Wireless Home Automation System using ZigBee with Voice Recognition
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Abstract— In this paper a wireless voice regulated smart home system has been presented for oldest man and disabled people. The proposed system has two main components one is voice recognition system, and other is wireless communication system. Arduino controller board has been used to implement the wireless system. ZigBee wireless module has been used to implement the wireless communication system. The main purpose of this system is to control home appliances by using voice commands as well as by using manual switching. The system can recognize is voice command and translate them into the required data format and send the data through ZigBee transmitter. Based on received data through ZigBee receiver, arduino controller will perform chosen switching operations with home appliances.

Key words: Arduino Mega 2560, Zigbee, HM 2007 Voice Kit

I. INTRODUCTION
Home automation is one of the major growing technologies that can change the way people live. Some of these home automation systems target those seeking luxury and sophisticated home automation platforms; others target those with special needs like the elderly and the disabled [1]. The wireless technology based home automation system can respond to voice commands and control the on/off status of home appliances such as lamps, fans, air conditioners, television etc, in the home. Also this system can open/close door of home through d.c. motor.

The overall system is controlled from a microphone which is connected with HM 2007 speech recognition chip. The microphone in the transmitters section will be picking up audio in a close range. The audio signal from the microphone will be input into the HM 2007 speech recognition chip. The HM 2007 chip will process the audio and determine if the commands are speech commands and valid then it will pass the commands through Arduino controller board and ZigBee to receiving section where the matched command operation will be performed [3]. A 16 x 2 LCD interfaces with the Arduino controller board to display the current status of the sensors and relay switches on/off state.

II. SYSTEM OVERVIEW
In Zigbee based home automation system basically there are two sections: (1) Transmitter section, and (2) Receiver section.

A. The transmitter section consists of speech recognition unit HM2007, Arduino controller board, 16 x 2 LCD and Zigbee transceiver.

The microphone in the transmitters section will be picking up audio in a close range. The audio signal from the microphone will be input into the HM–2007 speech recognition chip. The HM 2007 chip will process the audio and determine if the commands are speech commands and valid then it will pass the commands through Arduino controller board and ZigBee to receiving section where the matched command operation will be performed [3]. A 16 x 2 LCD interfaces with the Arduino controller board to display the current status of the sensors and relay switches on/off state.

B. The Receiver Section Mainly Consists of Zigbee Transceiver, Arduino Controller Board, DH11 TEMP + HUMIDITY Sensor and relay switches board.
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III. HARDWARE DESIGN METHODOLOGY

This section will mention the methodology involved in the hardware design of the Wireless Home Automation System Based on ZigBee with voice recognition.

The hardware descriptions of the modules are:
- Speech Recognition Unit
- ZigBee
- Arduino controller board
- Liquid Crystal Display (HD 162A): 16x2 LCD that is 16 characters per row.
- Power supply unit.
- Different sensors, relay switches board

A. Speech Recognition Unit

The speech recognition unit is a completely Assembled and easy to use programmable speech recognition circuit. The heart of the circuit is the HM2007 [4]. Speech recognition IC. The IC can recognize 20 words, each word a length of 1.92 seconds.

Fig. 3: Speech recognition unit based on HM2007 [5]

The HM2007 is a CMOS voice recognition LSI (Large Scale Integration) circuit. The chip contains an analog front end, voice analysis, regulation, and system control functions. The chip may be used in a stand alone or CPU connected.

1) Features:
- Single chip voice recognition CMOS LSI
- Speaker dependent
- External RAM support
- Maximum 40 word recognition (.96 second)
- Maximum word length 1.92 seconds (20 word)
- Microphone support
- Manual and CPU modes available
- Response time less than 300 milliseconds
- 5V power supply

Following conditions must be performed before/when Power-up of the hm2007:
- Pin cpum must be logical high (pdip pin 14, plcc pin 15), this means select Cpu-mode.
- Pin wlen must be logical low (pdip pin 13, plcc pin 14), this means select 0.92 sec word length.

This is very important; else the hm2007 will lock, or give Wrong command answer when result data is read [4].

B. Pin Configuration

Fig. 4: Pin Configuration of HM2007P

C. ZigBee

ZigBee is an IEEE 802.15.4 standard for data communications with business and consumer devices. Zigbee is targeted at applications that require low data rate, long battery life, and secure networking.

1) Features
- Global operation in the 2.4GHz frequency band according to IEEE 802.15.4
- 2.4GHz and 868/915 MHz dual PHY modes
- Frequency agile solution operating over 16 channels in the 2.4GHz frequency
- Incorporates power saving mechanisms for all device classes
- Discovery mechanism with full application confirmation
- Pairing mechanism with full application confirmation
- Multiple star topology and inter-personal area network (PAN) communication
- Various transmission options including broadcast
- Security key generation mechanism
- Utilizes the industry standard AES-128 security scheme
- Supports Alliance standards (public application profiles) or manufacturer specific profiles [6].

