used to control the DC motor speed depending on the width of the Pulses. In this paper, a proposal given on a home automation system based on Bluetooth home network technology. The main objective of this project is to develop a remote control home automation system over the Bluetooth.

2. LITERATURE REVIEW

Although there are many works has developed on home automation systems, these works has many limitations. Most of the developed systems based on Bluetooth are very costly. In the experimental study N. Sriskanthan*et al.*(2002) [1] used Bluetooth technology with relay to develop home automation system. Another work has developed based on Bluetooth and arduino by Md. RakibHossain*et al* (2017) [6].These systems can operate easily but PWM technology is absent there. So that it is difficult to increase/decrease the speed of fan due to lack of advanced technology. Recently a project has developed by A. Kashim*et al.*(2017) [2] based on arduino and Bluetooth . This system is well operable but due to use of arduino instead of microcontroller , it is costly than the microcontroller based home automation system.

In this work , a prototype of microcontroller and Bluetooth based home automation system has been designed and developed which is low cost and efficient than the abovementioned system.

3. AIM AND OBJECTIVES

1. To design and implement high efficient home automation system

2. To use pulse width modulation (PWM) technique to control the rotation of fan

3. To switch on/off the light by using relay

4. To design and implement a low cost home automation system

5. To implement Bluetooth based home automation system

6. To design a home automation system using microcontroller(PIC16C73B*)*

7. To control the home appliances by Smartphone application

8. To make user comfort and highly affordable home automation system

4. PULSE WIDTH MODULATION (PWM)

A PWM is a method of controlling the amount of power to a load without having to dissipate any power in the load driver. The amount of power delivered to the load is proportional to the percentage of time that the load is switched on. The on-off switching is called PWM [4]. In addition, PWM is one of the two principal algorithms used in photovoltaic solar battery chargers, the other being maximum power point tracking. A diagram of PWM output with source signal given below in figure (1).

