



**AMERICAN INTERNATIONAL UNIVERSITY-  
BANGLADESH (AIUB)**  
Faculty of Engineering  
Department of Electrical and Electronic Engineering

## **MICROPROCESSOR & EMBEDDED SYSTEM LAB**

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**Submitted By: Group-5**

SL	Group Member's Name	ID	Contact Number
01	HOSSAIN, SHAHRIAR	17-33388-1	01683512681
02	SAHA, DIPTA	17-33409-1	01814396274
03	RASHED KHAN MANON	17-33138-1	01862452937
04	JAKARIYA AHMED	17-33083-1	01757137104
05	TANZIL BIN AMRAN	17-33106-1	01950394255
06	AKTER SINTHIYA	16-32655-3	01741106865
05	HAFIZ MD WASIF BIN	16-32615-3	01711000493

**SUBMITTED TO:**

**SUJAN HOWLADER (ESSAN)**

**ASSISTANT PROFESSOR**

**FACULTY OF ENGINEERING**

**DEPARTMENT OF EEE**

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# **Arduino Based Home Automation System Using Android Application**

## **1.Introduction:**

### **Abstract:**

*The world is moving fast towards automation. People have less time to do any work so automation is simple way to handle any device will work to our desire. The objective is to develop and design a Home automation using Arduino. Home appliances like fan, Bulb, AC, automatic door lock is controlled by Home automation system using Arduino Uno with Bluetooth module. The main focus is on the monitor and control of smart home by Android phone and provide a security based smart home, when the people does not present at home. This paper motive is controlled home appliances in smart home with user friendly, design at low cost, simple installation.*

### **State of the Arts:**

Smart Home System designed and created by utilizing WLAN network based on Arduino microcontroller. The system is able to monitor and control lights, fan, any other electronics device and other household appliances. Results from testing the system show proper control and control monitoring functions can be performed from a device connected to a network that supports HTML5. [1]

Low-cost remote-controlled home automation system is presented using Arduino board, Bluetooth module, smartphone and some electronics device. A smartphone application is used in the suggested system which allows the users to control up to 18 devices including home appliances and sensors using Bluetooth

technology. The suggested system has more features than conventional home automation systems such as an ultrasonic sensor is used for water level detection and soil moisture sensor is use for automatic plant irrigation system. The system is able to work with the designed android application. Furthermore, the system uses low power ( $< 0.53958$  watt), making it suitable for low-power Internet of Things application. [2]

This report going to accomplish the goal of the project by designing a home automation system using the Arduino. Firstly, a home automation system will be built where all the appliances like light, fan, TV, PC etc. will be connected with relay board using the Arduino which will be ultimately connected to a mobile phone through the Bluetooth in order to control the appliances.

### **Motivation:**

To improve standard of living it is needed to change home environmental condition according to the mood of the habitants without any interruption. In some cases, physically disable or handicapped people are not able move much from one place so for them it is very difficult to access regular domestic appliances. For them it is essential to develop a system which requires less human interaction. It needs energy efficient, flexible system which also detect the fault in the devices automatically and notify the related technician and user about the problem automatically. To provide all these facilities in developing countries like Bangladesh it need a much smart system which provide all the above facilities in low price and less energy consumption. The benefits of home automation typically fall into a few

categories, including savings, safety, convenience and control. Additionally, some consumers purchase home automation for comfort and peace of mind.

**Savings:** Smart home automation system can save electricity as well as save energy, cutting utility costs over time. Some home automation technologies monitor water usage too, helping to prevent exorbitant water bills. Certain devices even offer rebates.

**Safety:** Many home automation technologies can make a place safer than before. Consumers purchase these devices because they want to make their homes safer and more secure. Automated lighting helps people to recover their mistakes. If anyone forgets to turn off the lights, can turn it off with the help of automation system and with less work.

**Convenience:** Because home automation technology performs rote tasks automatically, end users experience great convenience. Lots of smart gadgets are compatible with one another, and you can set different triggers between devices to automate regular home processes. For instance, it could set your smart locks to turn on your smart lighting when you unlock the front door.

**Control:** Consumers also choose smart home devices to better control functions within the home.

**Comfort:** Connected devices can also help create a comfortable atmosphere. They provide intelligent and adaptive lighting, sound which can all help create an inviting environment.

