Analysis of Asthma By Using Mel Frequency Cepstral Coefficient

V. D. Dighore, V. R. Thool

Abstract— **Asthma is a lung disease that affects airflow to and From the lungs. A whistling sound comes when a person suffering from asthma breathes in and out. Major symptoms of asthma are chest stiffness, breathe shortness and cough production during night and morning. In this paper, Asthma is analyze with the help of Mel frequency Cepstral Coefficient (MFCC). In this system, MFCC for Normal Voice and for Asthma patient voice is found out. The process of Feature extraction is that, in which the speaker is represented by the small amount of data from the voice signal. This system converts a speech waveform to type of parametric representation for further analysis and processing. There are two methods for MFCC feature extraction, either FFT based or LPC based. In this paper, MFCC extraction based on FFT is used.**

Keywords— ***Normal sound; Asthma patient sound; MFCC algorithm;***

I. Introduction

Asthma is a chronic respiratory disease. It causes the airways of lungs become narrow, constricted and inflamed. The Great physician Hippocrates, discovered the disease asthma and its resulting Spasms. While Galen, a Greco-Roman-Doctor discovered that, asthma is due to Bronchial Obstruction. He treated it with owl blood in wine [2]. According to World Health Organization (WHO), 235 million people currently suffers from asthma worldwide in which most are child [3]. The Bronchial Asthma has increased continuously since the 1970, and now affects an estimated 5% to 15% of people worldwide. At the age of six to seven years, the prevalence range from 4% to 32%. Asthma prevalence is expected to increase in the coming years and subsequently lead to increase in morbidity and mortality rates [5]. Asthma is a lung disease, which has an impact on airflow in and out from the lungs. When the airways starts functioning muscles around airways becomes tight and less air can flow into the lungs, also due to devouring of muscles around airways. When airways blocked, then asthma attack may occur, as shown in Fig. 1. Asthma has no cure, just it can be controlled. It can be controlled during asthma stages by doing long standing meditation daily, consistent physical check up by doctor in case of serious patients, taking some drugs through inhalers when a sudden violent occurrence of asthma attack. These treatment method may be very expensive to a normal or poor persons [1]. The objective of this project doing a start up for diagnosing asthma in initial stages, so that it can be regulated.

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MFCC are very suitable parameter of sound that can outlook auditory system of human more closely as other parameters work. In this paper cepstral coefficients are calculated by using MATLAB for feature extraction process. These extracted coefficients will be analyzed for calculating resemblance between patients and normal persons.

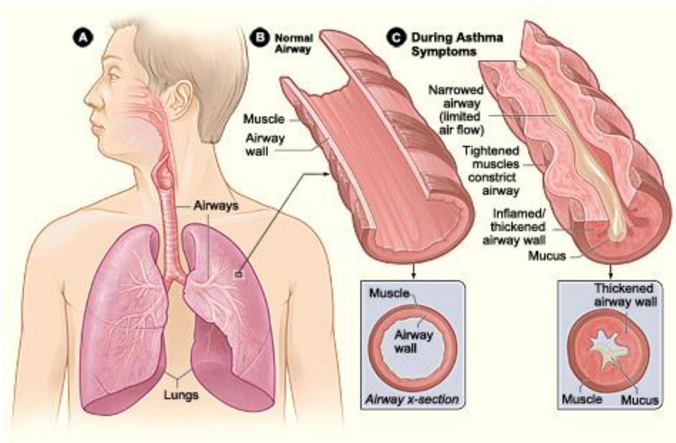

Fig.1: Asthmatic Respiratory System.

