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Speaker Identification Based Home Automation System for Aging populations through Speech Recognition

Aamir Ali Malik[1], Fahad Raza Nizamani[2]

[1]Department of Electrical Engineering, Sukkur Institute of Business Administration, Sukkur, Sindh, Pakistan

[1]aamir.malik@iba-suk.edu.pk

[2]Department of Electronics Engineering, Hamdard University Karachi, Sindh, Pakistan

[2]fahad.raza123@hotmail.com

Abstract— Old aged or disabled persons who can't walk are most sensitive persons and they must be served in a systematic, quick, sophisticated and efficient manner by very little effort. The problem is that there is no anybody who is always with them for 24 hours. Speech recognition can be used to serve the old aged or disable persons and to give a full control to them so that they may control all the appliances of home. Traditional home automation systems are not cost effective and they are not suitable for aging populations or disable persons. This paper presents an effective method to overcome these problems. We have designed and implemented a low-cost, reliable, efficient and secure speech operated system for home appliances especially for persons with disabilities to do their work at home. This system is both software and hardware designed using MATLAB R2009a. This system is divided into three main parts namely voice train process, voice recognition process and integration of hardware with MATLAB. This system used speaker dependent method. This proposed design is novel in the way that it is controlling loads by speech recognition using MATLAB to turn on/off loads via parallel port of a computer.

Keywords— Speaker Identification, Speech operated system, Home Automation system, Home Appliances, Aging populations, Speech Recognition, MATLAB Coding.

I. INTRODUCTION

Speech Recognition Systems have become so advanced and mainstream that business and health care professionals are turning to speech recognition solutions for everything from providing telephone support to writing medical reports [1, 2].

In many homes there are many people who are old aged or disabled and they can't walk. And there is no anybody who is always with them for 24 hours. There are people who look after them in periodic intervals. The problem is that when a people visits them then it is might not necessary that they needs them but the old aged or disabled person may need a person when he/she is not present with them. Hence home automation systems play a crucial role for elderly or disable persons, so that they can feel comfortable, independent and secure.

Voice activated technology is a rapidly developing area of the computer world. Today, many devices incorporate voice activation technology so certain functions of the device can be performed based on voice commands. For example, many home appliances are equipped with voice-activated technology as to allow a consumer to orally command, for example, a lighting system to power on by using voice commands. Such a feature is particularly advantageous when a person cannot manually activate a device because their hands are occupied or the device switch is in an inconvenient place. For example, one may be carrying groceries into a house and is unable to manually activate the light switch, consequently, if the lighting system in the house has voice activated technology therein, the person may simply say, for example, "lights on" to activate the lights [3].

Speech recognition is the process by which a computer (or other type of machine) identifies spoken words. Basically, it means talking to your computer, and having it correctly recognize what you are saying. This is the key to any speech related application. There are a number ways to do this but the basic principle is to somehow extract certain key features from the uttered speech and then treat those features as the key to recognizing the word when it is uttered again[4].

In this research paper, a low cost, reliable, efficient and secure Speaker identification based home automation system is presented which utilizes the use of biometric method such as human voice as a directive to activate any electrical appliances. This objective makes the human's voice as an input to the system and this system is speaker dependent that mean only the real or trained user and right command can activate the appliances. This produces and improves the security level of the system.

This research paper is based on 5 sections. Section II is based on literature review and reviews the common techniques and methods used for Home Automation systems. Section III is based on the methods and techniques which we have used for Speaker Identification based Home Automation system and describe our contribution as well. Section IV is based on results and discussions, and reflects the results obtained from research work. Section V is based on conclusions and future recommendations and concludes the research paper with the important suggestions and findings from the carried out research work.

II. LITERATURE REVIEW

Several techniques and methods are available for Home automation system. The common methods are given as:

1. Home Automation System using GSM Technology

Home Automation Systems are mostly developed by using microcontroller as a central controlling unit. The Central Control Unit is the hub and brain of a home automation system [5]. We consider three options for communication with GSM, namely SMS based, GPRS based and DTMF based Home Automation systems. Home appliance control system provides security on detection of intrusion via SMS using GSM technology [6]. In this system, user sends SMS from mobile phone to the GSM module connected with Microcontroller and on the basis of SMS various appliances in the home are turned on/off. This system provides mobility to user so that user can turn on/off appliances from anywhere in the world. However it is not possible to implement this system where the user is old aged or disabled with illness due to the main two reasons. The first main reason is that to use this system a user must know the use of mobile for sending SMS generally old aged person don't know much about creating and sending SMS and second is providing mobile phone to each old aged or disabled person is not cost effective. GPRS based technology uses a webcam to stream video and pictures of the home to its owner's mobile through GPRS. In GPRS based Home Automation system user has to monitor his/her phone constantly to successfully defend against intrusion detection. In DTMF based Home Automation system user calls a SIM number assigned to the home and presses the digits on their phone's keypad to control the home's devices by generating a DTMF tone. The tone is received and decoded by the GSM module at home using a DTMF decoder. The decoded instructions are passed to the microcontroller so that user commands can be implemented at home [7]. DTMF-based home security systems also have their security flaws. They are vulnerable to "fuzzing attacks," as described by R.Sasi [8]. This may cause whole home network to crash.

