Voice Controlled Home Automation System Using Arduino

Vikas Pal*[1], Sumit Kumar*[2], Virender Kumar*[3], Gunjan Jha*[4], Peeyush Pant*[5]

[1,2,3,4,5]*Department of Electrical and Electronics Engg., Bhagwan Parshuram Institute of Technology, Guru Gobind Singh Indraprastha University Delhi, India*

Abstract—Establishing home automation system to improve comfort, convenience and quality of life has gained popularity and effectiveness during last decades. This has encouraged researchers to develop flexible techniques for home automation systems which are user friendly and cost effective. For home automation utilizing smartphone with microcontroller and application platform seems attractive option. Among various schemes proposed by researchers voice controlled home automation is seems effective since it reduces human efforts and errors with improved efficiency. These systems also addresses problem of elderly/ disabled people else they require dedicated human assistance to control the household appliances. In this paper a voice controlled home automation system is designed and implemented using Arduino UNO, bluetooth HC-05 and smartphone. The Bluetooth module transmits data for controlling receives input signal from a device having bluetooth compatibility viz smartphone with interface software Arduino-Uno. The system prototype is operated by the voice commands for household electrical appliances electric lamp and table fan.

Keywords: Home Automation, Electrical Appliances, Voice Recognition, Arduino, Bluetooth Module, Smartphone Application.

I. INTRODUCTION

Improvement in comfort level, convenience to control appliances and quality of life by installing home automation system has increased its popularity and effectiveness. Modern home automation systems aim to deliver easiness to the users including elderly and disabled peoples by reducing human effort and labor [1], [2]. A typical modern home automation system uses single controller for connected appliances viz power plugs, lighting devices, temperature and/or humidity sensors, detectors installed for smoke, gas and fire besides regulating emergency and security systems [3]-[5]. Latest home automation devices also embed renewable energy based systems offering advantages of flexible control and easy management through smartphone, tablet, desktop and laptop [6]. Growth in wireless technologies has also boosted development of home automation systems by enabling controlling and monitoring automated home appliances by smartphones anywhere from the globe. Several home automation systems have emerged by using smartphones with microcontrollers. Various wireless communication techniques viz IoT, GSM, ZigBee, and EnOcean have been utilized for the same and proposed by the researchers [7]-[9]. Variety of home automation systems have been proposed to offer flexible functions, services and controls. Typically the common features may include appliance control, thermostat control, remote control lighting, live video surveillance, monitor security camera, real time text alerts [10]-[13].

Several investigations proposed by the researchers are focused on technologies which incorporates features like flexibility, easy operation and low cost. Accordingly Smart GSM based hhome aautomation ssystem has been proposed [14]. However the system was sluggish with limited operational features. Also, simple web controlled home automation system with fault detection is proposed [15]-[17]. Investigations were also made on sensor network for home automation [18], [19]. Courreges et.al. reported investigations to evaluate Performance and interoperability of radiofrequency home automation protocols and Bluetooth low energy for smart grid and smart home applications [20]. Voice controlled home automation system has scopes for development of reliable, effective and flexible systems.

In this paper voice controlled home automation system by using bluetooth technology has been proposed. The system enables user to control the home appliances from humane voice by microphone of a smartphone. This system has been integrated with electrical appliances and controls them by using voice commands. The proposed system uses Bluetooth module for transmitting data for controlling the operation of electrical appliances. The system interfaces on/off switches of electrical appliance by solid state relay to control the device. The voice command is sent by using software designed for controlling the system which integrates microphone and voice recognition system implemented in device such as Arduino Voice Control application. A micro-controller ATMEGA320P (Arduino Uno) is embedded in the system.

The systems user interface device is a smartphone and software which interface with Arduino Uno to execute commands of user. The proposed smart home automation can also offer support personal by eradicating the issue to turn on/off electrical switches and controlling by voice commands. The system is so designed that user can control all appliances at once or can control each appliance separately.

II. METHODOLOGY

Methodologies employed in a home automation system are rigorously analyzed to identify the gap for developing a platform by using proposed voice automation system [21]. The schemes are summarized as follows.