II. Mel Frequency Ceptral Coefficient

Mel-frequency Cepstral Coefficients are very popular parameter of voice that can view auditory system of human more closely [10]. The algorithm is developed to diagnose Asthma. So that, it can be controlled. MFCC are calculated using MATLAB for feature extraction process. MFCC are coefficients that collectively make up an MFC. They are obtained from the type of cepstral representation of the audio clip. The difference between the cepstrum and the Mel cepstrum is that, the MFC frequency bands are equally spaced on the Mel scale. It approximates the human auditory system respond more closely than the linearly spaced frequency bands, which is used in the normal cepstrum. This frequency deformed can allow for better representation of sound [8]. In this system Mel frequency Cepstral Coefficient for Normal Voice and for Asthma patient voice is find out. This system converts a speech waveform to some parametric representation for analysis and processing. Mel Frequency spectrum is used to represent speech signal for speaker recognition task. The method of MFCC extraction can be achieved by two way, either Fast Fourier Transform or Linear Predictive Coding. In this paper, MFCC extraction based on FFT is used. Fig.2., shows the algorithm for finding Mel-Frequency Cepstral Coefficient. In this MFCC trained vector is calculated for incoming speech signal. This MFCC vectors are array of size one into twenty. This MFCC vectors are only depends on frequency and power contained of different frequency of incoming speech signal.

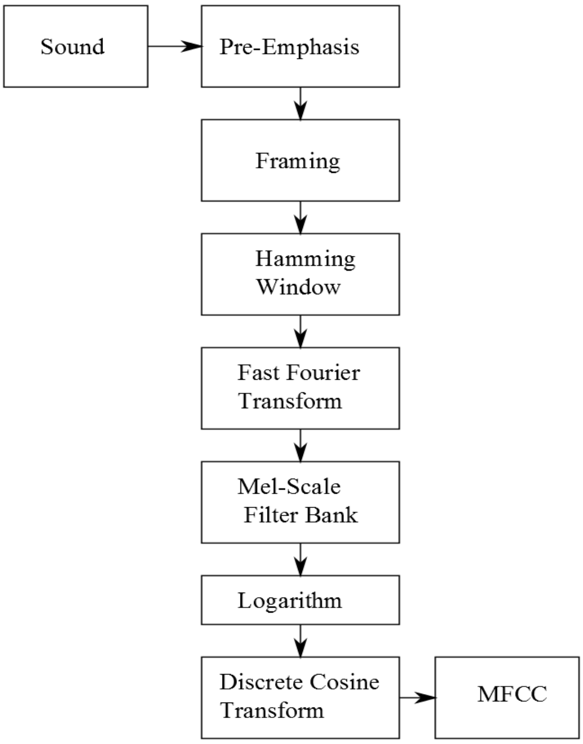

Fig. 2 : Procedure for Extracting Mel-Frequency Cepstral Coefficients

A. Per-Emphasis

Pre-emphasis is very simple signal processing method, which increases the amplitude of high frequency bands and decrease the amplitudes of lower bands. In this block sound signal is passed through a high pass filter shown in eq.1. In simple form it can be implemented as,

$$x_2(n) = x(n) - ax(n-1) \qquad (1)$$

Where, $x_2(n)$ is the output of filter and 'a' is normalization factor that varies between 0.9 and 1.

Pre-emphasis compensate the suppressed part of signal during sound production and it also improves or amplify the sound signal for superior results.

B. Framing

After filtering speech signal, blocks into frames. The 100th samples of previous frame are started from each subsequent frame. Thus, the overlapping takes place between each frame and the two other subsequent frames. This procedure is called as Framing. If the frame is long, signal properties may change across the window, affecting the time resolution. If the frame short, resolution of narrow-band components will be sacrificed, is affecting the frequency resolution adversely [8]. In this block pre-emphasized signal is segmented into the 30 ms to 40 ms of frames with alternative overlap of 1/3-1/2 of the frame size. Framing is very major part for desired results because variation of amplitude is greater in larger signals as compared to smaller signals, Fig.3. and Fig.4. shows the framing of signals.

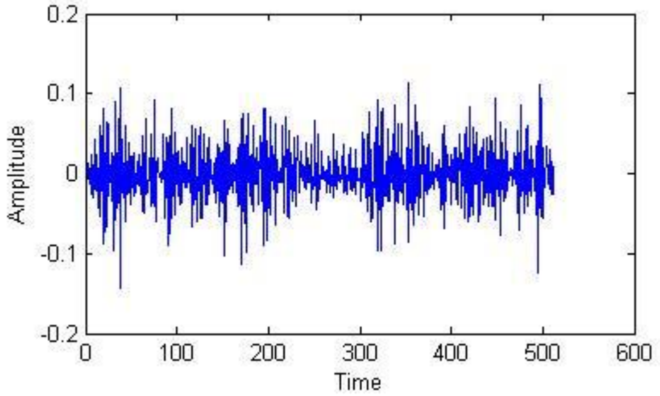

Fig.3 : Framing of Normal Voice.