2. Home Automation System via Gesture Recognition System

Traditional input systems for interaction with machines include keyboards, joystick or the mouse. Those suffering from physical handicaps such as Carpel Tunnel Syndrome, Rheumatoid Arthritis or Quadriplegia may be unable to use such forms of input [9]. In that case Gesture recognition is used for Home Automation. Gesture recognition is not based on voice commands but, rather, allows a device to recognize certain gestures [3]. This approach does not require any technical knowledge (like in SMS based automation system). Old aged or disabled will use his/her hand to control appliances. By using a simple webcam the images will be taken and will be processed at Laptop in MATLAB software and once a particular gesture is recognized then the corresponding action will be performed [9]. Although it is a sophisticated solution but when Old aged or disabled person is not able to move hand and when they can only shake hand then hand detection may not accurately detected and the chance of false alarm is more in this approach and mostly the hand gesture recognition is done by detecting the human skin color and so because of this the background of the hand must be a non-skin color background with fixed distance between hand and the camera. Moreover for the smooth working of system there must be a proper arrangement of lighting always. Gesture recognition system can be used in various applications like Virtual reality, games and sign language. Sign language is an important case of communicative gestures [10, 11]. Sign language for the deaf (e.g. American Sign Language) is an example that has received significant attention in the gesture literature [12, 13, 14 and 15].

3. Home Automation System using Bluetooth, WIFI, WSN and Zigbee Technologies

Many Wireless Technologies like RF, Wi-Fi, Bluetooth and Zigbee have been developed and remote monitoring systems using these technologies are popular due to flexibility, low operating charges, etc [16]. Bluetooth looks like an attractive communication

technology for creating smart homes. It is cheap, easy, and quick to set up. People are already familiar with the technology; however Bluetooth communication should only be used on occasions where there is a need for quick short-lived network communication with little concern for security. Limitations include, they have maximum communication range of 100m in ideal conditions, and it has high power consumption [7]. It has serious security concerns such as eavesdropping and weak encryption as discussed by M.Ryan [17]. Other wireless technologies like WIFI, WSN and Zigbee have very high developing and deployment cost due to needs of motes, sensors, and radio transceivers etc, spread over a large area. Further it is difficult to upgrade existing conventional control system with remote control capabilities [16]. Moreover they are commonly used by mobile users, who want to monitor and control their home appliances remotely; hence these technologies are not suitable for aging populations.

III. DESIGN AND IMPLEMENTATION OF SPEAKER IDENTIFICATION BASED HOME AUTOMATION SYSTEM THROUGH SPEECH RECOGNITION

The block diagram of Speaker Identification based Home Automation system using speech recognition is shown in **figure 1**.

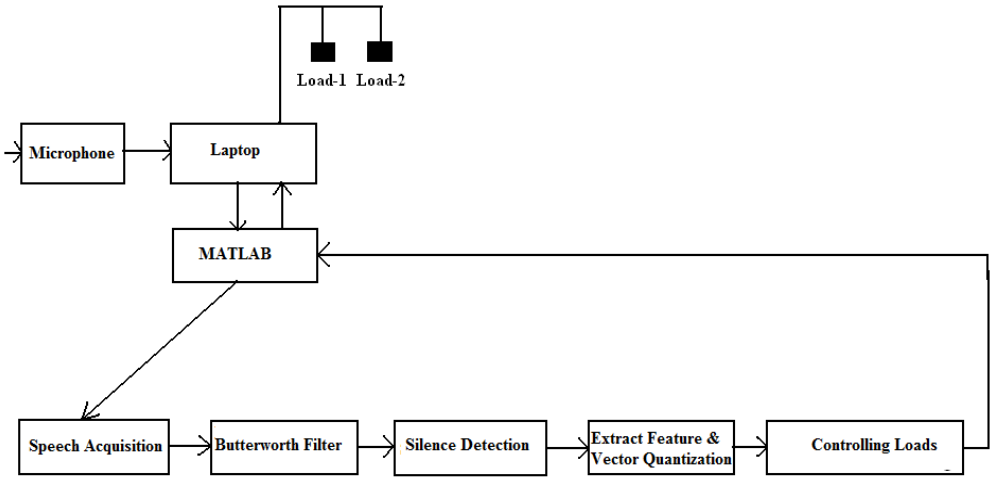


Figure 1 Block Diagram of Speech Operated System for Home Appliances

Speaker Identification based Home Automation system using speech recognition is a low-cost, reliable, efficient and secure method for Home Automation System.

