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Voice Control Home Environment to Ease of Use for Disabled Persons using MFCC

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Abstract:- Nowadays, automation of digital electronic systems is growing rapidly, which has made human life more comfortable and easier. There are various home appliances available in electronic market which can operate through remote or automatically by robotic intelligence. After surveying various techniques developed in the area of automation of home appliances, it has been observed that, there is a need of an intelligent system that can control through voice commands which can provide high level of accuracy and reliability to help in the most effective manner to persons with disabilities. This paper proposed a system which can operate through voice commands by employing Best Guess Method and LPC (Linear Prediction filter Coefficients). Proposed technique offers high level of accuracy to remotely operate the appliance just by using voice commands. To enhance the reliability of system, speech recognition technique is used. Recognition technique is exploited by voice tool box and further implemented in MATLAB.

Keywords:- *Speech Recognition, LPC, VCD, PLP, Home Automation, MATLAB.*

I. INTRODUCTION

Systems which can operate through voice commands of human are getting trendy, day by day. This technique is being modifying to implement almost at every control level to develop an advanced system. Meanwhile, this kind of technique would be very useful for the elderly, as well as people with disabilities. System requires high level of accuracy in recognition of speech and voice command devices.

A. Speech Recognition:

- Recognizing speech is basically a methodology that can identify and convert the spoken words into readable format like text by using computers.

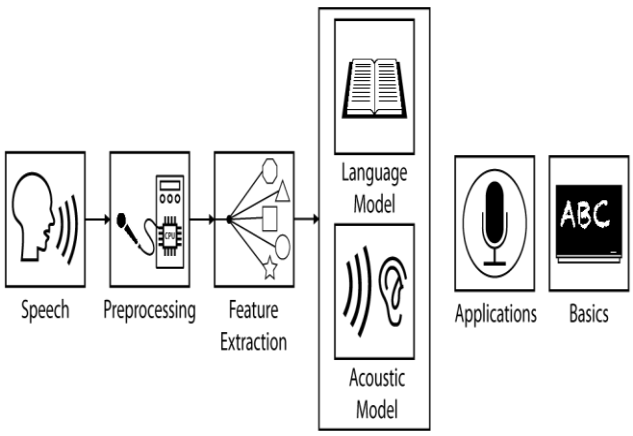

Fig 1:- Speech Recognition System [8]

System to recognize speech is categorized in two sections. One, which requires prior training to identify and sample it to provide precise output speech in terms of text, is known as speaker dependent recognition of speech. On the other side, identification that doesn't require any training is called speaker independent systems.

- Sampling of extracted speech is used to precisely measure the waves at regular interval of time.
- System will further filter the sampled data to eliminate surplus noise and split the information into various frequency bands.
- Filtered speech in the form of data will be processed to normalize the extracted sound and maintains the steady level of volume.
- As the pitch of spoken language varies, so the extracted sound of speech should be maintained that can further match with the already stored templates of speech and its volume in the database.

B. Voice Command Device:

- A voice command device (VCD) is a device operated by using voice of human. By remove the usage of buttons, dials and switches, consumers can easily operate appliances with their hands full or while doing other tasks.
- It's a device which can be operated and controlled by the voice of human. To eradicate the necessity of dials, buttons and switches, this device will enable the customers to operate the appliances through their voice even if they are indulge in another works.

Fig 2:- Voice Controlled Devices [9]

II. PROBLEM STATEMENT

Many techniques have been proposed in order to develop an ideal system which can be control by voice. Most of them are relied on either windows speech recognition or Google voice recognition systems. These systems are not so proficient because perceptive of a language is not competently understand by a machine as a human can do which results in high error rate especially for Indian native speakers. Some of the techniques used the platform of android applications to employ Google voice recognition system which requires either Bluetooth or wifi to get connected with the other appliances. In some cases, internet or LAN connections are used to wirelessly communicate with the home devices and operate them through voice or switches. These techniques are majorly used to control the devices through remote and are not effectively operate through voice. If user needs mobile to speak on and operate a device, it's better to access that device through remote. So, we require a system that should be cost effective as well as best at accuracy level which can easily operate through human voice.