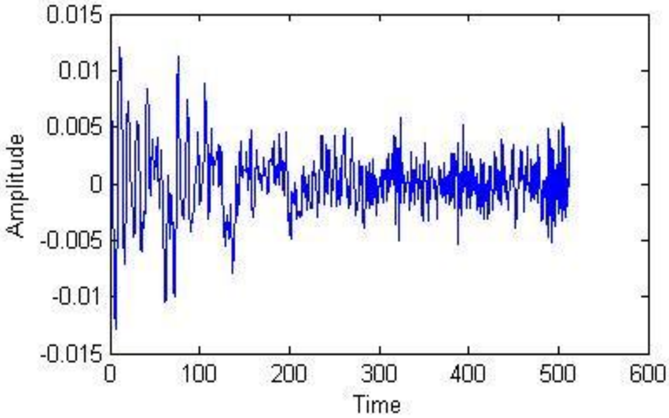

Fig.4 : Framing of Asthma Patient Voice

C. Windowing

The small window of signal is called Frame. While implementing, the windowing corresponds what is actually getting in filter design as a window method in which a long signal is multiplied with window function of finite length, giving a finite length weighted version of the original signal. The unwanted effects in the frequency response are introduced by the discontinuities at the beginning and the end of the frames. Hence, each row is multiplied by window function. In this paper, hamming window is used to overcome the discontinuities of the function [8]. Here sound signal is denoted by x(n), where n = 0, 1, 2.....N-1, then, after multiply signal with hamming window output of this block is

$$\omega(n,\alpha) = x(n) \times \omega(n) \qquad (2)$$

$$\omega(n) = (1-\alpha) - \alpha\cos((2\pi n)/(N-1)) \qquad (3)$$

D. Fast Fourier Transform

All processing is done in time domain. Now extract the power contain of signal across different frequency this signal need to convert into frequency domain. Fast Fourier transform changes the time domain signal into frequency domain signal Fig . 9. and 10. Shows FFT for Normal and Asthma Patient voice. While doing this transform, we will consider that signal is periodic within frame. If signal is non periodic in nature then, also compute this transform but discontinuity comes at start and the end points of the frame [6]. For dealing with this condition we have two options. One is for increasing signal consistency at first and last points, multiply all frames with hamming window and another is to take a frame of different size.

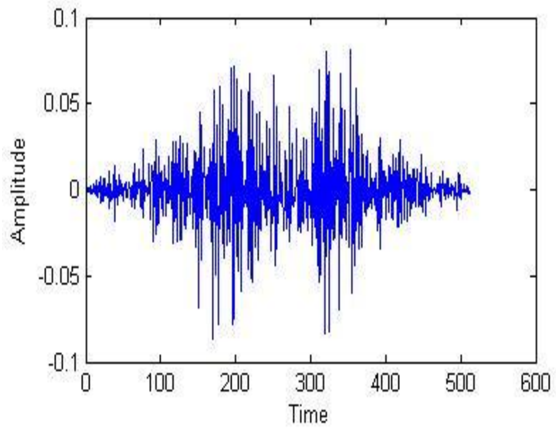

Fig.5 : After applying Hamming window to Normal Voice.

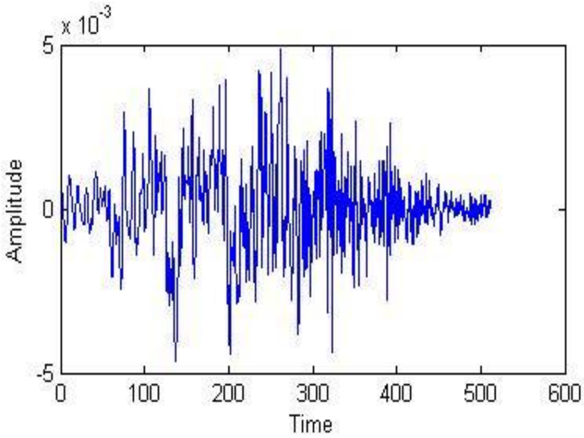

Fig.6 : After applying Hamming Window to Asthma Patient Voice.