As previously told paper is divided into three main parts which are Voice Training Process, Voice Testing Process and Integration of Hardware with the MATLAB. The system used is speaker dependant method that means user has to record his/her voice before using the system. Various steps involved in Speaker Identification based Home Automation system using speech recognition is shown in figure 1.

A. Voice Training Process

In voice training process the first step is acquisition of speech. Built in Microphone in laptop is utilized for Speech Acquisition, and then speech acquisition device is installed by simply Connecting the Microphone with laptop via sound card input port. In second step a function is created, which will record speech in MATLAB. In third step recorded speech is played on laptop based audio output device. Fourth step is to write acquired speech in MATLAB and .Wav file is created. In fifth step .wav file is loaded in MATLAB, in order to read the saved speech and in sixth step saved speech is acquired. In seventh step it is filtered out through the Butterworth band pass filter. Butterworth filter is used because it is the best compromise between attenuation and phase response. It has got no ripple in the pass band or the stop band. After that it is saved in the computer memory so that it can be matched with incoming utterance of speech. In this research work user has uttered two training voices to control the load. These uttered words are “CLOSE” and “YES”. Now all above steps are applied to these uttered words. Silence detection or Voice Activity Detection (VAD) is used in speech processing, which is used to detect presence or absence of human speech. VAD is used here to deactivate some processes when there

is a silence or non-speech section in audio session. Short time Fourier transforms is performed successfully so that for each incoming speech, the part of containing high frequency component is extracted. Actually here in MATLAB coding 2500 samples per word are created for feature extraction.

B. Voice Testing Process

In voice testing process the user has uttered two different words each process. One word is same as which was trained in training phase was "CLOSE" and other one is "OPEN". Then both uttered signals are further processed and analyzed by applying same steps which are already used in Voice Training Process. Like voice training process, 2500 samples per word are also created here for feature extraction. These testing signals are used to match with trained signals to authenticate the desired speech. There are various feature matching techniques used in MATLAB, from which Vector Quantization method is used in this research paper. Vector Quantization is a process of mapping vectors from a big vector space to a finite number of regions in that space. In the testing phase, a speaker-specific Vector Quantization codebook is generated for each known speaker by clustering his/her testing acoustic vectors.

C. Integration of Hardware with the MATLAB

Once all speech processing operations are completed now the final step is to perform a particular action related to the corresponding particular detected signal. There are two different loads that can be controlled via two different kinds of speeches. These loads are bulb and LED (light emitting diode). Loads can be different like fan, tube light, electronic room lock etc. Initially it was decided to use microcontroller for controlling loads based on speech recognition. As landline telephone can be used for controlling various home equipments. It was almost near to be implemented for the Speech Operated System but later on found that it was expensive and complex as compared to the approach which we have discussed in this research paper. In this approach parallel port (RS-232) of a computer is interfaced with the MATLAB and corresponding loads are turned on and off with the help of relays. This approach is simple and very less expensive as compared to other approaches. The block diagram of whole hardware design is shown in **figure 2**.