In this era of global climatic change with the advancing mechanization, home automation system will provide personal and environmental safety for maintaining a good

standard of living. This system will make the efficient use of energy as well as optimization of ventilation technology. This will also increase the security. This modern society demands a comfortable life and improved living conditions which will result from the implementation of the automation-based network with the Arduino.

### **Organization of the chapters:**

In the introduction part abstract, state of arts, motivation was described. The abstract helps to understand the overall concept of the project. In the state of the arts the current states of the project were described briefly. In the motivation part the advantages were described.

In literature review part, eight papers were described in summarized way.

In the method section the working principle of the project and how its working was described. The description of the components as well as their importance were described. Also, the hardware implementation was shown how to implement the circuit. The measurements were also shown for the project result.

The result and discussion part are all about the summary of the result of the full project where the simulations (hardware, software) both were shown with figures. Results were also described.

In the Impact of professional engineering solutions on society and environment section, the impact as well as advantages and disadvantages of the full project was described briefly.

Lastly in the conclusion part the full project was summarized and future work was also described.

## 2. Literature Review:

According to the survey many systems are exist which is used to control home appliance. Every system has its unique features. In present time a lot of companies are officially registered and they are working to give better home automation system features. The Bluetooth wireless technology is set to revolutionize the way people perceive digital devices in our homes and office environment. Now they are no longer just the individual devices; instead, with the embedded Bluetooth technology, they form a network in which appliances can communicate with each other. This wireless technology is especially useful in-home environment, where there exists hardly any infrastructure to interconnect intelligent appliances. It could be suitably used for home automation in a cost-effective manner. Operating over unlicensed, universally available frequency of 2.4 GHz, it can link digital devices within a range of 10 m (expandable to 100 m, by increasing the transmitted power) at the speed of 1 Mbps a home automation system based on Bluetooth wireless technology allows the user to monitor and control different appliances connected over a Bluetooth network in home environment. The system has been demonstrated to be functioning by developing a room temperature control system.[3]

A prototype electrical device control system using web was designed where the server was fixed with auto restart if the condition of the server is currently down. In this the prototype has been successfully control the lamp. The owner of the house can monitor and control the electrical device remotely. This will assist in energy safety, and security.[4]

Sensors can be used in home automation system. This project is quite interesting and

also challenging too. The author has developed a home automation system using raspberry pi and we also trying to implement home automation system using Arduino uno. In this project the H.A system has got Raspberry pi tied together with Arduino controller for the controlling of a number of devices. On the other hand, his project conceptualized to integrate both the LAN network and internet for two different aspect of the same project idea, however has not managed to do so. And a web browser also used in the project, but we are not using any web browser for our project.[5]

Remote control system by telephone presented in this paper is based on PIC and has very secure structure. Designed circuit is isolated both optically and electrically, therefore it does not create any effect on telephone line. With pin-check system, non-authorized people cannot connect to or use this system. For controlling the devices pin check algorithm has been introduced where it was the cable network but not wireless communication. In this application, secure, cheap and safe remote-control system for intelligent houses has been presented.[6]

The home automation system can be controlled by an android app and it also has goggle-based voice command system. Some of their hardware requirements are closely related to ours. They also include video streaming from an IP camera to the android device and other home appliance control system which is based on local network connection using Wi-Fi. This is an important point where we have to improve our project by integrating both local network and internet connection, to allow remotely control of home appliances. [7]

Home automation gives an individual the ability to remotely or automatically control things around the home. A home appliance is

a device or instrument designed to perform a specific function, especially an electrical device, such as a refrigerator, for household use. The words appliance and devices are used interchangeably. Automation is today's fact, where things are being controlled automatically, usually the basic tasks of turning ON/OFF certain devices and beyond, either remotely or in close proximity. [8]

Each and every system has their own unique features and on difference to one another lack some advancement. Apart from the actual project we also did some research on other background of this field, we looked up on basics and foundations which is necessary for our project. For this we went through the book "Raspberry Pi Home Automation with Arduino" by Andrew K. Dennis. It is really very helpful for the beginners who wants to work in the field of Home Automation. It provides maximum necessary background details needed to build a Home Automation system. Some of the important topics mentioned in this are Arduino controller, raspberry Pi, database design and so on. Another good one is "Arduino for beginners" by Simon Knight. It helped us to get knowledge about Arduino and step by step knowledge about software and hardware of Arduino. We also looked up the book "Designing the Internet of Things" written by Adrian McEwen and co. Which gives a great knowledge on the concept of Internet of Things which ranges from the day to day example of IoT based projects.

