Home Automation System using Bluetooth

Controlling home appliances using voice/text commands.

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***Abstract*—Technology is a never ending process. To be able to design a product using the current technology that will be beneficial to the lives of others is a huge contribution to the community. This paper presents the design and implementation of a low cost but yet flexible and secure cell phone based home automation system where you can control your home appliances through voice or text commands. The design is based on a stand alone Arduino UNO board, HC-06 Bluetooth Module and the home appliances are connected to the input/ output ports of this board via relays. The communication between the smartphone and the Arduino UNO board is wireless. This system is designed to be low cost and scalable allowing variety of devices to be controlled with minimum changes to its core. Password protection is being used to only allow authorised users from accessing the appliances at home.**

Keywords—Android, Arduino, Microcontroller, Bluetooth, Wireless, Technology, Relay Board, Smartphone, Automation.

I. INTRODUCTION

Home automation system is use of information technologies and control system to reduce the human labor. The rapid growth of technologies influence us to use smartphones to remotely control the home appliances. An automated devices has ability to work with versatility, diligence and with lowest error rate [1]. The idea of home automation system is a significant issue for researchers and home appliances companies. Automation system not only helps to decrease the human labor but it also saves time and energy. Early home automation systems were used in labor saving machines but nowadays its main objective is provide facilities to elderly and handicapped people to perform their daily routine tasks and control the home appliances remotely. The Allied Business Intelligence (ABI) research [2] reports that almost 1.5 million automatic home appliances were installed in United States of America (USA) during 2012 and their increasing rate is 45.2%. In wireless based home automation system different type of technologies such as ZigBee, Z-Wave, Global System for Mobile (GSM), General Packet Radio Service (GPRS), Infrared, wireless fidelity (Wi-Fi)and Bluetooth are used, each technology has their own pros and cons. A Bluetooth based wireless home automation system can be implement with a low cost and it is easy to install in an existing home [3]. A research work proved that Bluetooth system are faster than wireless and GSM systems. Bluetooth technology has ability to transmit data serially up to 3 Mbps within a physical range of 10m to 100m depending on the type of Bluetooth device.

Wireless technologies are becoming more popular around the world and the consumers appreciate this wireless lifestyle which gives them relive of the well known “cable chaos” that tends to grow under their desk. Now with the embedded Bluetooth technology, digital devices form a network in which the appliances and devices can communicate with each other. Today, home automation is one of the major applications of Bluetooth technology. Operating over unlicensed, globally available frequency of 2.4GHz, it can link digital devices within a range of 10m to 100m at the speed of up to 3Mbps depending on the Bluetooth device class. With this capability of Bluetooth; we propose a home automation system based on Bluetooth technology.

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 we present a low cost secure cell phone based, flexible home automation system. Appliances at home are connected to the Arduino UNO board. The communication between the cell phone and the Arduino UNO board is wireless. Additional devices can be connected into the system with little modifications. Since the smartphone script and the app is written in Java, it is portable and can run on any Android Operating System platform. Figure 1[4] shows the block diagram of the overall system’s architecture.

In the next section, the system’s block diagram, general architecture and hardware implementations are discussed.

II. BLOCK DIAGRAM

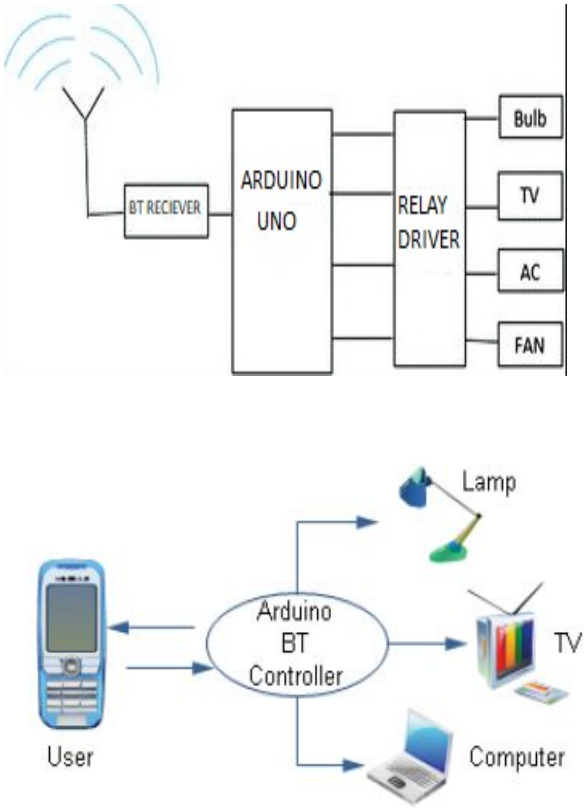

Figure 1. Block diagram of home automation system.