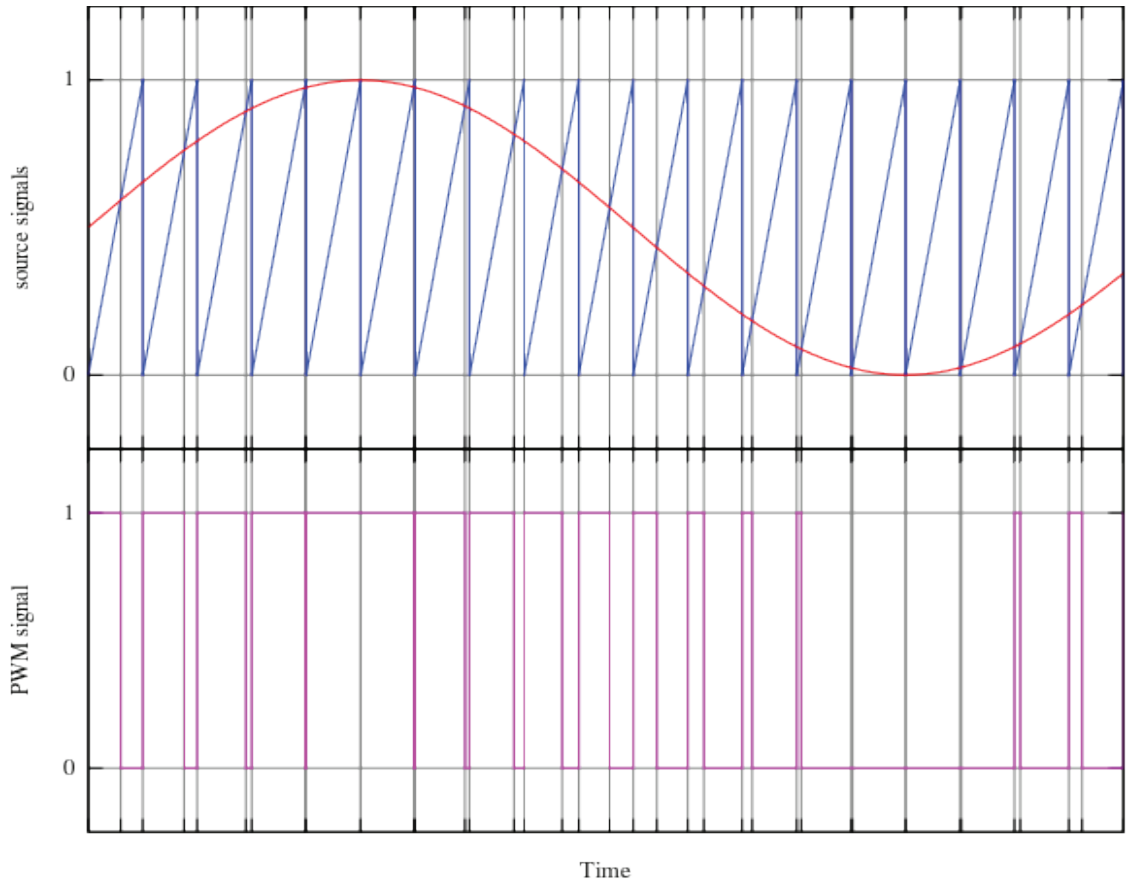

Figure 1. PWM Technique

[4] In this paper, the PWM module is used the motor speed control and dimming system.

5. MICRO C PRO

Micro C PRO for peripheral interface controller (PIC)is a full-featured ANSI C compiler for PIC devices from Microchip®. It is the best solution for developing code for PIC devices. It features intuitive integrated developed environment (IDE), powerful compiler with advanced optimizations, lots of hardware and software libraries, and additional tools that will help you in your work. Compiler comes with comprehensive Help file and lots of ready-to-use examples designed to get you started in no time.

6. BLUETOOTH SPP PRO

[5] HC-05/06 module is also called Bluetooth SPP Serial Port Protocol (SPP) module, designed for transparent wireless serial connection setup. The software for the Bluetooth client communication tools (ie: Bluetooth slave mode), Can connect a Bluetooth microcontroller unit (MCU) and PC serial port support android 4.0+ version of the system.A Bluetooth spp pro overview from Smartphone given in figure (2).

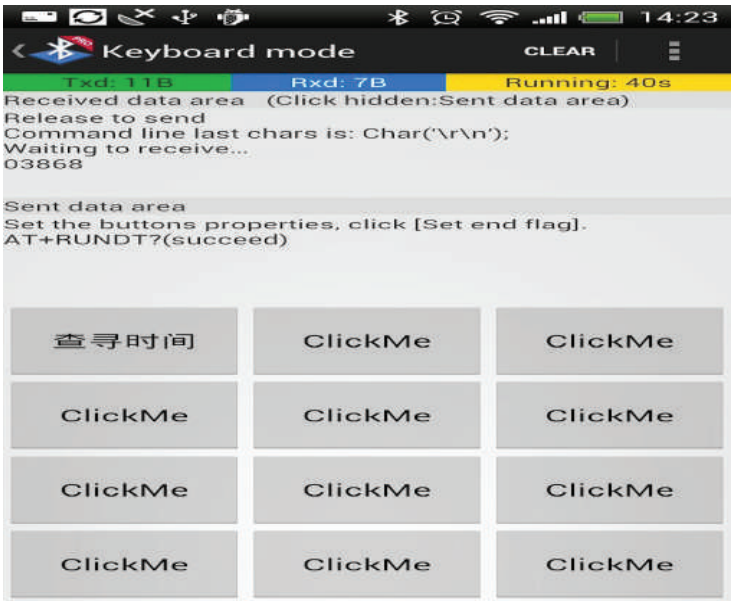

Figure 2. Bluetooth SPP Profile

7. BLOCK DIAGRAM

The block diagram of the system given below in figure (3). The system has several blocks.