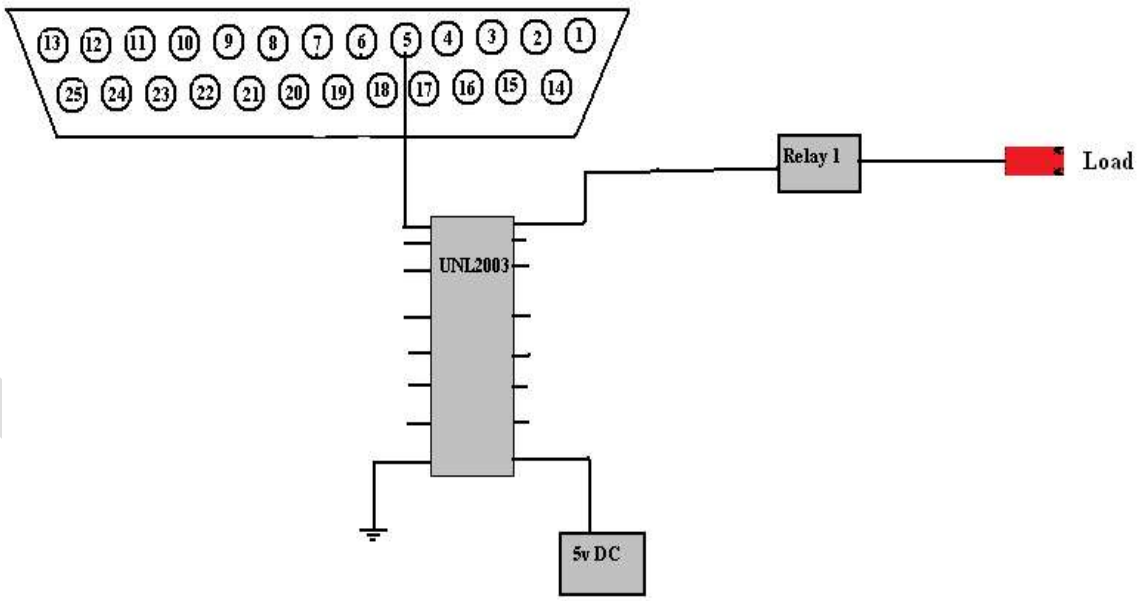
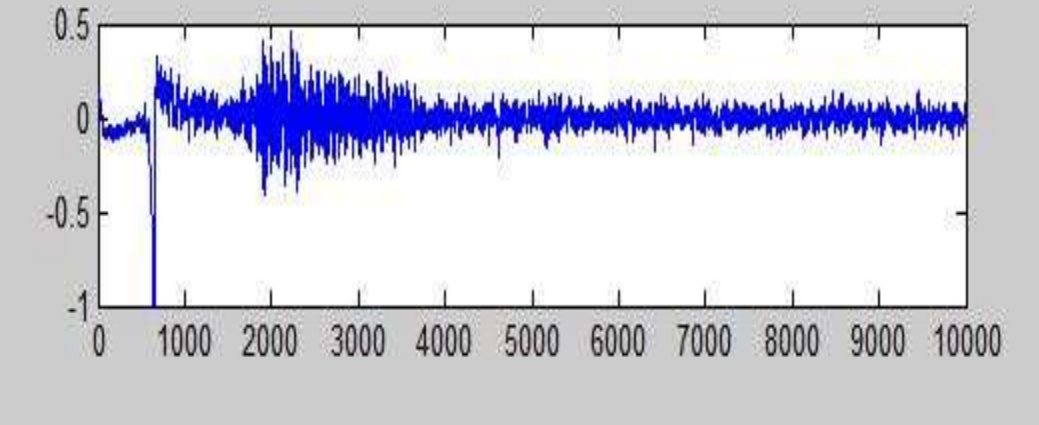


Figure 2 Block Diagram of whole Hardware Design

Figure 2 is showing over all hardware circuit of the project. A DC voltage of 3.2 volts will come out from the parallel port (RS-232) of a computer and this voltage will be input to the UNL2003 IC where this IC will generate 5 volts DC at the corresponding output pin and this 5 volts DC will be input for the relay so that relay should turn on and the corresponding load should also turn on.