A. Bluetooth Based Home Automation System

Home automation systems use smartphone and Arduino BT board. The communication between Arduino BT board and cell phone is made wirelessly using Bluetooth technology. The range of Arduino BT board lies in 10-100 meters with 3 Mbps data rate and 2.4GHz bandwidth. Accordingly the home appliances are connected to the Arduino-BT board with a relay circuit. The cell phone has a software platform allowing user to control the device. These systems can use password protection enabling system security. Also the advantage of easy setting into homes and automated system with low cost user friendly, smart living system. The system suffers from issue of having limit to control the home appliances within the Bluetooth range.

B. Voice Recognition Based Home Automation

A voice recognition based home automation system consists of Arduino UNO and smartphone. Bluetooth technology is employed for the wireless communication between the smartphone and the Arduino UNO. Since Android operating system has voice recognizing feature which is utilized to develop an application capable to control the home appliances from the command of user voice. Conversion of user voice command into text and its transmission to message via Bluetooth module is made. The bluetooth is connected with Arduino UNO. One advantage of such voice controlled home automation system includes the fact that user only pronounce the appliance name in smartphone microphone and telling it to switch ON or OFF the appliances, in this way the users can control home appliance easily without any effort. The main issue of this system is of having limited range due to Bluetooth. However the range can be increased using internet instead of Bluetooth. Also the system is not effective in a noisy environment.

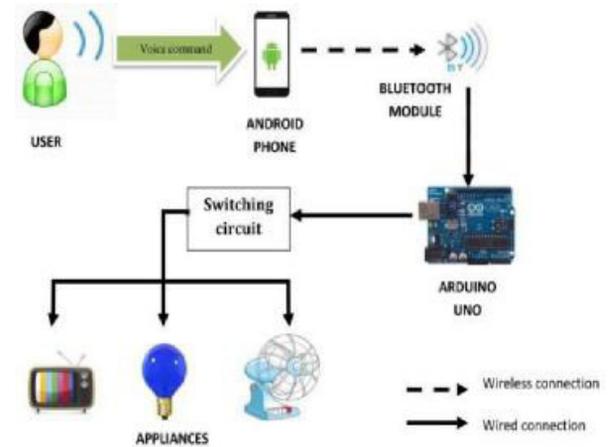### C. ZigBee Based Wireless Home Automation System

Figure 1: Block Diagram of the proposed System

These systems consist of three main modules as handheld microphone, central controller and the appliance controller. The Handheld microphone module uses ZigBee protocol and whereas the central controller module are based on PC. Microsoft speech API is used as a voice recognition application and the wireless network is established using RF ZigBee modules. These offers low power and cost efficiency. The system records voice at a sampling frequency of 8 KHz. The encoding frequency range lies in between 6 Hz to 3.5 KHz. Differential pulse code modulation technique compresses data from 12 bits to 6 bits. The data bits are sent from the microcontroller to the RF ZigBee module at the

maximum baud rate of 115200 bits/s. The ZigBee communication protocol offers maximum baud rate of 250 Kbps, but 115.2 Kbps was used for microcontroller for sending and receiving data. Accuracy of this system is restricted in the range of 40 meters and the recognition system is accurate, up to 80m.

D. Global System for Mobile communication Based Home Automation System

The hardware architecture of the system by using global system for mobile communication (GSM) consist GSM modem, PIC16F887 microcontroller and a smartphone. The system used a GSM modem controls the electric appliances through SMS. In schemes PIC16F887 microcontroller is interfaced with a GSM modem and it is used to read and decode the received SMS to execute the specific command. Home appliances are connected with microcontroller and relays. RS232 is used for serial communication between modem and microcontroller.

The process of sending and receiving commands executes within 2 seconds. This system permits users to get feedback status of household appliances via SMS on their smartphones. The wide availability of GSM network assures users can get worldwide accessibility to control appliances for maximum security and reliability.

E. EnOcean based home automation system

The EnOcean is a new technology for developing energy harvesting and used in transportation, building and home automation systems. These devices utilize 315 MHz band and provides convenient ways for home automation system. Home automation system can be built up by utilizing internet, router, automation controller, duckbill-2 and EnOcean and devices. This system can effectively work as a stand-alone automation controller inside building automation systems.

