Novateur Publication's
International Journal of Innovation in Engineering, Research and Technology [IJIERT]
ICITDCEME'15 Conference Proceedings
ISSN No - 2394-3696

DEVELOPMENT OF PIEZO DISC AS A THROAT MICROPHONE

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ABSTRACT:
This paper mainly focus on the development of piezodisc as a throat microphone.Piezoelectric materials become the most attractive functional materials for sensors because they can directly convert mechanical energy to electrical energy and vice versa. The throat mic separates the environmental noise from voice via a non-traditional method of sound induction through the vibrations of the throat. Due to the voice coming from the vibrations in the neck and not from the air, there is no extra background noise for the microphone to pick up. The throat microphone picks up the voice signals from the vibrations in the users' neck, rather than from the air. They eliminate noises and allow the speaker to reach a larger audience more effectively by protecting the throat.

KEYWORDS: Piezoelectric disc, power amplifier, throat microphone

INTRODUCTION

Microphones are basically pressure sensors that detect airborne pressures generated by sound having pressures with 10 orders of magnitude lower than the ambient pressure. The microphone for most communication systems is based on traditional acoustic induction from sound waves in the air. The most common types of microphones available as sound transducers are Dynamic, Electret Condenser, Ribbon and the newer Piezo-electric Crystal types and typical applications for microphones as a sound transducer include audio recording, reproduction, broadcasting as well as telephones, television, digital computer recording and body scanners, where ultrasound is used in medical applications[1].
In this case use of a piezo disc as a microphone which absorbs the vibrations from vocal cord. Normally the microphones are designed to pick up the users voice from the air, then convert the received voice signal into a corresponding electric signal for output to an amplifier. These microphones are functional; however they cannot effectively eliminate the interference of background noises or the occurrence of an echo. The most important is piezodisc throat microphone eliminates background noise. These are low cost throat microphones. The recording of both close-speaking microphone and piezodisc throat microphone is analyzed. The response obtained from piezo disc and signal amplification by power amplifier is then recorded in computer and analyzed in Matlab.

EXPERIMENTAL SETUP

The throat microphone converts the vibrations that it picks up into equivalent normal speech signals. Place the piezodisc in contact with the skin of neck. When the user's talks, vibrating waves are transmitted from the user's skin through the bottom of the piezodisc & converted into a sound wave signal. The sound wave signal is then transmitted to the amplifier &converted it into an electric signal for output. Generally, the output signal from a microphone is an analogue signal either in the form of a voltage or current which is proportional to the actual sound wave.Record a single word only with the help of microphone, then same word record by piezodisc in quiet room. Same procedure is repeated for different words. The results analyze the original sound and the sound from piezodiscwith the help of Matlab.
A basic circuit consists of piezoelectric disc (sensor), power amplifier, battery and PC is designed for signal amplification and signal processing. Piezodisc connect wires, one soldered to the middle of the piezodisc and other the metal plate on the edge of the piezodisc, these wires are connected respectively the analog input and ground which then connected a high power amplifier. The amplifier consists of preamplifier, noise and band pass filter, power amplifier and output signal. The microphone is the piezoelectric disc, which allows for very low frequency operation but having very good sensitivity. The experimental set up used for only speech analyzer is shown in Figure 1:

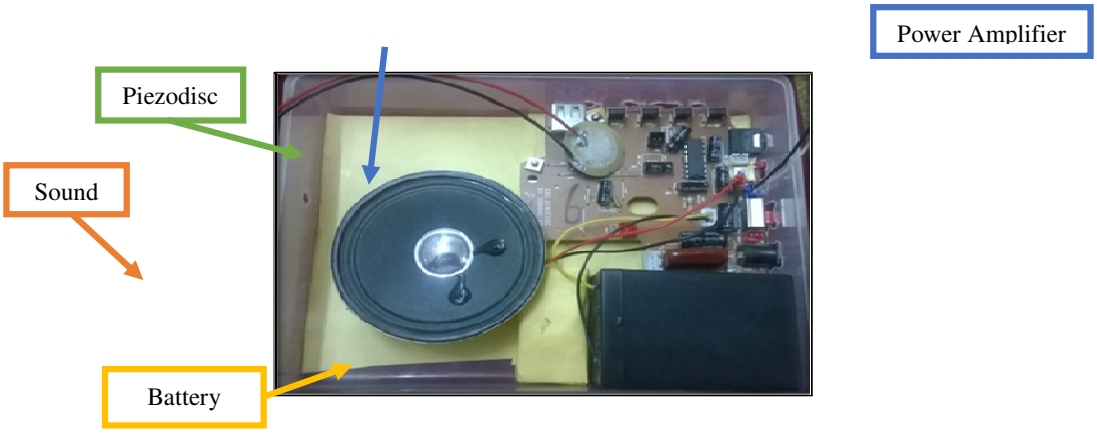

Figure 1: Experimental setup of power amplifier with sensor and laptop

The objective to develop the application of piezoelectric sensor as a throat microphone and compared with the normal speech. The system includes sensor interfacing, signal conditioning and data acquisition system.