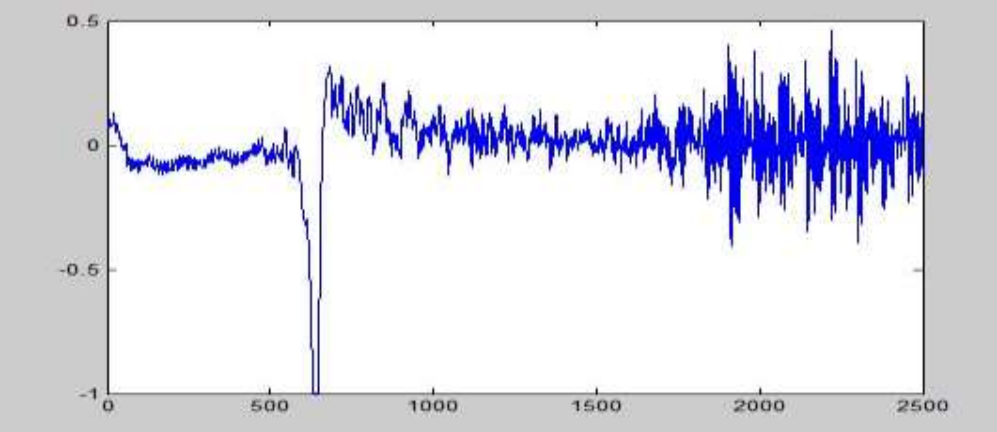
IV. RESULTS AND DISCUSSIONS

In this research work, we were able to successfully integrate hardware with the MATLAB software. In voice training and testing phase different words are uttered and correlation is performed between them to authenticate the trained user to control the different home appliances. In voice training phase user has uttered two different words ''CLOSE'' and ''YES'' in separate sections via using MATLAB. These uttered words are converted into .wav files and saved in computer memory. Short time Fourier transforms is applied and 2500 samples are created for each uttered word and features are extracted from them. The results obtained for Voice training phase are shown in **Figure 3(a) (b)** and **Figure 4(a) (b)** in form of graphs respectively.



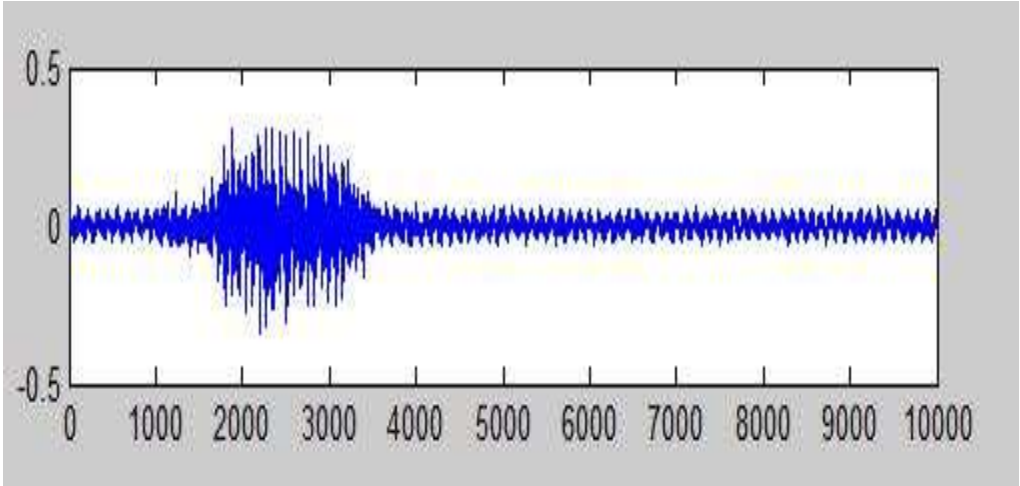
Time vs. Amplitude

Figure 3(a) Train Signal Uttered as "CLOSE"



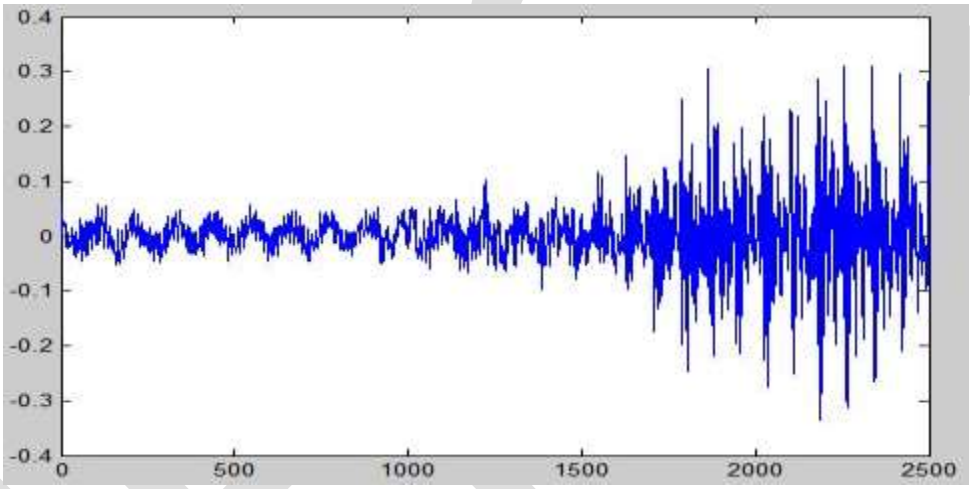
Samples vs. Amplitude (db)

Figure 3(b) Extracted 2500 Samples from Uttered Word "CLOSE"