III. SYSTEM DESIGN

The block diagram of the proposed System is shown in Fig.1. The voice-operated android and Arduino home automation system uses an android based bluetooth enabled phone for its application and the Arduino Uno as the microcontroller. The key components of this system included android smartphone, Bluetooth module, arduino Uno and relays. The brief description is as follows.

a) Android based smartphone

Android is a mobile operating system (OS) based on the Linux kernel and currently developed by Google. With a user interface based on direct manipulation, the OS uses touch inputs that loosely correspond to real-world actions, like swiping, tapping, pinching, and reverse pinching to manipulate on-screen objects, and a virtual keyboard. The voice recognizer which is an in built feature of Android phones is used to build an application which the user can operate to automate the appliances in his house. The microphone button is tapped and the voice command is given to switch the corresponding device on/off. The voice recognizer listens and converts what is said to the nearest matching words or text. The Bluetooth adapter present in the phone is configured to send this text to the Bluetooth module on the Arduino Uno board that would in turn control the electrical appliances through the relay boards.
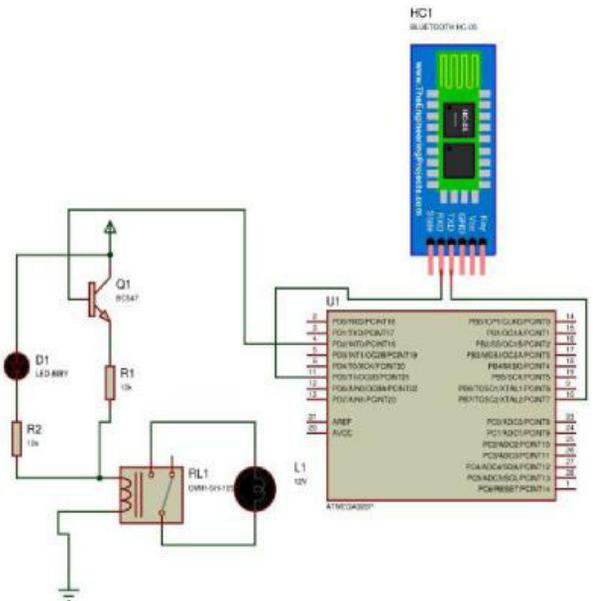

Figure 2: Configuration of proposed circuit

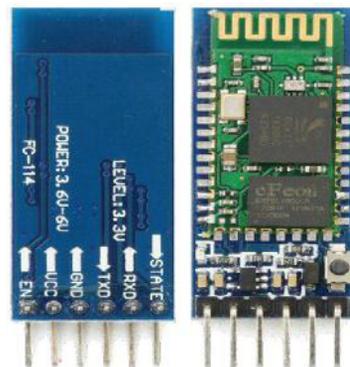**Figure 3: Arduino Voice Control Application**

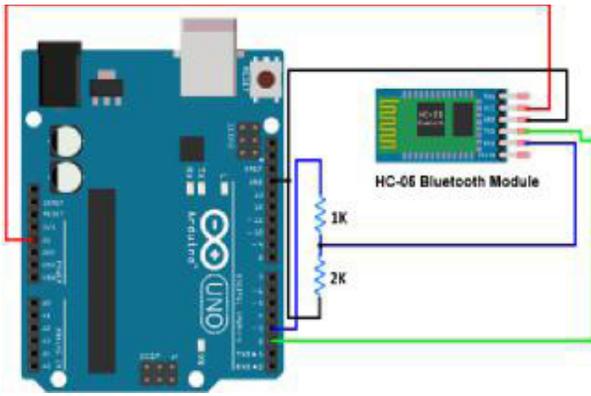**Figure 4: HC-05 Blutooth Module**

Figure 5: HC-05 Bluetooth Interfacing with Arduino UNO

The automation system connects with the smartphone through Bluetooth. The smart phone sends control signals to switch home appliances ON or OFF by an android app through Bluetooth interface. The project is built on Arduino UNO and is used to control LEDs and four home appliances connected to the Arduino through relays. (Refer Figure 2). Application in an android smartphone as shown in figure 3.