SENSOR AND SENSOR INTERFACING

Sensors are the devices which perform an input function because they "sense" a physical change in some characteristic that changes in response to some excitation, for example pressure, vibration, heat or force and covert that into an electric signal. Devices which perform an output function are generally called actuators which are used to control some external device, for example movement [2]. Both sensors and actuators are collectively known as transducers because they are used to convert energy of form one form into energy of another form, for example, a throat microphone (input device) converts sound waves into electrical signals for the power amplifier to amplify, and a loudspeaker (output device) converts the electrical signals back into sound waves and an example of this is shown in Fig.2:

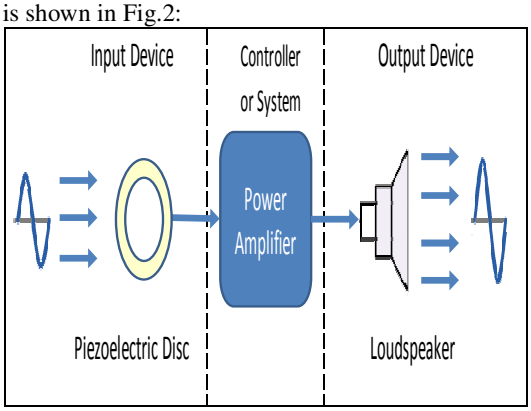

Figure 2: Simple Input/output System using Sound Transducers

SIGNAL CONDITIONING AND DATA ACQUISITION SYSTEM FOR SPEECH ANALYZER

Data acquisition system interaction between software and hardware which connect to the physical world. The component of data acquisition system consists of sensor,signal conditioning, software and finally data analysis. Signal conditioning hardware is a component of data acquisition system. In this component the hardware is used to amplify the absorbed signal by the piezo disc. This amplifier strengthens the signal for further analysis.

The signal processing and amplification for speech analyzer is represented by block diagram which is shown in Figure 3.

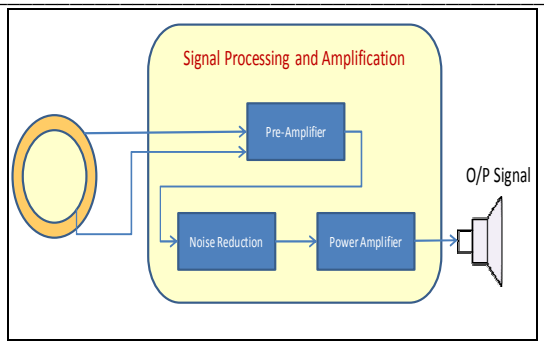

Figure3: Block Diagram Signal Processing and amplification for speech analyzer

The two important features of a data acquisition system for throat microphone:

- Signals are input to a sensor, signal conditioning and then converted into bits that a computer can read and analyzed to significant information. For example, sound signal is acquired from a microphone, signal amplification and converted into a sound signal and stored in MATLAB workspace for further analysis of frequency data.
- Signal from a computer is converted into an analog signal and output to an actuator. For example, signal in MATLAB workspace is converted to an analog signal by a sound card and output to a loudspeaker.

STEPS INVOLVED

I started this project by testing the vibration sensing ability of the piezo disc. Record the single word with original sound, then same word record with the help of piezodisc throat microphone. The output signals then analyzed with the help of Matlab program. In Matlab program we are go through the time domain analysis and frequency domain analysis. In time domain analysis output signals are compared and the obtained graph is time (sec.) vs. frequency (Hz). In time domain analysis recorded large amount of raw data so we cannot get the exact voice characteristics so we are doing frequency domain analysis. In frequency domain analysis we obtain the exact voice characteristics. The graph is of Power density of frequency vs. frequency (Hz). FFT consist of voice characteristics but they are overlap to each other so we are going to cut that speech signal into number of frames which is known as "Windowing". The result is a matrix where each column is a frame of n samples from original speech signal. We can press the Piezodisc on the neck surface for absorbing the vibrations coming from it. The disc is mounted with the help of Velcro band here, which is as shown in Figure 4:

Figure 4: During the speech production, the microphone must be in direct contact with the lowest part of the speaker's throat, with a reasonable but comfortable pressure.

The steps to be performed for the analysis are:

1. Record any word in original sound and also record the same word by using piezodisc throat microphone.
2. Two output signals convert into .wav format.
3. Make the program in Matlab for time domain analysis for analysis of that recorded signals and save that file in .m extension (e.g. Filename.m).
4. We have to write the program for same signals for frequency domain analysis by using the Periodogram and save this file in the format of .fft extension. (e.g. Filename.fft).