An application in a universal XML format which can be easily ported to any other mobile devices rather than targeting o single platform. Here the design and implementation of the Home automation system on one of the Operating System and creation of a unique XML document that can be placed over the server which can be

adapted by any other mobile device without any platform issues. The XML format which controls the layout of the screen remains common, only the part which needs to be coded on every platform is the downloading of the XML file from the server and parsing it. This reduces a lot of coding effort as the design part is coded only once, and the same file can be used by every other platform. [9]

A wireless home automation system controlled by a smartphone specifically an android device. And they explained why the Arduino should use and how it works very beautifully. Beside this they also explained about Bluetooth features. This system consists of an Arduino-Uno board, a Bluetooth Module, an Android phone, power sockets, home appliances and an android Application (Android). It is user friendly and it is cost effective.[10]

Each paper has different specialty, different concept and different points of view also. Those are really very helpful to build a project. In our project we used simple android app which you can use to control electrical appliance with clicks.

### **3. Methodology and Modeling:**

#### **Introduction:**

This is 21<sup>st</sup> century where automation of any form home or industrial plays an important role in human life. When it comes to industrial automation, the concept is applied to large machines or robots which helps in increasing the efficiency in terms of production, energy and time. Home automation on the other hand involves automating the household environment. This is possible because of the smartphones and internet that we are widely using. Home automation can be again divided in to just

controlling the appliances using a smartphone from a remote location and another type filled with sensors and actuators which controls the lighting, temperature, door locks, electronic gadgets, electrical appliances etc. using a “Smart” system.

In this project, we will design a simple home automation project using simple components using which different electrical appliances can be switched on or off. The project is based on Arduino and commands are sent via Bluetooth (HC05) to Arduino Uno, which controls the relay operation for the project. [11]

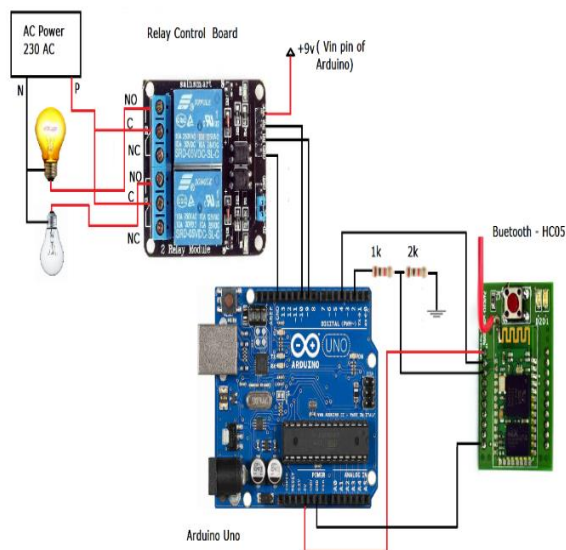


Figure-1: Circuit Diagram

**Circuit Construction:** First make the circuit connection as shown in fig. The 1<sup>st</sup> Pin (Vcc) of Bluetooth (HC05) is connected to +5v of Arduino Uno and 10<sup>th</sup> pin (GND) to Arduino Uno GND. The 2<sup>nd</sup> pin (Tx) and 3<sup>rd</sup> pin (Rx) of HC05 is connected to 4<sup>th</sup> and 2<sup>nd</sup> of Arduino Uno. Make sure that Rx pin of HC05 is connected to Arduino and pin through

voltage divider contains 1k and 2k resistor, because Rx pin of HC05 is 3.3v compatible but Arduino GPIO output is 5v. So we decrease the voltage from 5v to 3.3v using voltage divider to make Arduino and Bluetooth compatible. Then 9<sup>th</sup> and 10<sup>th</sup> pin of Arduino Uno is connected to R1 and R2 of relay board. Vcc and GND pin of relay board is connected to Vin(+9v) and GND pin of Arduino Uno. Another side of relay board three pin connector available, named NO (Normally open), C (common) and NC (Normally closed). Each relay contains separate connector. Phase (P) of 230v AC is connected to C (common) and one end of bulb is connected to NO (normally open). Another end of bulb is connected to Neutral (N) of AC supply. [12]

