

Arduino Based Home Lighting Control by Android Phone

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Today, home automation is one of the major applications of Bluetooth technology.

Home automation system is used for information techniques and control system to reduce the human labor. The rapid growths of technologies influence to use smart phones to remotely control the home appliances. An automated device has ability to work with versatility, diligence and with lowest error rate. This system not only helps to decrease the human labor but it also saves time and energy. A Bluetooth based wireless home automation system can be implemented with a low cost and it is easy to install in an existing home. Bluetooth technology has ability to transmit data serially up to 3Mbps within a physical range of 6m to 15m depending on the type of Bluetooth device.

There are few issues involved when designing a home automation system. The system should be scalable so that new devices can easily be integrated into it. It should provide a user-friendly interface on the host side, so that the devices can be easily setup, monitored and controlled. This interface should also provide some diagnostic services so that if there is any problem with the system, it can be tracked down. Moreover the overall system should be fast enough to realize the true power of wireless technology. Finally the system should be cost effective in order to justify its application in home automation.

In this paper, a low cost smart phone based, flexible home automation system is presented. Appliances at home are connected to the Arduino BT board. A bluetooth module is connected to FPGA board to control the home appliances.

ABSTRACT

Energy Conservation is the effort made to reduce the consumption of energy by using energy more efficiently. Energy can be conserved by reducing wastage and losses, improving efficiency through technological upgrades. In this thesis, Bluetooth based home lighting control system using Arduino UNO is presented as the good example for energy conservation by applying updated technologies. Bluetooth Module, relays, bulbs, android phone, arduino application and power supply are used to complete this system. Not only lighting but also any home appliance can be controlled through the customized smartphone application thanks to the advantages of Bluetooth Wireless Technology. Remote controlled Bluetooth based home lighting control system provides a most modern solution with smartphones. The design is based on mainly a stand-alone Arduino BT Board to which home appliances are connected via relays. Password protection is added to protect unauthorized access making a perfect system.

KEYWORDS: Bluetooth; Arduino UNO; arduino application; smartphones; Wireless Technology

I. INTRODUCTION

Wireless technologies are becoming more popular around the world. Now with the embedded Bluetooth technology, digital devices form a network in which the appliances and devices can communication with each other.

The commutation between the smart phone and the Arduino BT board is wireless. Additional devices can be connected into the system with little modifications. The system is used to control the bulb using a smart phone application with Bluetooth wireless technology.

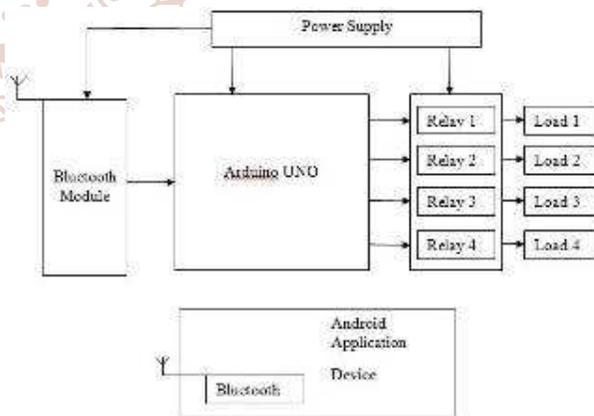


Figure1. Overall Block Diagram of the System

II. LITERATURE REVIEW

The first release of Bluetooth was for a wireless data system that could carry data at speeds up to 721 Kbps with the addition of up to three voice channels. The aim of Bluetooth technology was to enable users to replace cables between devices such as printers, fax machines, desktop computers and peripherals, and a host of other digital devices. One major use was for wirelessly connecting headsets for to mobile phones, allowing people to use small headsets rather than having to speak directly into the phone.

Another application of Bluetooth technology was to provide a connection between an ad hoc wireless network and existing wired data networks.

The technology was intended to be placed in a low cost module that could be easily incorporated into electronics devices of all sorts. Bluetooth uses the license free Industrial, Scientific and Medical (ISM) frequency band for its radio signals and enables communications to be established between devices up to a maximum distance of around 100 meters, although much shorter distances were more normal.

Bluetooth technology is well established and the standard is being developed to ensure that it meets the growing needs for connectivity for many electronic devices. Even though it was initially aimed at streaming audio to items like headphones and other audio devices, Bluetooth is now able to provide connectivity for many devices enabling it to be used for new applications like M2M, IoT and remote device connectivity.

Bluetooth is designed as a short range, low energy, and low cost wireless connectivity that uses radio technology. Bluetooth devices work with 2.4GHz frequency. A channel hopping technique the data is separates into smaller pieces called packets.