Time vs. Amplitude

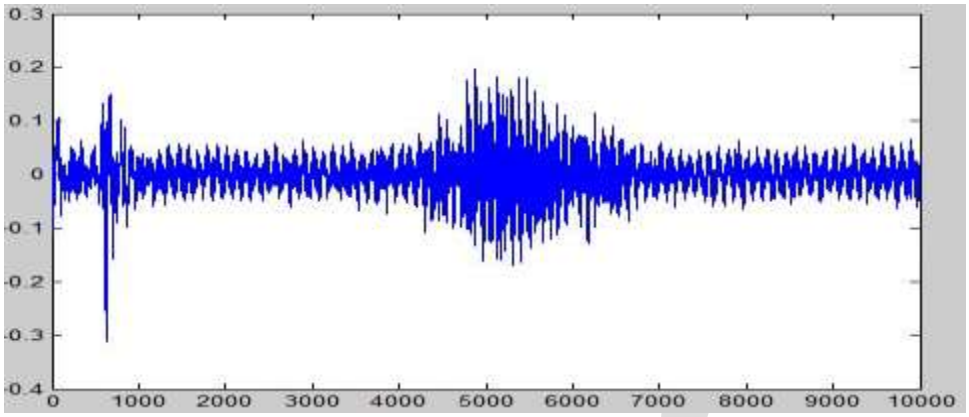
Figure 4(a) Trained Signal uttered as "YES"



Samples vs. Amplitude (db)

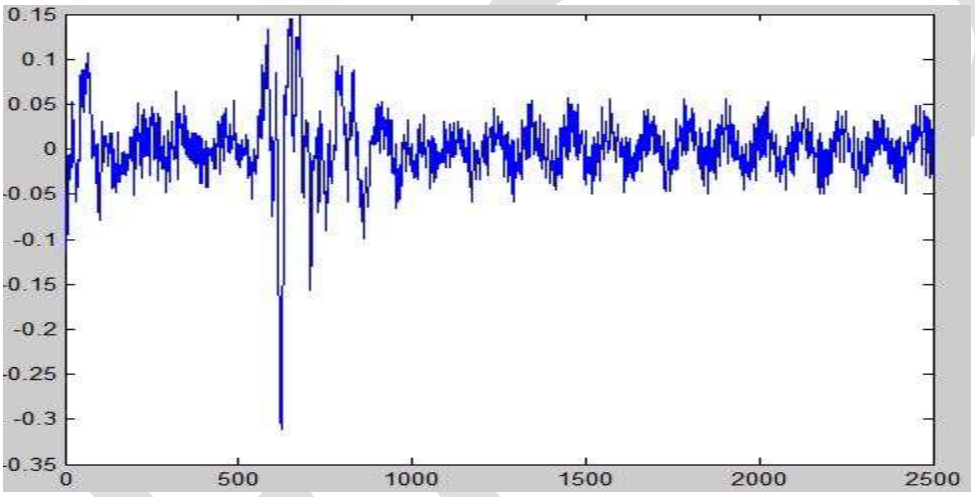
Figure 4(b) Extracted 2500 Samples from uttered word "YES"

Similarly for Voice testing process, user has uttered two different words each process. One word is same as which was trained in training phase was "CLOSE" and other one is "OPEN". Then both uttered signals are further processed and analyzed by repeating same steps which were used in Voice Training process. Finally correlation is performed between two phases by using Vector Quantization. The results of Voice Testing phase are shown in **Figure 5(a) (b)** and **Figure 6(a) (b)** in form of graphs respectively.



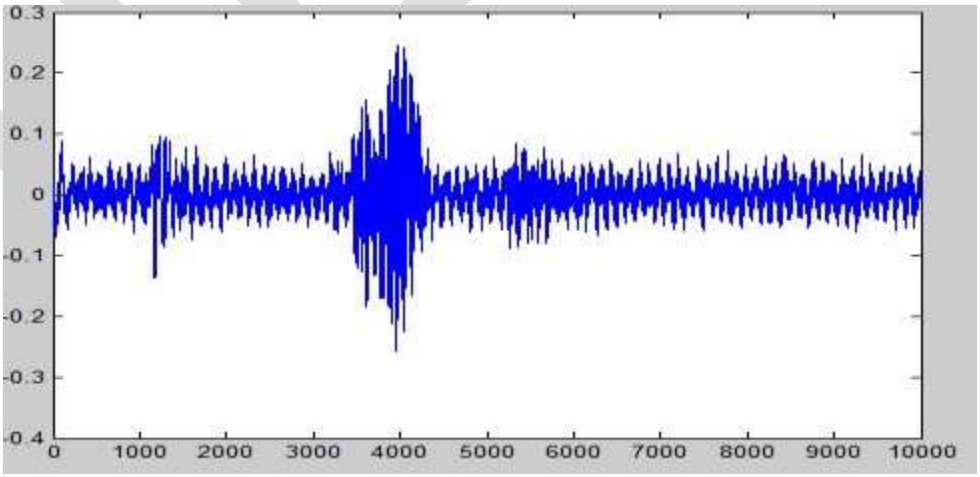
Time vs. Amplitude

Figure 5(a) Test Signal Uttered as "CLOSE"