### Working principle of the proposed project:

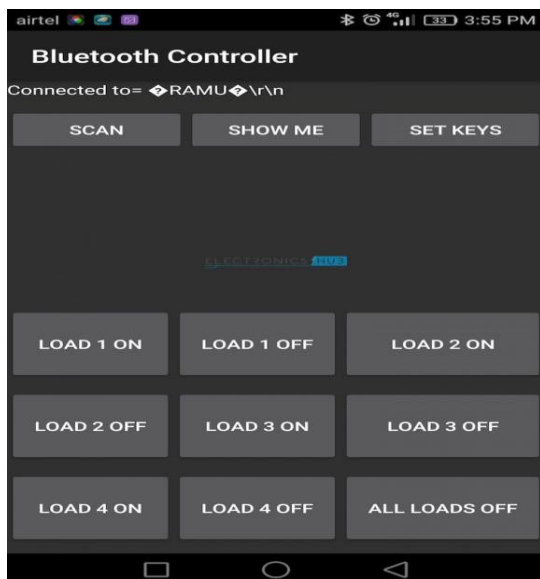
A simple home automation project using Arduino UNO, Bluetooth module and a smartphone. The aim of this project is to control different home appliances using a smartphone. After making circuit connection as per the fig, compile the Arduino program given below in Arduino IDE and upload program to Arduino Uno using USB B type data cable. Power up Arduino using 9v DC adapter. When the power is turned on, the connection LED on the Bluetooth module starts blinking. We need to start the “Bluetooth Controller” app in our smartphone and get connected to the Bluetooth module. If the pairing is successful, the LED becomes stable. Now, in the app, we need to set different keys for different loads and their corresponding value that must be transmitted when that key is pressed. The following image shows a set of keys to control 4 loads and an additional key to turn off all the loads.





Then we are ready to control the loads. When a key is pressed in the smartphone, the Bluetooth module receives the corresponding data and intern transmits that data to Arduino.

For example, if we press “LOAD 2 ON”, then the data received by the Bluetooth module is “2”. This data “2” is transmitted to Arduino. Arduino then compares the received data with the data written in the sketch and accordingly turns on the load 2. The similar action can be applicable to other keys and loads. Using this type of connection, we can control turn on or off different home electrical appliances using our smartphones. [12]



## Hardware Requirement:

- Arduino Uno
- Bluetooth – HC05
- Relay Board
- Tungsten Bulb(2)
- Connecting Wires
- AC power supply(230v)

## Software Requirement:

- Arduino IDE

## Description of the Important Component:

**Arduino UNO:** Arduino Uno is based on ATmega328 microcontroller (MCU). It consists of 14 digital input/output pins, six analogue inputs, a USB connection for programming the onboard MCU, a power jack, an ICSP header and a reset button. It is operated with a 16MHz crystal oscillator and contains everything needed to support the MCU. It is very easy to use as you simply need to connect it to a computer using a USB cable, or power it with an AC-to-DC adapter or battery to get started. The MCU onboard is programmed in Arduino programming language using Arduino IDE. In this home automation project circuit, Pins 10 and 11 of Arduino are connected to pins TXD and RXD of the Bluetooth module. Pins Gnd and Vcc of the Bluetooth module are connected to Gnd and +3.3V of Arduino board respectively. Pins 2, 3 and 4 are connected to the three relays (RL1, RL2 and RL3) of the relay board. Pins Vin and Gnd of the relay board are connected to pins Vin and Gnd of Arduino board, respectively. [13]

**Bluetooth Module:** The Bluetooth Module used in this project is HC- 05. As seen in the image below, this Bluetooth module has 4 – pins for VCC (5V), ground, TX and RX. This Bluetooth can be used with Bluetooth enabled phone (or tablet or laptop) and the

range of this module is approximately 10 meters. The module runs on 3.3V to 5V power supply. [13]