The data packets exchanges between the transmitter and receiver at one frequency, then at another frequency the transmitter and receiver exchange another packet. The process will be continued by repetition until all data is transmitted. The channels changes every use seventy-nine 1-megahertz frequencies in the ISM band as shown in figure 1. The ISM frequency bands having a range of 2.4 GHz and 2.483 GHz in the radio spectrum, has been reserved for industrial, scientific and medical purposes.

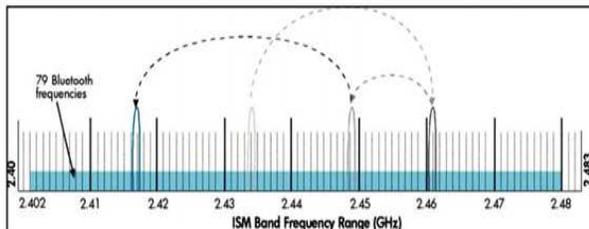


Figure2. Bluetooth Devices Frequencies Hop up to 1600 Times per Second

III. HARDWARE COMPONENTS

A. Arduino UNO

Arduino is a single board computer. Arduino is an open source physical computing platform based on a simple input/output (I/O) board. The type of the Arduino board used in this paper is ATmega328P Arduino Uno Microcontroller having 2KB static RAM, 32KB flash memory, 8 bit CPU, 6 Analog I/O pins and 14 Digital I/O pins. The language used to program the Arduino microcontroller is C/C++. Programs are created in the Arduino development environment that compiling and linking source code and downloaded to the Arduino board where it starts running.

Arduino is an open-source design for a microcontroller interface board, it is actually rather more than that, as it encompasses the software development tools that need to program an Arduino board, as well as the board itself. There

is a large community of constructions willing to share their expertise and experience on the Internet.

Arduino is a small microcontroller board with a USB plug to connect to computer and a number of connection sockets that can be wired up to external electronics, such as motors, relays, light sensors, laser diodes, loudspeakers, microphones, etc. They can either be powered through the USB connection from the computer or from a 9V battery. They can be controlled from the computer or programmed by the computer and then disconnected and allowed to work independently. The Arduino is an open-source hardware design, anyone is free to take the designs and create their own clones of the Arduino.

Arduino is an open-source platform used for building electronic projects. Arduino consists of both a physical programmable circuit board and a piece of software, or IDE (Integrated Development Environment) that runs on the computer, used to write and upload computer code to the physical board.

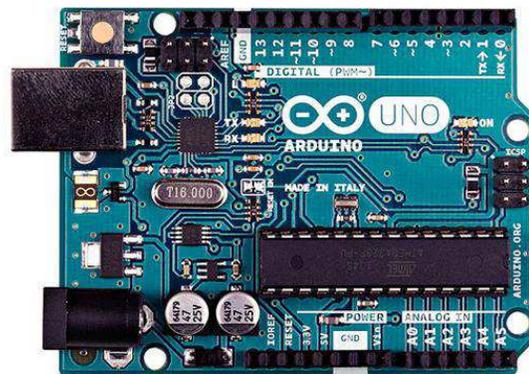


Figure3. Arduino UNO

The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board - can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package. The Uno is one of the more popular boards in the Arduino family and a great choice for beginners.

B. Bluetooth Module HC-05

The standard feature for cellular phones is a Bluetooth technology which can be used in wireless connection for cellular phones and home appliances. Bluetooth technology gives an efficient method for controlling home automation. It is a low cost and a secured technology. The Arduino Bluetooth board is used in the system. The cell phone is used python program to supply the user interface. The band frequency of working is over 2.4 GHz ISM with a range of 10 m and 1 Mbps speed. This module HC-05 provides a good wireless transmission and a well receiving serial data; it can be used to provide a connection between MCU and PC for the data transferring purpose. The I/O ports of the Bluetooth board and relays are used to connect the devices which be controlled. The Bluetooth simply is password protected. A Bluetooth device has the ability to scan and detect other

devices easily. It has the ability of checking whether devices are working properly or not.

HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. The HC-05 Bluetooth Module can be used in a Master or Slave configuration, making it a great solution for wireless commutation.

The Bluetooth module HC-05 is a MASTER/SLAVE module. By default the factory setting is SLAVE. The Role of the module can be configured only by AT COMMANDS. The slave modules cannot initiate a connection to another Bluetooth device, but can accept connections. Master module can initiate a connection to other devices.

The HC-05 Bluetooth Module has 6 pins. They are as follows:

- Enable: When enable is pulled LOW, the module is disabled which means the module will not turn on and it fails to communicate. When enable is left open or connected to 3.3V, the module is enabled i.e the module remains on and communication also takes place.
- Vcc : Supply Voltage 3.3V to 5V.
- Gnd: Ground pin
- Txd & Rxd: These two pins act as an UART interface for communication.
- State: It acts as a status indicator. When the module is not connected to / paired with any other bluetooth device, signal goes Low. At this low state, the led flashes continuously which denotes that the module is not paired with other device. When this module is connected to/paired with any other bluetooth device, the signal goes High. At this high state, the led blinks with a constant delay say for example 2s delay which indicates that the module is paired.
- Button Switches: This is used to switch the module into AT command mode. To enable AT command mode, press the button switch for a second. With the help of AT commands, the user can change the parameters of this module but only when the module is not paired with any other BT device. If the module is connected to any other bluetooth device, it starts to communicate with that device and fails to work in AT command mode.