B. *Bluetooth module*

The pictorial representation of the deployed Bluetooth modules is shown in Figure. 4. The Bluetooth technology for exchanges data over short distances (using short-wavelength UHF radio waves in the ISM band from 2.4 to 2.485 GHz) from fixed and mobile devices, and building personal area networks (PANs). The Bluetooth module being used allows us to transmit and receive signals. It receives the text from the Android phone and transmits it to the serial port of the Arduino Uno. HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. 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 Bluetooth system with CMOS technology and with AFH(Adaptive Frequency Hopping Feature). It has the footprint as small as 12.7mmx27mm. Hope it will simplify your overall design/development cycle. HC-05 Bluetooth Module Interfacing with Arduino UNO is compulsory for the data or command transmission. Default settings of HC-05 Bluetooth module can be changed using certain AT commands. As HC-05 Bluetooth module has 3.3 V level for RX/TX and microcontroller can detect 3.3 V level, so, there is no need to shift TX voltage level of HC-05 module. But we need to shift the transmit voltage level from microcontroller to RX of HC-05 module.

C. *ARDUNO UNO*

The Arduino Uno as depicted in Figure 6 is a microcontroller board based on the ATmega328p. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller. We either need to connect it to a computer using a USB cable or power it with an AC-to-DC adapter. The Arduino circuit acts as an interface between the software part and the hardware part of the project.
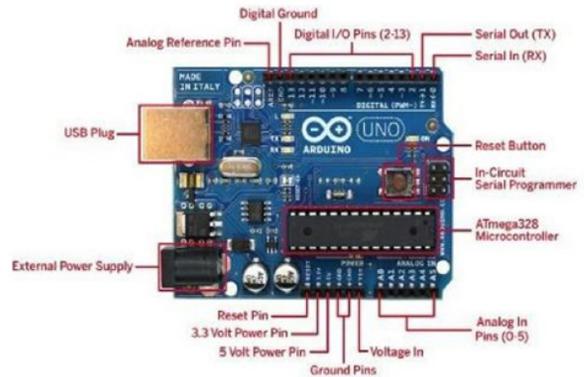
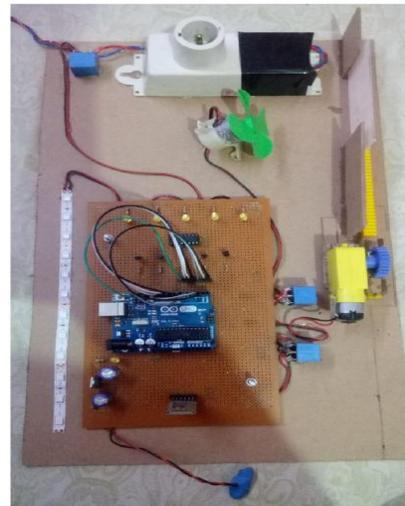

Figure 6: arduino uno

Figure 7: Prototype of proposed voice controlled home automation

The Bluetooth module transmits the text to the Arduino Uno serial port. The text is matched against the various combinations of predefined texts to switch the appliances on/off. The appliance name and a command for on/off are stored as predefined command. For example, to switch on a television the user needs to say "television

on" and to switch it off he needs to say "television off". The appliances are connected via the relay boards to pin numbers 2, 3 and 4 of the Arduino Uno. When the matching text is detected the corresponding pin number is given a high or low output signal to switch the appliance on and off respectively.

D. Relays

The mechanical relay have capability for acting as switch for turning on and off electrical loads. They Woks simply by providing small electrical power in form of electrical signal. This allow high power loads controlled by using small amount of power. The mechanical relay uses electromechanical coil to open and close the circuit. When small amount of current passes through coil it excites the coil and generates magnetic field and either pull the bar or release the bar which is used for opening and closing the circuit, here opening and closing means restricts flow of current and vice versa respectively.(Refer Figure 7) a relay is an electromagnetic switch. In other words it is activated when a current is applied to it. Normally a relay is used in a circuit as a type of switch (as shown below). There are different types of relays and they operate at different voltages. When a circuit is built the voltage that will trigger it has to be considered. In this project the relay circuit is used to turn the appliances on/off. The high/low signal is supplied from the Arduino Uno microcontroller. When a low voltage is given to the relay of an appliance it is turned off and when a high voltage is given it is turned on. The relay circuit to drive four appliances in the Voice-operated Android and Arduino Home automation system is shown below. The number of appliances can be modified according to the user's requirements.

Figure 8: Relay

IV. PROPOSED SYSTEM MODEL

The system is designed by using three main components, first is microcontroller Arduino Uno, second is Bluetooth module HC-05 and third is mechanical relay. Firstly user gives the command to microcontroller by using speech recognition system of smartphone and system software application via Bluetooth module HC-05. The microcontroller acts accordingly to the command give user and controls the functionality of mechanical relay. The Arduino Uno is programmed using Arduino IDE which is software; the user interface application is Arduino Voice Control. As the figure 8 shows it is is the home automation system or we called Voice Controlled Home Automation.