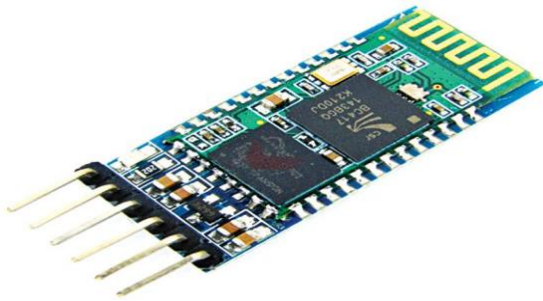


Fig: Bluetooth Module [3]

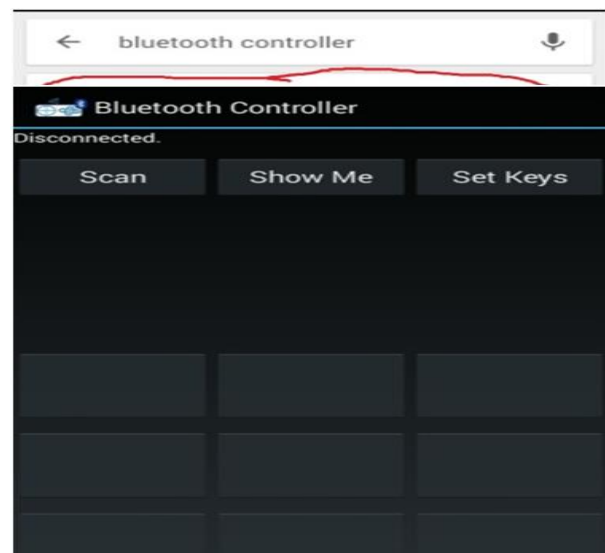
**Relay Board:** A relay board is used in this project to control different loads. A relay allows to turn on or turn off a circuit using voltage and/or current much higher than what Arduino could handle. Relay provides complete isolation between the low-voltage circuit on Arduino side and the high-voltage side controlling the load. It gets activated using 5V from Arduino, which, in turn, controls electrical appliances like fans, lights and air-conditioners. [13]

### Implementation:

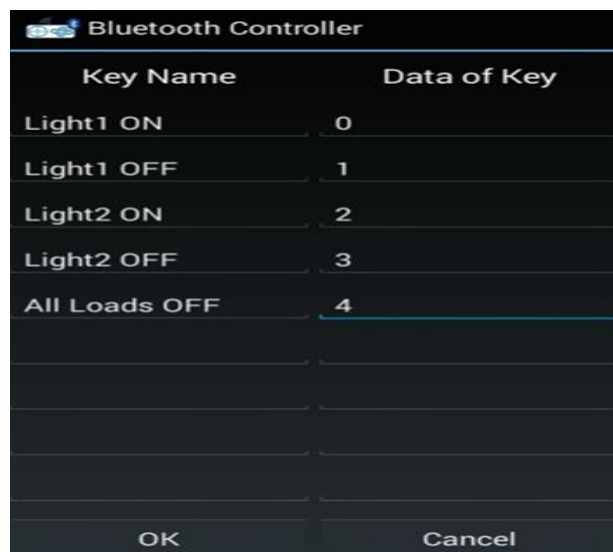
Since, we are not able to implement the project work in hardware due to the global crisis so we have to depend on simulation-based project. In our proposed system we are going to make a system by which will be able to control all the electrical appliances through the operation of microcontroller and Bluetooth module. In the system Arduino UNO will be used as a microcontroller and HC05 will be used as a Bluetooth module. The relay control board will be connected to the Arduino and electrical appliances. Using Bluetooth controller app, the whole system will be maintained.

### Test setup:

After implementing the simulation of the project, the system should be set up using the following procedure. First, we have to install Bluetooth controller app from play store. Once the Bluetooth in Android phone is turned ON and app is started, the following screen will be opened.