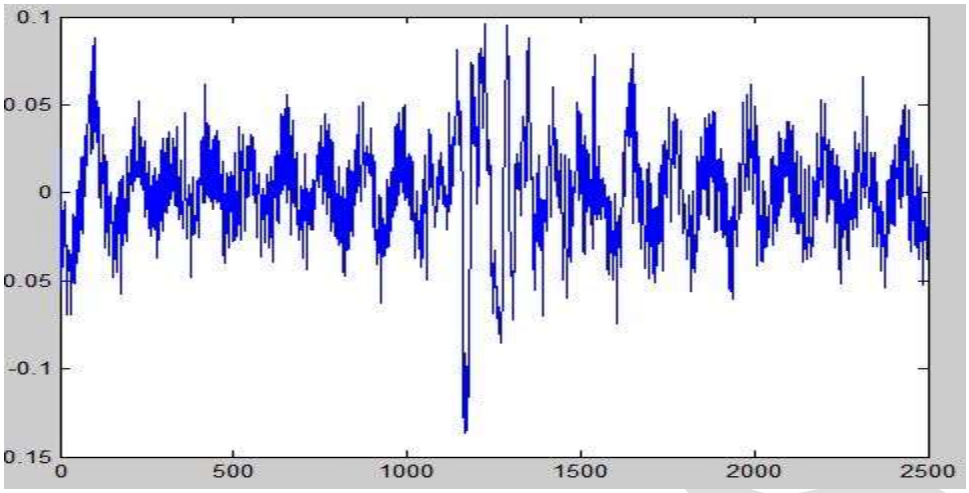
Samples vs. Amplitude (db)

Figure 5(b) Extracted 2500 Samples from Uttered Word "CLOSE"



Time vs. Amplitude

Figure 6(a) Test Signal Uttered as "OPEN"



Samples vs. Amplitude (db)

Figure 6(b) Extracted 2500 Samples from the Test Signal Uttered as "OPEN''

Now when user has uttered same word "CLOSE" in Testing Part then the load (LED) is turned "ON" as shown in **Figure 7(a).**

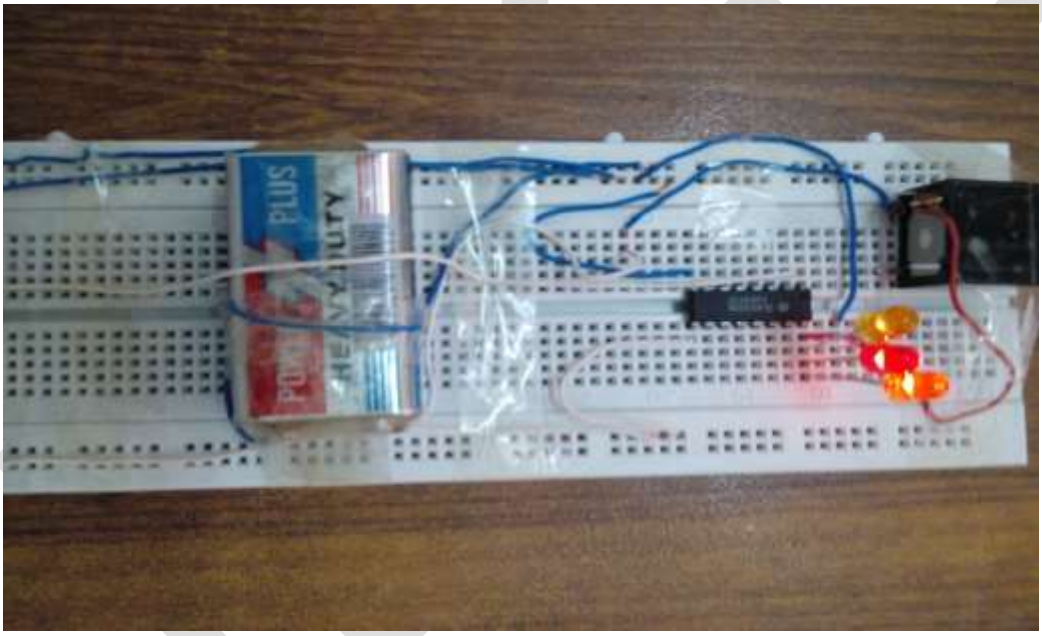


Figure 7(a) Load (LED) is turned ON when User has Uttered word "CLOSE"

As shown in **figure 7(a),** Load(LED) is turned ON when user has uttered the word ''CLOSE'' in testing part, because this word is already recorded or trained in MATLAB program, in training phase and saved in computer memory. Now when user is again uttering or speaking the same word in testing part, then speaker identification is matched by MATLAB program and authentication is successful and Load (LED) is turned on for that user.