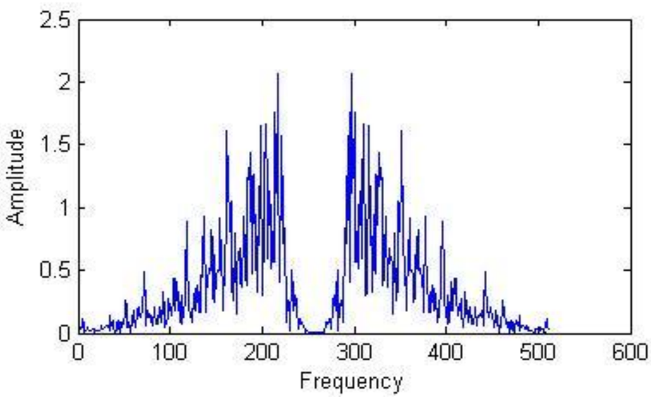

Fig.7: After applying FFT to Normal Voice.

E. Mel Scale Filter Bank

The output of FFT is pass through Mel scale filter bank. Mel-frequency analysis of speech is based on human perception experiments.

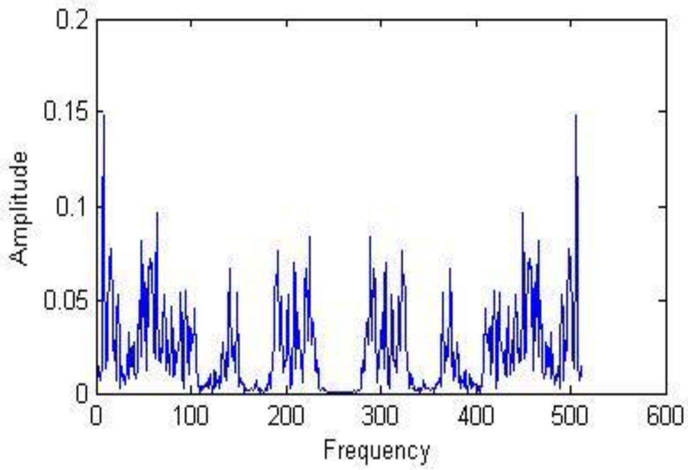

Fig.8 : After applying FFT to Asthma Patient Voice.

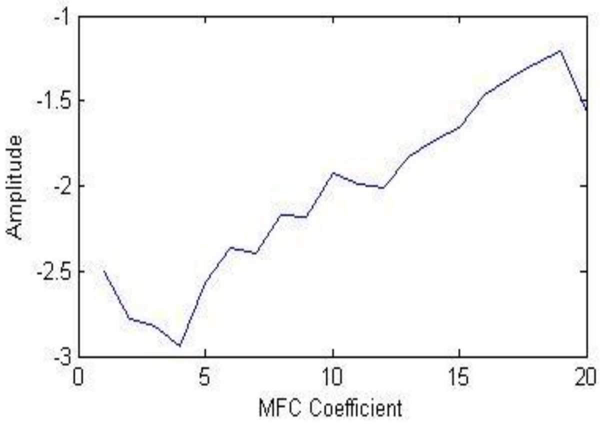

Fig.9 : After applying MFCC to normal voice.

Hence, the filter bank is designed so as to maintain the low frequency over the high frequency. Also, the voice signal does not act in accordance with the linear frequency scale used in FFT. Hence, perceptual scale of pitches equal in distance Mel scale is used for feature extraction. We use Mel frequency filter bank with 20 triangular overlapping filters for obtaining log energies of each filter Fig. 9. and Fig. 10. shows the MFC coefficient to Normal and Asthma patient voice. All these filters are uniformly spaced along with Mel frequency. Basic formula to convert normal frequency to Mel-scale is

$$Mel(freq.) = 1125 \times \ln(1 + f / 700) \qquad (4)$$

F. Logarithm and Discrete Cosine Transform

Each frame per filter holds the log-energy obtained by computing logarithm of weighted sum of spectral magnitudes in that filter-bank channel.