V. IMPLEMENTATION AND TEST PROTOTYPE

A low cost and efficient smart home system is presented in the proposed design shown in Fig.8. This system has two main modules: the hardware interface module and the software communication module. At the heart of this system is the Arduino Mega 2560 microcontroller which is also capable of functioning as a micro web server and the interface for all the hardware modules. All communication and controls in this system pass through the microcontroller.

Using the above mentioned components we implement our system on a breadboard. The microcontroller device with the Bluetooth module and relay circuit needs to be attached with the switch board. Then we need to launch the android based application-"ARDUINO VOICE CONTROL" on our Smartphone. Through the application we can instruct the microcontroller to switch on/off an appliance. After getting the instruction through the Bluetooth module the microcontroller gives the signal to the relay board.

The application first searches for the Bluetooth device. If it is available then it launches the voice recognizer. It reads the voice and converts the audio signal into a string. It produces a value for each appliance which will be given to the microcontroller device. The microcontroller uses the port in serial mode. After reading the data it decodes the input value and sends a signal to the parallel port through which the relay circuit will be activated. In this work we use Bluetooth module. We can also attach a GSM module to do the work, using which the application can be used anywhere where a mobile network is available.

VI. FURTHER DEVELOPMENT

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. Replacement of Bluetooth by GSM modem may achieve device controlling by sending SMS using GSM modem.

VII. CONCLUSIONS

The prototype of the voice controlled home automation system is fabricated in laboratory. The test results of experimental prototype has proven to work satisfactorily by connecting sample appliances to it and the appliances were successfully controlled from a wireless mobile device. Also the Bluetooth client was successfully tested on a multitude of different mobile phones from different manufacturers, thus proving its portability and wide compatibility. Thus a low-cost home automation system was successfully designed, implemented and tested. The project has been designed by keeping in mind needs of all consumers for performing operation of turning on and off electrical appliance by using user interface device by giving voice commands wirelessly. The Bluetooth module can be removed and instead of Bluetooth module high range communication device can be implemented in system for better and reliable use of system.
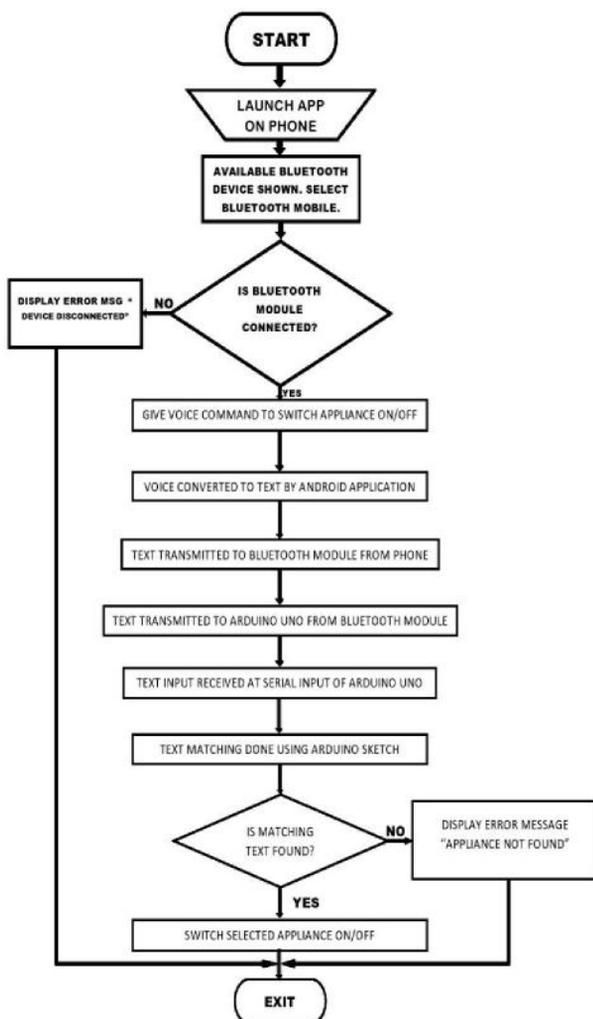

Figure 9: System flow chart

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