When user has uttered the word other than the trained word like "OPEN" then there is no any signal to load (LED) as shown in **Figure 7(b).**

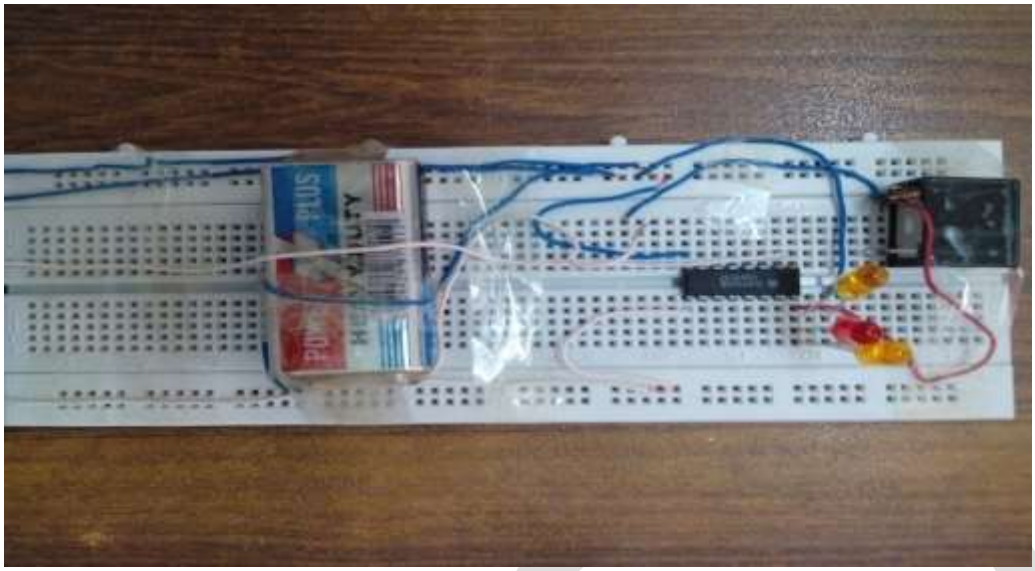


Figure 7(b) when user has uttered word other then the trained word

As shown in **figure 7(b)**, Load (LED) is not turned ON when user has uttered the word ''OPEN'' in testing part, because this word is not trained in MATLAB program, in training phase. Now when user is uttering or speaking the word ''OPEN'' in testing part, then speaker identification is not matched by MATLAB program and authentication is unsuccessful and Load (LED) is not turned on for that user.

This experiment shows that only the trained user and right command can activate the home appliances. It increases the security level of the system. For the smooth working of system there must be a proper arrangement of room always, there must be no any other noise. This is because speech operated system is very sensitive to noise. Noise can be of fan, other person speaking while in system's process. The utterance of speaker must be very different like pitch, frequency and loudness. This is because the pitch, frequency and loudness each represent different information about the speech.

V. CONCLUSIONS AND FUTURE RECOMMENDATIONS

A successful experiment of Speaker Identification based Home Automation system is carried out in this research work. The designed Speech operated system is a low-cost, reliable, efficient and secure. The designed Speech Operated system can be used in various areas of application. In the area of Home security, the designed system can be used by using biometric system such as human voice to centrally monitor the doors, rooms, windows and other electrical home equipments. Moreover an intercom system can be integrated to the telephone or video door can be equipped with voice operated system, where old aged or disable person can remotely monitor the outdoor activity on the CCTV camera, this provides a remote surveillance of security. Speech operated system can be used in Ubiquitous transcripts to keep real-time transcripts during conversations. Speech operated system can also be used to answer computers in a hands-free environment, like when driving. Speech operated system can be used in tasks that require human-machine interface, for example automatic call processing in the telephone network and data query information systems. Smart Grid technology can also be integrated with Speaker Identification based home automation systems.

In future, a significant research can be carried out in the area of Speech Operated system for Home Appliances. Speaker Identification based Home Automation system with better efficiency can be developed which will also be operate able in noisy environment. Reliable and efficient Home Automation system can be designed in future which will be both speaker dependant as well as speaker independent with maximum efficiency, security and performance.

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