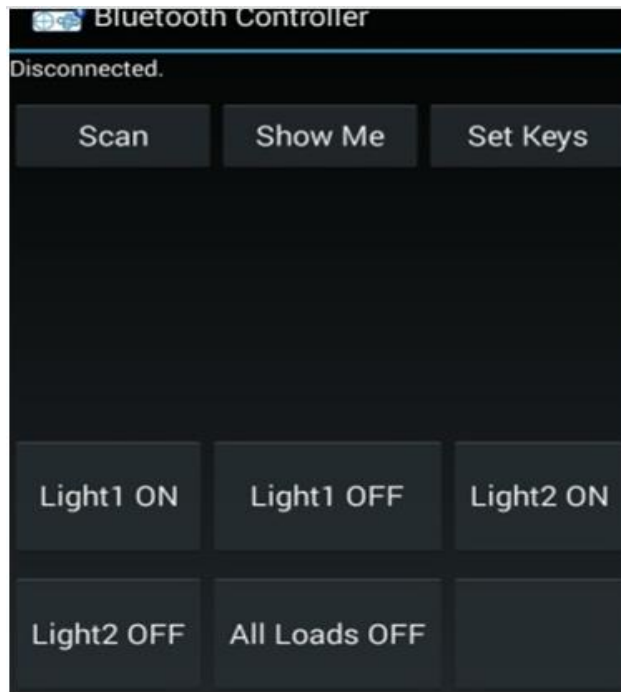


Here, we can set the data to be transmitted when a particular key is pressed by selecting “SET KEYS” option.





In order to connect Bluetooth module, it needs to press “SCAN” and list of available Bluetooth device select **your** Bluetooth device. “**Connected**” is appeared on top left of screen. Once the setup is done, we are ready to transmit the data to Arduino. When Light1 ON is press light1 will glow and if Light1 OFF is pressed Light1 will Off. Same to Light2. If we need turn OFF all lights, we need no press All Loads OFF.



### Cost analysis:

PRODUCT	Price
1.Arduino UNO	450 BDT
2.Bluetooth HC05	350BDT
3.Relay Board	1680BDT
4.Connecting wire	50BDT
<b>TOTAL COST:</b>	<b>2530BDT</b>

## 4. Results and Discussion:

### Home automation system codes:

```
sketch_apr14a | Arduino 1.8.12 (Windows Store 1.8.33.0)
File Edit Sketch Tools Help

sketch_apr14a $
#include <SoftwareSerial.h>
const int rxPin = 4;
const int txPin = 2;
SoftwareSerial mySerial(rxPin , txPin);
const int Loads[] = {9, 10};
int state = 0;
int flag = 0;
void setup()
{
  for (int i=0;i<2;i++)
  {
    pinMode(Loads[i], OUTPUT);
  }
  mySerial.begin(38400);
  for (int i=0;i<2;i++)
  {
    digitalWrite(Loads[i], LOW);
  }
}
void loop()
{
  if(mySerial.available() > 0)
  {
    state = mySerial.read();
    flag=0;
  }

  switch(state)
  {
    case '0':digitalWrite(Loads[0], HIGH); // turn ON light1
              flag=1;
  }
}
```

Done compiling.

```
sketch_apr14a | Arduino 1.8.12 (Windows Store 1.8.33.0)
File Edit Sketch Tools Help

sketch_apr14a $
    digitalWrite(Loads[i], LOW);
  }
}
void loop()
{
  if(mySerial.available() > 0)
  {
    state = mySerial.read();
    flag=0;
  }

  switch(state)
  {
    case '0':digitalWrite(Loads[0], HIGH); // turn ON light1
              flag=1;
              break;
    case '1':digitalWrite(Loads[0], LOW); // turn OFF light1
              flag=1;
              break;
    case '2':digitalWrite(Loads[1], HIGH); // turn ON light2
              flag=1;
              break;
    case '3':digitalWrite(Loads[1], LOW); // turn OFF light2
              flag=1;
              break;
    case '4':digitalWrite(Loads[0], LOW); // turn OFF light1
              digitalWrite(Loads[1], LOW); // turn OFF light2
              flag=1;
              break;
  }
}
}
```

Done compiling.