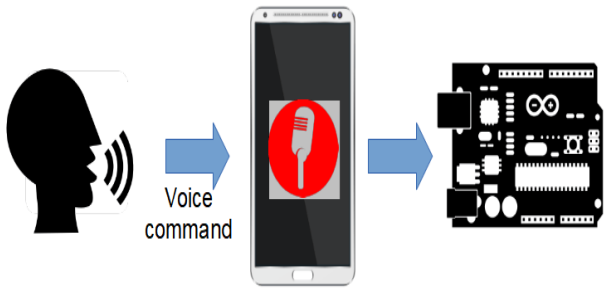

Fig 3:- Android and human Voice used to Control IoT device [10]

Fig 4:- Voice Controlled Devices [11]

III. PROPOSED WORK

The flaws encountered in the prior developed techniques like windows speech recognition and Google voice recognition limits the application provided by the system. Windows speech recognition is ineffective due to lack of understanding of accent and context of languages. Google speech recognition requires internet to get accessed which limits the usage of system. In the proposed system, Voice Box is introduced to effectively recognize speech. Voice Box is basically a tool box offered by MATLAB. Furthermore, MFCC is also induced with Perceptual Linear Predictive Analysis (PLP). Since, PLP is applied for noise reduction, reverberation suppression or echo cancellation. So, the proposed work proficiently control or operates home appliances through voice commands that helps disabled person.

A. Perceptual Linear Prediction Analysis

PLP is a method used to evaluate speech signals; this system depends on three different theories obtained from psychophysics which are critical band spectral resolution, equal loudness curve and the intensity loudness power law. Since, PLP is considered better than LP (Linear Prediction) method as LP method is efficient to provide healthy speech but PLP can effectively handles the poor signal. So, PLP is a best predictive method for unknown speech analysis to offer enhanced level of precision.

B. Critical Band Spectral Resolution:

This concept is used to enumerate the capability of human ears through which various frequency tones can be differentiated.

C. Equal Loudness Curve:

It is used to examine and calculate the echo pressure over frequency spectrum.

D. Intensity-loudness power law:

This is used to differentiate the loudness and intensity obtained from a speech signal.

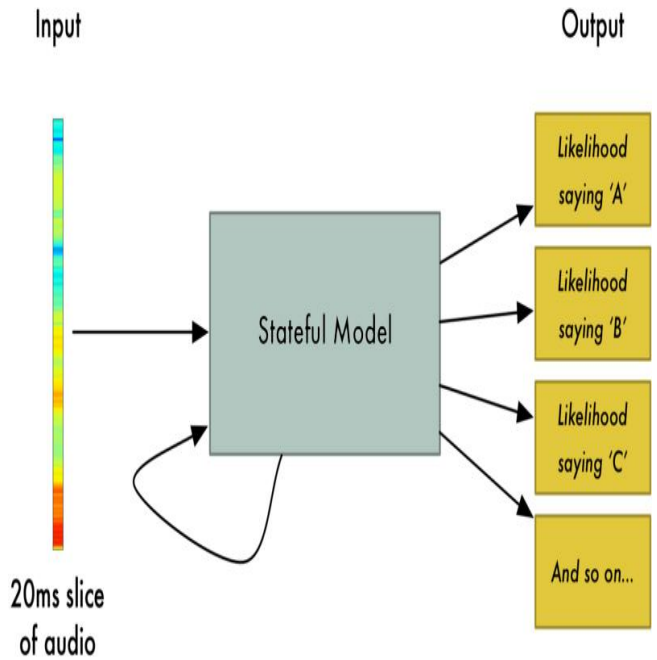

Fig 5:- PLP Analysis

In the proposed system, two voice commands have been used-

- ON
- OFF

Initially, system gets trained through these commands in a particular voice along with default noises. Training performed with different voice commands which surpass the default guess with garbage commands. A system is required to behave like human ear that possibly works with best possible

guess for providing more accurate results. Accuracy is often important as the evolution goes towards automation in the field of speech analysis.