RESULT AND ANALYSIS:

We have analyzed the characteristics of the speech signals collected from a throat microphone and close-speaking microphone. The analysis will be carried out for different words in different languages like English, Hindi, & Marathi. The results are getting from all words is almost similar to the close-speaking microphone and piezodisc throat microphone. Analysis is supposed to carry out for time domain analysis and frequency analysis in Matlab. The subplots within help characterize the sound recorded by each component. The time domain signal shows speech signal recorded, but it contains a very large amount of raw data so we cannot analyze voice characteristics. To overcome this we are doing frequency domain analysis. The Frequency domain analysis analyzes the exact voice characteristics from the signal recorded. The result plotted in time domain analysis for word "Hello" is shown in Figure 5.

I) WORD "HELLO"

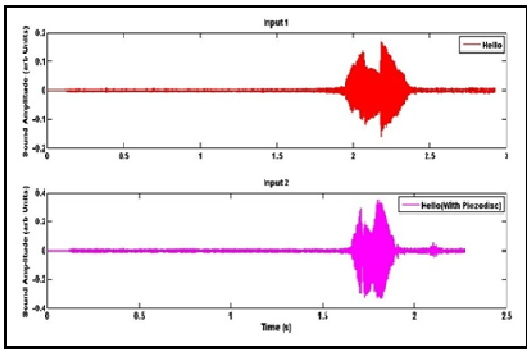

Figure 5: Time domain analysis for word "Hello"

II) THE RESULT PLOTTED FOR WORD "HELLO" IN FREQUENCY DOMAIN ANALYSIS IS SHOWN IN FIGURE 6

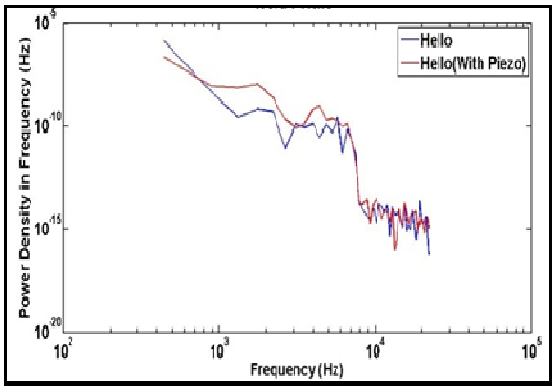

Figure 6: Frequency Domain Analysis for word "Hello"

The testing was carried out on 15 different words in different languages for the same procedure followed for word "Hello". The result obtained from the analysis for different words are shown in Table 1:

Table 1: (a) which shows the quality of each word for close speaking microphone and throat microphone and (b) the number of words obtained in good, average and very good manner with the help of piezodisc throat microphone.

Table (a)

Sr. No.	Language	Words	Quality
1	English	Hello	Very Good
2	English	Piezo disc	Good
3	English	Amplifier	Good
4	English	Crocodile	Average
5	English	Flower	Good
6	English	Story	Average
7	English	Welcome	Very Good
8	Hindi	बूरा	Average
9	Hindi	अच्छे	Average
10	Hindi	कैसे	Good
11	Hindi	सुबह	Good
12	Marathi	आई	Very Good
13	Marathi	नेत्रज	Average
14	Marathi	बाबा	Very Good
15	Marathi	शर्वरी	Average

Table (b)

Quality	Results
Very Good	4
Good	5
Average	6

SPECIFICATIONS:

- Input Device: Normal microphone, piezoelectric disc throat microphone, connecters, power amplifier, PC, sound, loudspeaker
- Input environment: Noiseless room
- Speaking language: English, Hindi & Marathi
- Purpose of work: Testing of piezoelectric disc throat microphone with normal speech
- No. of words: 15 words

SUMMARY AND CONCLUSION

In this section, we have analyzed the characteristics of the speech signals collected from close-speaking microphone and throat microphone.The analysis will be carried out for different words in different languages like English, Hindi, & Marathi. The results are getting from all words is almost similar to the close-speaking microphone and piezodisc throat microphone. Analysis is supposed to carry out for time domain analysis and frequency analysis in Matlab. The performance of the systems using throat and close-speaking microphone speech signals, when the signals are recorded under noise-free conditions is almost similar. This shows that the performance of the system using close-speaking microphone data decreases as the background noise increases whereas the performance of the system using throat microphone data is unaffected by the background noise.

ACKNOWLEDGEMENT

In this research I would like to acknowledge the support of Dr. Priam Pillai, of mechanical department, Pillai Institute of Information Technology, Mumbai University, India.

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