III. CIRCUIT DIAGRAM

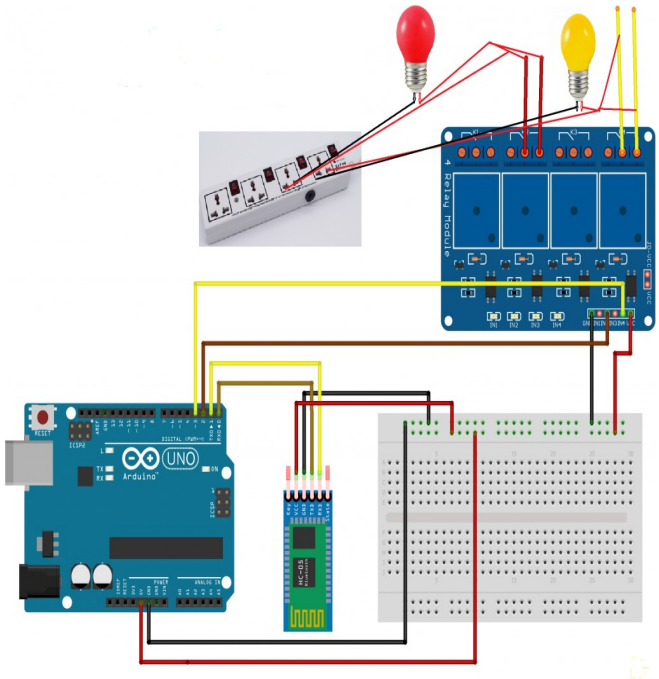

Figure 2: Circuit diagram of home automation system

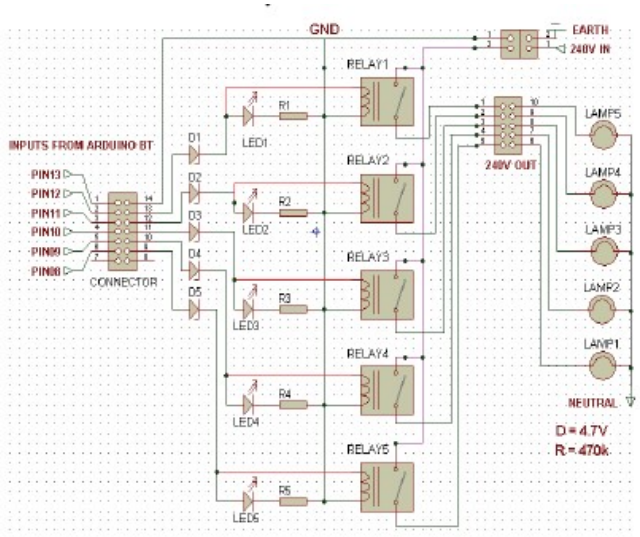

Figure 3: 15V-240V switching circuitry (Relay Drive)

IV. HARDWARE ARCHITECTURE AND IMPLEMENTATION

A. Hardware Architecture

This home automation system consists of two main hardware components: the cell phone and the Arduino UNO board. The smartphone phone hosts the Java script which enables the user to access the home appliances and also the control commands for the appliances. The Android app script communicates with the Arduino UNO board and sets up an ad-hoc communication protocol between the two devices, which allows controlling the behaviour of the Arduino UNO board.

The Arduino UNO is a widely used open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board features 14 Digital pins and 6 Analog pins. It is programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable. It can be powered by a USB cable or by an external 9 volt battery, though it accepts voltages between 7 and 20 volts. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform. The ATmega328 on the Arduino Uno comes preprogrammed with a bootloader that allows uploading new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol. The Uno also differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.[5]

An off-shell ready made 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 communication.This serial port bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate)3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Bluecore 04-External single chip Rluetooth system with CMOS technology and with AFH (Adaptive Frequency Hopping Feature).[6]

A Relay driver IC is an electro-magnetic switch that will be used whenever we want to use a low voltage circuit to switch a light bulb ON and OFF which is connected to 220V mains supply. The required current to run the relay coil is more than can be supplied by various integrated circuits like Op-Amp, etc.Relays have unique properties and are replaced with solid state switches that are strong than solid-state devices. High current capacities, capability to stand ESD and drive circuit isolation are the unique properties of Relays.[7]

B. Implementation

The Bluetooth antenna in HC-05 module picks up the packets sent from the smartphonephone. Subsequently, these packets containing the appliance status commands are pipelined through Atmega328 microcontroller and the designed analogue circuitry according to the definition of each output. Different home appliances are connected to the digital output ports of the Arduino BT board via relays to provide sufficiently high currents and voltage compatibility. For test purposes, 25W, 240V lamps have been used. Figure 2 shows the relay configuration for each device and Figure 3 depicts the Arduino BT board's communication with the home appliances. Sending commands from software to turn ON/OFF a device may not guarantee the successful operation of the device as the device may be defective. To solve this problem, a feedback circuit has been designed and implemented to indicate the device's actual status after it receives the command (ON/OFF) from the cell phone. Once the command has been sent to turn ON a device, the feedback circuit senses the current and gives an output signal by turning ON a respective led on the switching circuitry indicating that the device is ON. Otherwise, the device is malfunctioning indicating that the command was not executed successfully.

V. APPLICATIONS

Using this project, we can turn on or off appliances remotely i.e. using a phone or tablet. ¬ The project can be further expanded to a smart home automation system by including some sensors like light sensors, temperature sensors, safety sensors etc. and automatically adjust different parameters like room lighting, air conditioning (room temperature), door locks etc. and transmit the information to our phone.

Additionally, we can connect to internet and control the home from remote location over internet and also monitor the safety. Future Development of the project Arduino based device control using Bluetooth on Smartphone project can be enhanced to control the speed of the fan or volume of the buzzer etc.

Home automation and Device controlling can be done using Internet of Things – IOT technology.We can replace Bluetooth by GSM modem so that we can achieve device controlling by sending SMS using GSM modem.

VI. CONCLUSION

In this paper we have introduced design and implementation of a low cost, flexible and wireless solution to the home automation. The system is secured for access from any user or intruder. The users are expected to acquire pairing password for the Arduino BT and the cell phone to access the home appliances. This adds a protection from unauthorized users. This system can be used as a test bed for any appliances that requires on-off switching applications without any internet connection. The full functionality of the home automation system was tested and the wireless communication between the smartphone and Arduino UNO was found to be limited to <20m in a concreted building and maximum of 40m range was reported to be applicable in an open range.

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