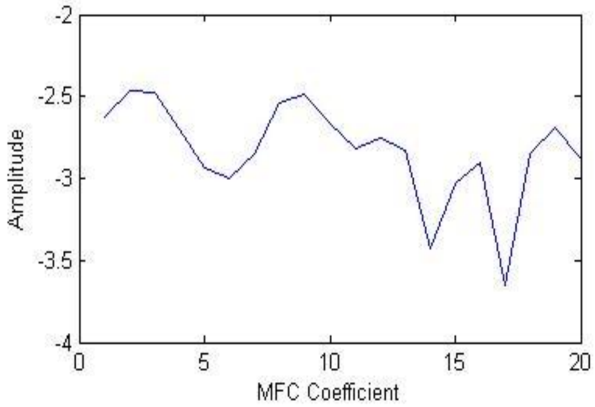

Fig.10 : After applying MFCC to Asthma patient voice

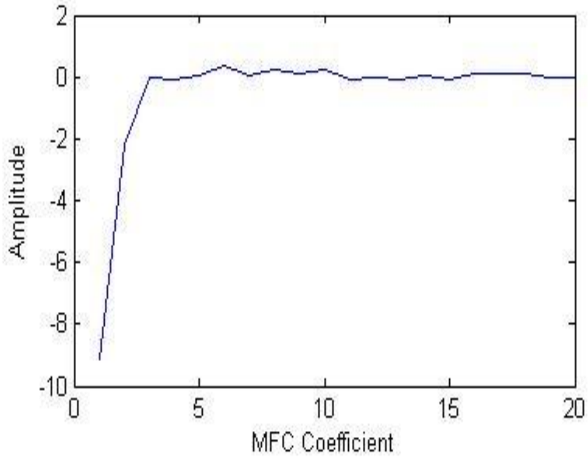

Fig.. 11. After applying DCT to Normal voice

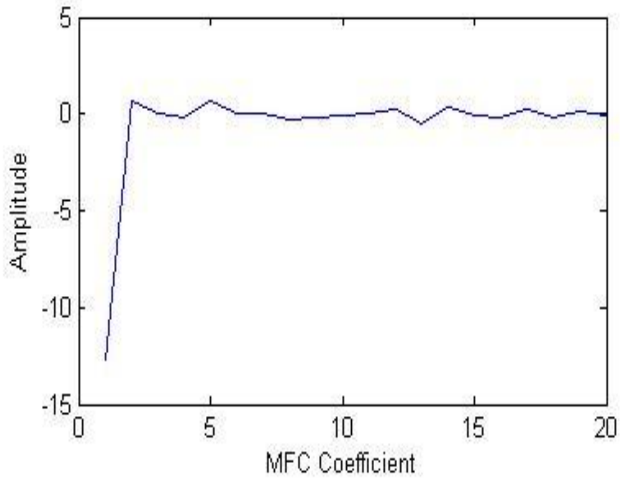

Fig.12 : After applying DCT to Asthma Patient voice.

Hence, we get 20 numeric values for each frame at the output of this stage. Output of Mel scale filter bank then passed through logarithm block. This block is used for normalization purpose. The discrete cosine transform converts the log power spectrum into time domain. After that normalized signal is passed through DCT block that de-correlates the log energies of filters. Fig.11. and Fig. 12. shows the result after applying DCT to Normal and Asthma patient voice. Finally, the output of DCT block furnish us the MFCC coefficient values.

III. EXPERIMENTAL RESULT

In this analysis 20 coefficients of MFCC were computed for feature extraction purpose. After calculating these coefficients using MATLAB, large fluctuation has been seen in the first coefficient of asthmatic persons. Fig. 13. Shows the extracted feature of MFCC for Normal Person and Table I. Depicts the value of 20 triangular band pass filter for Normal Person.