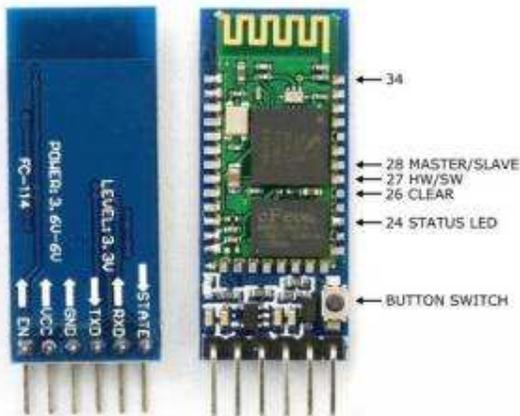


Figure4. Pin Description of Bluetooth Module

IV. IMPLEMENTATION OF THE SYSTEM

A. Interfacing HC-05 Bluetooth Module with Arduino

Bluetooth Module HC-05 is connected to the 5V and GND pin of Arduino with connecting wire. Note: In case HC-05 module supports 3.3V and 5V please power it using the 5V supply from Arduino. The TXD pin on the HC-05 module is

connected with the RXD pin (Pin 0) of Arduino. TXD on HC-05 transmits data from the Bluetooth transceiver. Pin 0 on Arduino (RXD) receives data on Arduino two-way by connecting these pins, users are establishing a two-way communication between Arduino and HC-05, so that can turn the device get on/off with the command properly. Next, as the receiver data lines on HC-05 are 3.3V tolerant, need to convert the 5V input signal from Arduino into a 3.3V signal. While it can be achieved easily through a bi-direction logic level converter, using a voltage divider to convert the 5V input signal into a 3.3V signal.

B. Bluetooth Connection Test

Once user has connected the HC-05 module with the Arduino, user can power the Arduino with the 12V DC supply or USB cable. If the red and blue LEDs on HC-05 are blinking, user has successfully paired the Bluetooth module with Arduino. Users can also check the Bluetooth connectivity status using the State pin on Arduino.

C. System Circuit

The circuit design of system based on Arduino and Bluetooth is very simple and is explained below.

The Bluetooth module has 6 pins but just 4 pins: VCC, TX, RX and GND are used. Bluetooth module is connected to the Arduino Uno. Tx pin of Bluetooth module is connected to the Rx pin of Arduino. Rx pin of Bluetooth module is connected to the Tx pin of Arduino. GND of BT module is connected to the GND of Arduino. This system is used 7805 IC to get 5volt supply for BT module and Arduino Uno. 5 volt pin of BT module and 5volt pin of Arduino are combined and it is connected to the 5V power supply. Digital pins of Arduino (8, 9, 10, 11) are connected to the base of 4 channel relay. Collector of 4 channel relay is connected to the switchboard power supply. Emitter of 4 channel relay is grounded. Positive and negative of switchboard power supply are connected to the positive and negative of bulbs. Four channel relays are used as a switch for turning ON and OFF the home appliances running on AC mains.

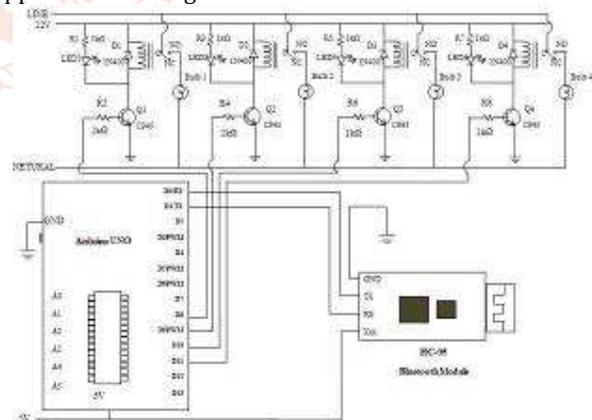


Figure5. System Circuit

D. ArduDroid by TechBitar Application

ArduDroid is a simple tool to control Arduino from Android phone. It's both an Android app and an Arduino program. ArduDroid has a simple Android user interface to control Arduino's digital and PWM pins, send text commands to Arduino and receive data from Arduino over Bluetooth serial using the ever popular and really cheap HC-05 Bluetooth over serial module. This app has been tested and designed for the HC-05 Serial Bluetooth module. Other Bluetooth modules may or may not work.