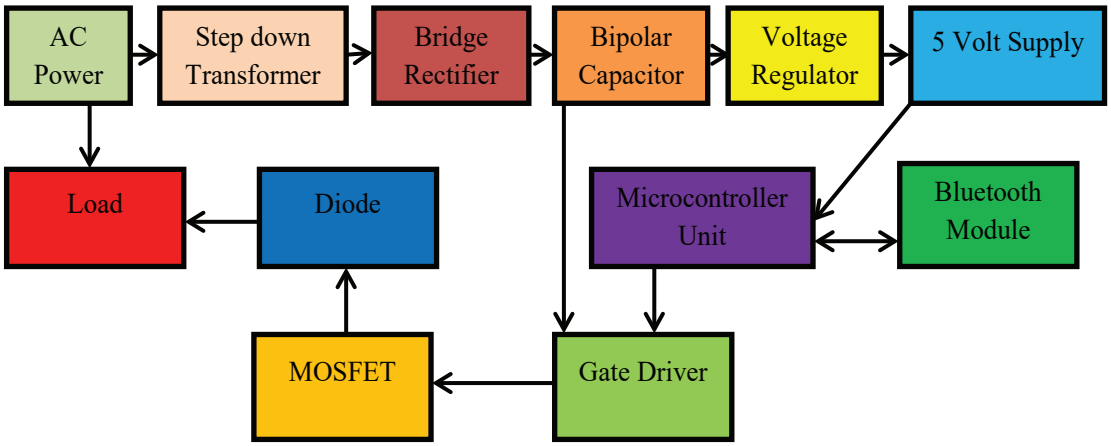

Figure 3. Block diagram of PWM and Bluetooth based Home Automation Systems

The Microcontroller unit is the heart of the system. The Bluetooth module is connected inbidirectional way with microcontroller unit. The gate driver also connected bidirectional way to microcontroller unit. The function of gate driver is to provide power to MOSFET for switching. The microcontroller unit takes 5V supply from power supply unit to operate itself. The voltage regulator used for voltage control. The transformer used for high voltage supply low voltage supply and vice-versa. The diode is used for unidirectional flow of power in the system.

8. COMPONENTS

The components used in this system are Microcontroller (PIC16C73B), Bluetooth Module (HC-06),Optocoupler (TLP250),Relay,Voltage regulator, Transistors (BC547),Resistors, Capacitors,High Voltage bridge rectifier,Bulbs etc.

9. WORKING CIRCUIT DIAGRAM

The working circuit diagram of Bluetooth and Pulse Width Modulation (PWM) based home automation system given below in figure (4).