Fig. 4: Pin Configuration of ZigBee

D. Data Transfer Modes in Zigbee Technology:

The data can be transferred in two modes: Beacon Mode and Non-beacon mode. In beacon mode, the data is sent periodically in the network. During the time period when the devices do not send information, they enter into a low-power sleep state to gain power consumption. But, the close timing and network synchronization have precise
timing needs as the beacon period is of the order of low time. So, the beacon state reduces costs and eventually is a tradeoff between the design constraints and costs. With a non-beacon mode, the coordinators and the routers active in the network have to stay awake for most of the time to listen to the incoming data and hence need robust power supply. So, the end devices can sleep most of the time and wake up solely for sending data and receiving a trigger; while the core devices are in active mode, the non-beacon mode creates an asymmetric power distribution within the network area by creating a heterogeneous network.

E. Arduino Controller Board

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.

It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC to DC adapter or battery to get started. The Mega is compatible with most shields designed for the Arduino Duemilano or Diecimila.

![Arduino Mega2560 controller board](image)

1) Features

- Open source
- Large community
- Multi-platform Win/Mac/Linux
- USB interface and USB programmable
- Voltage regulator
- Communication
- Input or output

<table>
<thead>
<tr>
<th>Microcontroller</th>
<th>ATmega2560</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Voltage</td>
<td>5V</td>
</tr>
<tr>
<td>Input Voltage (recommended)</td>
<td>7-12V</td>
</tr>
<tr>
<td>Input Voltage (limit)</td>
<td>6-20V</td>
</tr>
<tr>
<td>Digital I/O Pins</td>
<td>54 (of which 15 provide PWM output)</td>
</tr>
<tr>
<td>Analog Input Pins</td>
<td>16</td>
</tr>
<tr>
<td>DC Current per I/O Pin</td>
<td>20 Ma</td>
</tr>
<tr>
<td>DC Current for 3.3V Pin</td>
<td>50 Ma</td>
</tr>
<tr>
<td>Flash Memory</td>
<td>256 KB of which 8 KB used by bootloader</td>
</tr>
<tr>
<td>SRAM</td>
<td>8 KB</td>
</tr>
</tbody>
</table>

Table 1: Technical Specifications

The Arduino Mega 2560 can be powered by the USB connection or with external power supply. External power can come either from an AC-to-DC adapter or battery.

The Arduino Mega 2560 board has a number of facilities for communicating with a computer, another board, or other microcontrollers. The ATmega2560 provides four hardware UARTs for TTL serial communication.

2) Driver IC L293D

![Pin configuration of Driver IC L293D](image)

Driver IC L293D is used to interface DC motor with arduino controller board for door open/close in this home automation system.

a) LCD

Types of LCD

- Alphanumeric LCD
- Graphical LCD

Types of Alphanumeric LCD:

- 16x2
- 20x2

Two types of Graphical LCD

- Colour LCD
- Non-colour LCD

![Pin Configuration of LCD](image)

Table 2: Pin Description of LCD
b) DH11 temp+humidity sensor

![DH11 temp+humidity sensor](image1)

This DH11 Temperature & Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output. By using the exclusive digital-signal-acquisition technique and temperature & humidity sensing technology, it ensures high reliability and excellent long-term stability. The calibration coefficients are stored as programmers in the OTP memory, which are used by the sensor’s internal signal detecting process. The single-wire serial interface makes system integration quick and easy. Its small size, low power consumption and up-to-20 meter signal transmission making it the best choice for various applications, including those most demanding ones. The component is 4-pin single row pin package. It is convenient to connect and special packages can be provided according to users’ request.

3) Software Design

Software design includes voice recognition, transmission and reception of wireless signal using ZigBee transceiver, read the sensors, update the status of relay switches and display the status on LCD display accordingly.

The main program for this system is written by using the AVR C programming language in Arduino software. The Arduino software includes a serial monitor which allows textual data to be sent to and from the board via USB connection between Arduino board and the computer. So the main program of Arduino software is sent to Arduino controller board via USB connection. The schematic diagram for this system which consists of all the components was designed by using the Proteus ISIS 7 professional editions.

![Software design for Tx.](image2)

![Software design for Rx.](image3)

![Software design for Arduino](image4)

IV. CONCLUSION

Wireless Home Automation system based on ZigBee with Voice recognition is very useful project for physically disabled persons and old aged people. The prototype developed can control electrical devices in a home or office. The system implements the wireless network using ZigBee RF modules for their efficiency and low power consumption. ZigBee Home Automation provides operating range much higher as compared to Bluetooth and other wireless sensor module. The Arduino software is used in this project which is easy to use and flexible enough for user.

REFERENCES