To be more specific with the proposed system, flow chart is shown below,

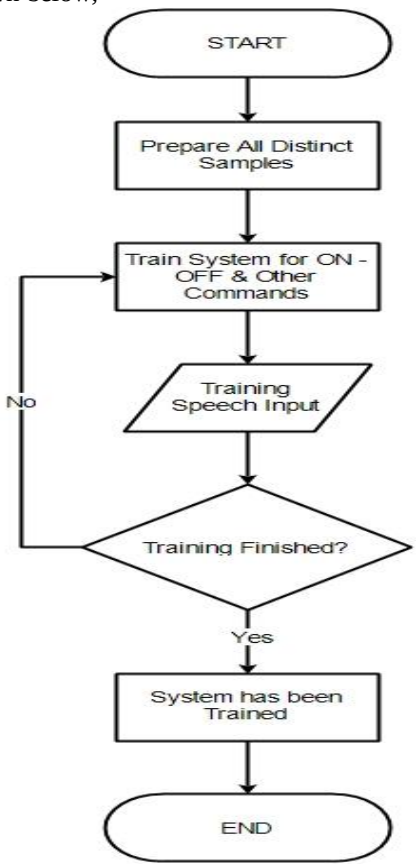

Fig 6:- Flow Chart for Training

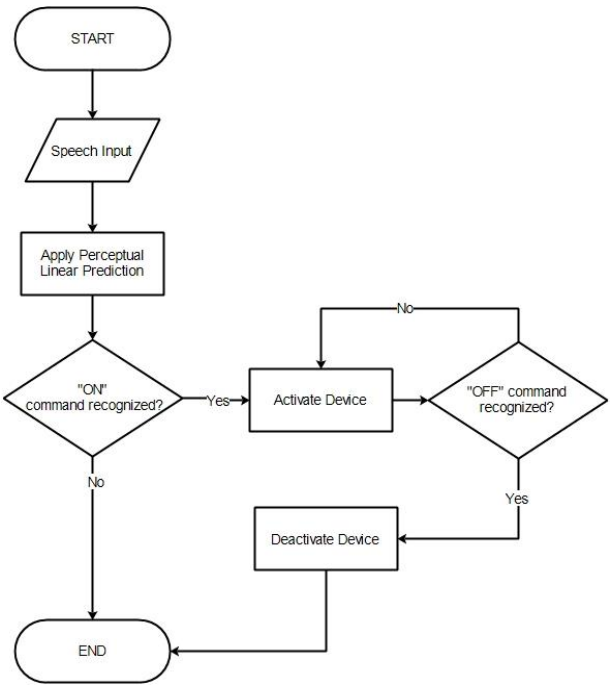

Fig 7:- Flow Chart for Speech analysis

System will be trained first then perceptual linear prediction will be applied for speech analysis. How system analyze speeches, let it be more precise in proposed methodology.

IV. PROPOSED METHODOLOGY

Proposed system develops an algorithm to precisely execute the functioning which can easily control home devices through voice.

A. Mel-Filter Sampling Algorithm (MFS):

Input – Audio Frames
Output – Command based Operations

- Record and Train audio samples for state “ON” & “OFF”
- Sampling the signals with the rate of 12800 sample/second
- Window is divided into 256 frames for each voice command for any speaker of 20 Milliseconds
- Use 40 Mel Filter to filter the samples to extract the required frequencies
- Calculate Fourier transform

$$F(s) \equiv \int_{-\infty}^{\infty} f(x)\, e^{-2\pi i s x}\, dx$$

This is to be calculated for signal processing in the form of graph, whereas -
f(x) is auditory function
‘x’ is time domain signal
‘s’ corresponds to inverse time
‘i’ frequency-domain signal

- Calculate Power Spectrum to identify the variations or energies in your voice commands
- Apply Perceptual Linear Prediction for nearest output.
- End

V. RESULT ANALYSIS

Command No.	Commands	Operation	Result
C_1	Hello	Null	-
C_2	ON	Activate	Activate Device
C_3	Left	Null	-
C_4	Right	Null	-
C_5	Finish	Null	-
C_6	Come	Null	-
C_7	OFF	Deactivate	Deactivate Device
C_8	_Blank	Null	-
C_9	_Blank	Null	-

Table 1. Result Analysis I

In Table 1, various commands given to the system and accordingly operation performed by the system which in result deactivate or activate the system.

Time Duration in Min.	Best Distance in Meter	No. of ON command spoken	No. of ON command recognized	No. of OFF command spoken	No. of OFF command recognized	No. of automatic ON recognition	No. of automatic OFF recognition
0-3	0-10	16	14	18	15	0	1
0-6	0-10	30	25	31	22	0	0
0-9	0-10	43	41	45	32	1	0
0-12	0-10	62	46	65	45	0	0
0-15	0-10	79	52	82	58	0	0
0-18	0-10	91	61	93	68	0	0
0-21	0-10	105	70	108	71	0	0
0-24	0-10	127	92	130	97	0	0
0-27	0-10	139	96	141	102	0	0
0-30	0-10	148	102	151	112	0	0
0-3	0-10	16	14	18	15	0	1
0-6	0-10	30	25	31	22	0	0
0-9	0-10	43	41	45	32	1	0
0-12	0-10	62	46	65	45	0	0
0-15	0-10	79	52	82	58	0	0
0-18	0-10	91	61	93	68	0	0
0-21	0-10	105	70	108	71	0	0
0-24	0-10	127	92	130	97	0	0
0-27	0-10	139	96	141	102	0	0
0-30	0-10	148	102	151	112	0	0