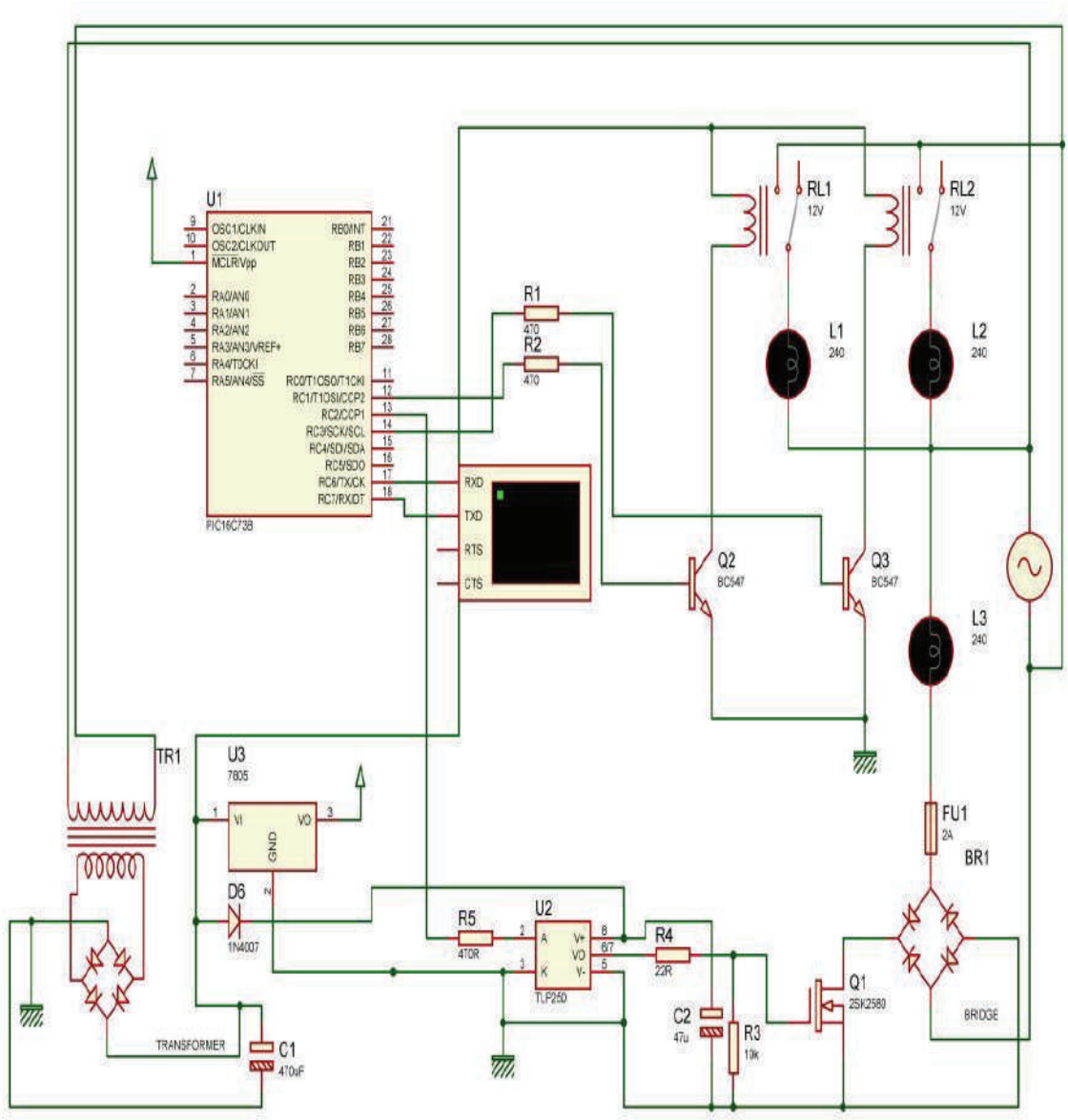

Figure 4. Circuit diagram of the system

10. OPERATION

The controlling purpose of this prototype based on two phases. The first phase is to control the lights simply ON/OFF and the second phase is to control the fan speed. The fan is shown in the circuit as L3.The fan controlling system based on the Pulse Width Modulation (PWM) signal which isgenerate from microcontroller port Capture, Compare or PWM (CCP1). The inbuilt PWM module of microcontroller generate PWM signal. In the code the duty cycle has been adjust to control the speed of fan.The intensity control required the increasing/decreasing of the duty cycle ofthe signal generated from microcontroller. The increasing / decreasing of duty cycle has been done using designed code and android application(Bluetooth spp pro). The Universal Asynchronous Receiver/Transmitter (UART) is used as transmission/ reception control and connection protocol. The Optocoupler (TLP 250) is used for providing ground voltagefor equivalent series resistor (C2) which is used for the purpose of virtual grounding. The Metal Oxide Semiconductor Field Effect Transistors (MOSFET) areconnected as per circuit diagram. The Gate of MOSFET takes 10 Volt from Optocoupler . The Drain is connected to bridge rectifier for providing required voltage based on Source. The Source of MOSFET is connected with a High Voltage (HV) source and the control of PWM fully based on the Source of MOSFET. The width of pulse controlled from Bluetooth application which is connected with system using a Bluetooth module and UART protocol. In PWMmode, the RB3/CCP1 pin can output a 10-bit resolution periodic digital waveform with programmable period and duty cycle. To operate in PWM mode, the CCP1 pin must be configured for output. The duty cycle of the waveform to be generated is a 10-bit value of which the upper eight bits are stored in the CCPR1L register, whereas the lowest two bits are stored in bit 5 and bit 4 of the CCP1CON register. The pulse width modulated signal generated from microcontroller need to control with respect to ac sign wave generated from alternator. The width of pulse width modulated signal need to control for increasing /decreasing the intensity of light L3(prototype of fan). The pulse width modulated signal has the range from 5 kHz to 10 KHz. The resistor (R3) is used for noise reduction.The setup for this experiment is very simple.. A light L3 is driven by the PWM output from the RB3/CCP1 pin through a current limit resistor of R4.