## **Simulation:**

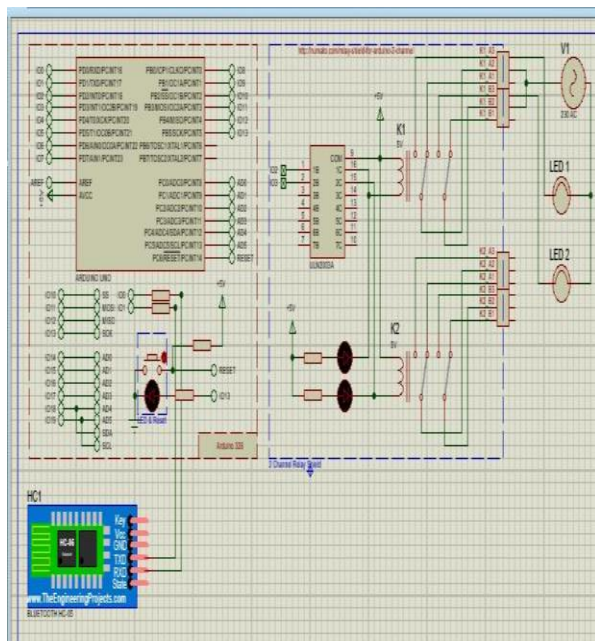


Figure-2: Home Automation

## **Experimental result:**

In this experiment, a flexible home control and monitoring system using Android based Smart phone is proposed and implemented. So, first of all we use Bluetooth controller app and connected it with the Bluetooth - HC05. And then we send data to relay board and relay send the data to switch. Relay 1 for bulb 1 and relay 2 for bulb 2. When we on the bulb 1 from Bluetooth app it sends data to relay 1 and relay 1 sends the data to the bulb1 and the bulb will on and When we on the bulb 2 from Bluetooth app it sends data to relay 2 and relay 2 sends the data to the bulb2 and the bulb will on . When the bulb 1 is on the bulb 2 will be off and when the bulb 2 is of the bulb 1 will be off.

## **Comparison between numerical result and experimental result:**

For the numerical result we selected a file where we store data and we selected the variable and pin mode will be with the output session. From Bluetooth HC05 we set high and low pulse and we upload the code. For experimental result we find the project are working according to the code simulation and we found some difficulties with the connection but we fix it.

The limitation is we try to update the device more but there are some difficulties of buying devices so that the implementation process is less than what we deserved and we can just use this only by Bluetooth ,without Bluetooth it will not work and we try to use sensor but because of some problem we failed to implement it. And this project will work for some limited IoT base devices like switch of fan and lights and some other devices which are connected with Bluetooth.

## **5. Impact of professional engineering solutions on society and environment:**

This project is mainly developed for Bluetooth based home automation system with Arduino UNO Board and Android application technology. The main concern of this project allows people to easily control fan, TV and everything from anywhere in the house with remote control. Home automation using Bluetooth and Arduino can prove to be very useful for Elderly/Handicapped people. Any android phone can be used, no internet required once the app is download. Everything is automated so it is easy to use. There is no need for extra training of that person who is using it. This project can provide the facility of monitoring all the appliances within the communication range through Bluetooth.

Besides supporting everybody's lifestyle, smart homes also have a large effect on the natural environment. The research has shown that automation can have a positive impact on the environment by reducing the peak load and shifting some of the energy consumption from day to night. This concept surely sounds familiar. Everyone remembers how our mothers used to do laundry at night when electricity is cheaper and then wake up earlier to hang them before work. When it comes to home automation, the principle is the same, except that you don't have to carry any burden of responsibility on your shoulders. This means that you do not even need to look at the clock to know when to turn on the washer. So, it's good for society people and environment. [14]

## **6. Conclusion:**

The system as the name indicates, 'Home automation' makes the system more flexible and provides attractive user interface compared to other home automation systems. In this system we integrate mobile devices into home automation systems. A novel architecture for a home automation system is proposed using the relatively new communication technologies. The system consists of mainly three components is a BLUETOOTH module, Arduino microcontroller and relay circuits. WI-FI is used as the communication channel between android phone and the Arduino microcontroller. We hide the complexity of the notions involved in the home automation system by including them into a simple, but comprehensive set of related concepts. This simplification is needed to fit as much of the functionality on the limited space offered by a mobile device's display. This paper

proposes a low cost, secure, ubiquitously accessible, auto-configurable, remotely controlled solution. The approach discussed in the paper is novel and has achieved the target to control home appliances remotely using the Wi-Fi technology to connects system parts, satisfying user needs and requirements. Wi-Fi technology capable solution has proved to be controlled remotely, provide home security and is cost effective as compared to the previously existing systems. Hence, we can conclude that the required goals and objectives of home automation system have been achieved. The system design and architecture were discussed, and prototype presents the basic level of home appliance control and remote monitoring has been implemented. Finally, the proposed system is better from the scalability and flexibility point of view than the commercially available home automation systems.

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