Table 2. Result Analysis II

In Table 2, result has been analyzed in Household environment with background noise. In Normal Household Environment: Success Rate of "ON" & "OFF" command is calculated by-

$$\text{Success Rate} = \frac{\text{No. of ON recognized} * 100}{\text{No. of ON spoken}}$$

$$= 764 * 100/946$$

$$= 80.76$$

$$\text{Success Rate} = \frac{\text{No. of OFF recognized} * 100}{\text{No. of OFF spoken}}$$

$$= 748 * 100/948$$

$$= 78.9$$

$$\text{Average Success Rate} = 80.76+78.9 / 2$$

$$= 79.83\ \%$$

In Household environment with background Noise:
Success Rate of "ON" & "OFF" command is calculated by-

$$\text{Success Rate} = \frac{\text{No. of ON recognized} * 100}{\text{No. of ON spoken}}$$
$$= 599 * 100/840$$
$$= 71.3$$
$$\text{Success Rate} = \frac{\text{No. of OFF recognized} * 100}{\text{No. of OFF spoken}}$$
$$= 622 * 100/864$$
$$= 71.99$$
$$\text{Average Success Rate} = 71.3+71.99 / 2$$
$$= 71.64\ \%$$

Terms	PRESENT	PROPOSED
Normal Household Environment	73	79.83
Household environment with background or noise	60	71.64
Best Distance	0-5 (cm)	0-10 (m)

Table 3. Result Comparison

cm – Centimeter
m - Meter
Normal Household Environment in %
Household environment with background or noise in %

VI. CONCLUSION AND FUTURE SCOPE

The system is concluded at a point of enhancement to control home appliances by the help of voice commands which makes life easier especially for disabled or handicapped people. It reduces your effort and can turn your home to smart one. We need a system which should be cost effective and works with high level of accuracy. The current proposed concept of controlling home appliances via voice commands get enhanced by applying this concept for door, curtains, televisions, pumps, windows and many more with high level of accuracy that can really develop a digital world and it will help disabled persons a lot.

REFERENCES

[1] M.A. Khalid, K. Kishan, K. Kishen, U. Gounder, P. Chand, U. Metha, K. A. Mamun, "Design and Development of Low Cost Voice Control Smart Home Device in the South Pacific" Computer Science and Engineering (APWC on CSE), 2014 Asia-Pacific World Congress on IEEE 2014.

[2] Norhafizah bt Aripin and M. B. Othman , "Voice Control of Home Appliances using Android" in Electrical Power, Electronics, Communications, Controls, and Informatics Seminar (EECCIS) in 2014 of IEEE.

[3] Samah A. F. Manssor', Abdalla A. Osman2 and Sally D. Awadalkareem3, "Controlling Home Devices for Handicapped People via Voice Command Techniques" in International Conference on Computing, Control, Networking, Electronics and Embedded Systems Engineering in 2015 of IEEE.

[4] Sushant Kumar and S.S Solanki , "Voice and Touch Control Home Automation" in 3rd Int'l Conf. on Recent Advances in Information Technology in 2016 IEEE.

[5] Aml A. Arriany and Mohamed S. Musbah ,"Applying Voice Recognition Technology for Smart Home Networks", Engineering & MIS (ICEMIS), International Conference in 2016 IEEE.

[6] Md. Ahsan Iqbal, Sk Asrafuzzaman, Md. Mahfuz Arifin, SK Alamgir Hossain, "Smart Home Appliance Control System for Physically Disabled People Using Kinect and X10" in 5th International Conference on Informatics, Electronics and Vision (ICIEV) in 2016 of IEEE.

[7] Julio Cabrera, Maria Mena, Ana Parra and Eduardo Pinos , "Intelligent Assistant to Control Home Power Network", in International Autumn Meeting on Power, Electronics and Computing (ROPEC 2016). Ixtapa, Mexico in 2016 IEEE.

[8] recognize-speech.com/

[9] makeuseof.com/tag/7-ways-add-voice control-home-automation/

[10] dzone.com/articles/using-your-voice-and-android-to-control-iot-device

[11] amazon.com/Amazon-Echo-Dot-Portable-Bluetooth-Speaker-with-Alexa-Black/dp/B01DFKC2SO