The others two lights connected to serial clock (SCL) port and Capture/Compare/PWM2 port respectively via transistors. These transistors are working as switches. By simply ON/OFF the base power of the transistors it can be possible to ON/OFF the relays and ON/OFF the lights. The relays are connected with sources which provide 12 volts supply. The relays are connected with TXD and RXD ports of Bluetooth module for controlling using Bluetooth application. The transformer us used to provide 220 V ac to 12 V dc supply to the circuit. The voltage regulator provides 5V supply to microcontroller.

10.1 Connection toBluetooth spp pro

The operation of this project maintained from Bluetooth SPP profile which is an application installed in android phone. The connection procedure with Bluetooth module given below in figure (5).The following diagram given is in keyboard mode. From smartphone keyboard, different loads are needed to be select for on/off these devices. The implemented hardware system given in figure (6). In implemented system, the light 1(L1) and light 2(L2) has shown as the bulbs of the home and light and light 3(L3) shown as the prototype of fan.3) shown as the prototype of fan.3) shown as the prototype of fan.3) shown as the prototype of fan.

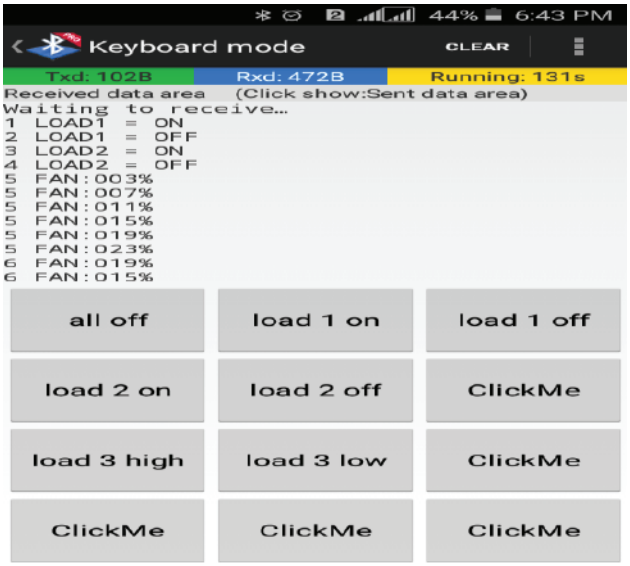

Figure 5. Device selection in Keyboard

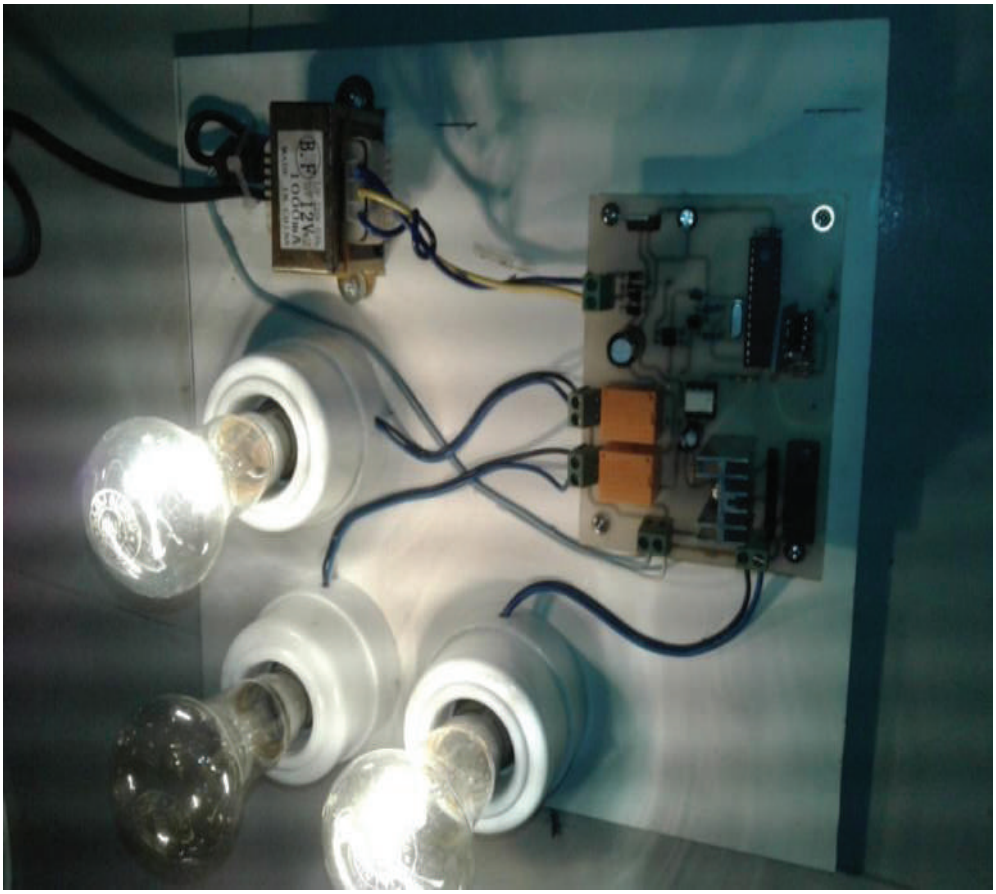

Figure 6. Implemented system

10.2 Duty Cycle Calculation

Table 1.Controlling of fan with respect to duty cycle

Observation	Duty cycle(%)	Speed /Intensity(rpm)
1	00	00
2	03	10
3	06	20
4	09	30

as well as decreasing and so on.

The duty cycle calculation shown in Table 1. From the application of PWM, the duty cycle of the wave is needed to control the speed of fan. For this reason the intensity of L3 is controlled as a prototype of fan speed is shown in above table. It shows that the speed/intensity of light/fan is directly proportional to the duty cycle of wave.

11. RESULT AND DISCUSSION

The figure (7) given below shows that the home automation system has been implemented. The light on/off has been successfully operated. The intensity or rotation control has been operated successfully. The final output shows the three lights are well bighting for ‘’all on mode’’ from mobilekeyboard of Bluetooth spp profile. The system function is easily controllable and operable as per description above. The system is also can be considered as a trading product for successful of its operation.