ArduDroid is an Android app that sends/receives data from Arduino with the help of an Arduino sketch named arduDroid.ino. In this sketch, there are four code blocks supporting the four key functions of ArduDroid. The blocks are labeled according to their functions in a comment line at the start of each code block.



Figure6. Software Application of ArduDroid by TechBitar

E. System Flow Chart

A software implementation is a systematically structured approach to effectively integrate software based service or component into the workflow of an organizational structure.

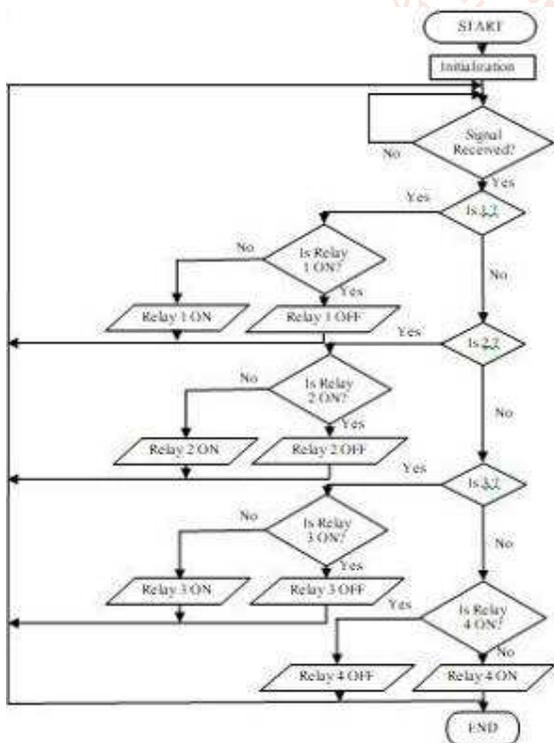


Figure7. System Flow Chart

V. TESTS AND RESULTS

The system has been implemented step-by-step and in each step experimental testing has been made to make sure that there is no error. Moreover, the important thing is to get expected results. Lighting ON/OFF has been tested Room by Room as follows.

The predetermined data from the smartphone is sent to the Bluetooth Module; it receives this signal and transmits to the Arduino. This signal from Arduino is sent to the relay for switching on and off the bulbs. When the key 8 from the smartphone is pressed, the bulb in the living room is on as shown in Figure 8.



Figure8. Switching ON the Bulb of Living Room

When the key 9 from the smartphone is pressed, the bulb in the dining room is on as shown in Figure 9



Figure9. Switching ON the Bulb of Dining Room

When the key 10 from the smartphone is pressed, the bulb in the bed room is on as shown in Figure 10.



Figure10. Switching ON the Bulb of Bed Room

When the key 11 from the smartphone is pressed, the bulb in the warehouse is on as shown in Figure 11.



Figure11. Switching ON the Bulb of Warehouse

After pressing all keys, the bulbs in all rooms are on as shown in Figure 12.



Figure12. Switching ON All Bulbs

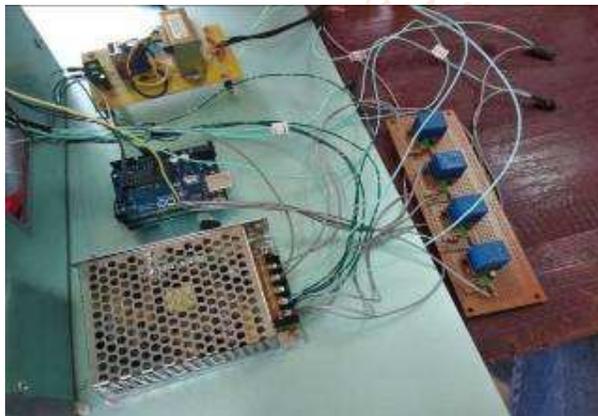


Figure13. Testing the implemented Circuit

VI. CONCLUSION

It can be concluded that Arduino based home lighting control by android phone has been successfully designed and prototyped. This system consists of an Arduino Uno board, a

Bluetooth Module, an Android phone, bulbs and an android Application. It is a low cost, flexible and wireless solution to the home automation. The Bluetooth client was successfully tested on a multitude of different mobile phones from different manufacturers, thus proving its portability and wide compatibility. The wireless communication between the cell phone and Arduino BT was available to be limited to be less than 20ft in a concreted building and maximum of 50ft range was available in an open range. Finally, the developed system offers a flexible, economical and remotely controllable smart home automation system.

VII. FURTHER EXTENSION

The rooms can be extended to some extent by modifying a little in software and hardware design. Light sensors, temperature sensors, smoke sensors etc. can be added in the system to be a smart home system. It can also be designed to adjust different parameters like room lighting, air conditioning (room temperature), door locks etc. The distance of the Bluetooth range can be increased by using Wi-Fi Topology.

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