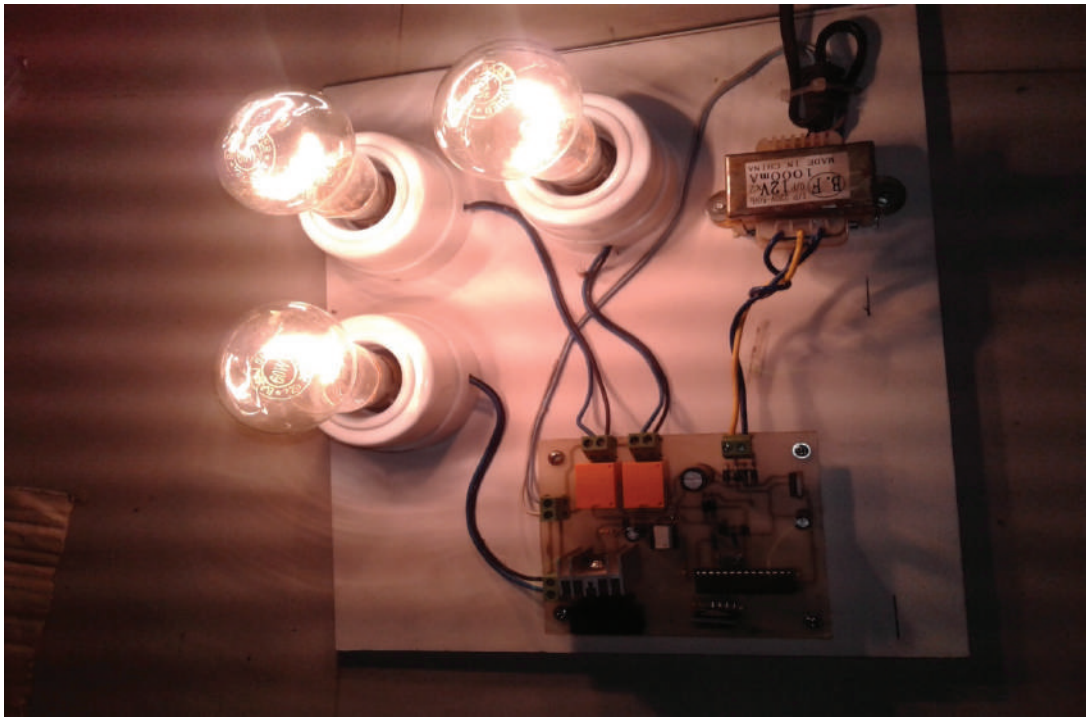

Figure7. Output /Result of the system

12. COST ANALYSIS

Table 2. Cost analysis of Home automation system

Serial No.	Components	Cost(Tk.)
01	Microcontroller(PIC16C73B)	60
02	Bluetooth Module(HC-06)	400
03	TLP-250 Optocoupler	100
04	Relay(2x)	25
05	Voltage regulator(7805)	15
06	Transistors(BC547)	06
07	MOSFET(2SK2580)	55
08	Resistors	10
09	Diode(1N4007)	05
10	Transformer	100
11	Capacitors	20
12	High Voltage bridge rectifier	90
13	Bulbs(3x)	50
14	Android Phone	3000
	Total	**3936 Tk. Only**

The cost analysis shows in Table 2.that the microcontroller used PWM and Bluetooth based home automation systems are available at a cost of only 3936 Tk. while the other systems based on arduino and Bluetooth are available at cost more than 5000 Tk. So, it can be easily decided that the PWM and Bluetooth based home automation systems with microcontroller used are low cost than other systems.

13. CONCLUSION

The home automation system has been designed and implemented successfully. The system prototype is working well. The home appliances such light and fan prototype has been controlled. According to cost analysis this prototype is low cost as compared with other systems. Home automation system suitable for practical purpose in home, offices, and educational institutes and inside and outside of building such as road or street light control. The above designed prototype provides efficient and comfortable and easily controllable by amateurs. Though the system worked well, it has some limitations such as Bluetooth has short coverage area and required android applications. The limitations will be possible to overcome through further analysis. In conclusion, this low cost system is designed to improve the living standard at home. The remote control function by smart phone provides help and assistance especially to disabled and elderly. In order to provide safety protection to the user, a low voltage activating switches is replaced current electrical switches. Moreover, implementation of wireless Bluetooth connection in control board allows the system install in more simple way. Further it gives a feature to control the parameters of the electrical devices.

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