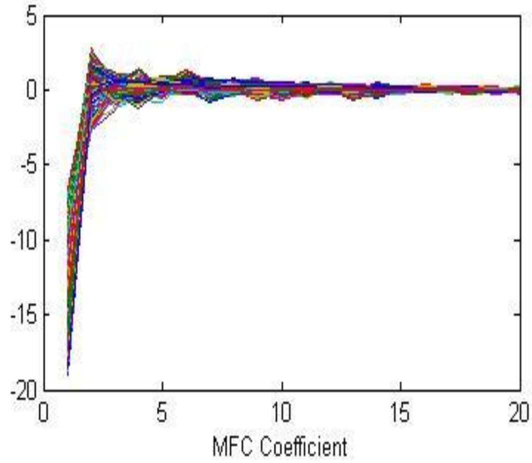

Fig.13 : Extracted feature using MFCC for normal person for 20 coefficients

TABLE.I : VALUES OF 20 MFC COEFFICIENT FOR NORMAL PERSON

Sr. No.	Frame1	Frame2	Frame3
1	-18.3253	-18.5111	-18.0269
2	-0.4484	-0.4358	0.1294
3	0.3190	0.2992	0.6444
4	0.2996	0.3973	0.4494
5	0.1543	0.5292	0.0769
6	0.3905	0.3473	0.0542
7	0.2491	0.1907	0.0615
8	0.2425	0.3074	0.1727
9	0.2397	0.1746	0.2018
10	0.1653	0.2992	0.3300
11	0.1176	0.2906	0.3713
12	0.1678	0.3089	0.3766
13	0.0680	0.1199	0.3301
14	-0.0055	0.1954	0.2921
15	-0.0166	0.0802	0.1274
16	0.1219	0.525	0.1063
17	0.1011	0.0109	0.1064
18	0.0439	0.0589	0.1059
19	-0.0048	0.0575	0.0937
20	-0.678	-0.0409	0.0513

Fig.14 Presents the extracted feature of MFCC for Normal person and Table II. Depicts the value of 20 triangular band pass filter for Normal Person.

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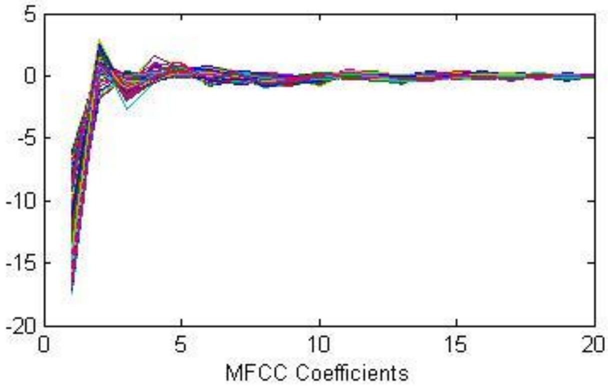

Fig.14 : Extracted feature using MFCC for asthmatic person for 20 coefficients

TABLE.II : VALUES OF 20 MFC COEFFICIENT FOR ASTHMATIC PERSON

Sr. No.	Frame1	Frame2	Frame3
1	-16.8547	-16.6263	-16.4790
2	0.6612	0.8175	1.0052
3	-0.0757	0.0481	0.1255
4	-0.0232	-0.3236	-0.0531
5	0.2439	0.3821	0.4236
6	0.3690	0.5206	0.7219
7	-0.0106	0.0820	0.2801
8	-0.0697	-0.1378	-0.2339
9	-0.3028	-0.3935	-0.1529
10	0.0098	0.1619	0.2935
11	0.0201	0.1070	0.1664
12	-0.0579	0.0086	-0.0373
13	-0.1532	-0.1110	-0.2631
14	0.0757	-0.0831	-0.1158
15	0.0301	-0.0577	-0.0858
16	0.1791	0.583	-0.0700
17	0.0064	-0.0209	-0.0804
18	-0.1125	-0.0455	0.0180
19	-0.2273	-0.1875	-0.0603
20	-0.0885	-0.0816	-0.0963

IV. CONCLUSION AND FUTURE SCOPE

Features are extracted for all voice samples in the database using Mel frequency Cepstral Coefficients in MATLAB. After analyzing the extracted features for both asthmatic and normal persons, it has been recognized that there is a large variation in coefficients of asthma affected person as compared to normal persons especially in the 1st and 2nd coefficients.

1. This method is used to find out the initial stage of asthma.
2. In the future this work could be extended by matching the MFCC coefficient with various types of Voice.

In future, matching of Normal voice and Asthma patient voice is done and more collection of asthma patient data. Base on this data we try to recognize the disease with less time which will automatically detect Asthma.

REFERENCES

[1] Asthma UK,http://www.asthma.org.uk/index.html

[2] Asthma Canada,http://www.asthma.ca/adults/

[3] http://www.who.int/mediacentre/factsheet/fs206/en/

[4] http://www.nhlbi.nih.gov/health/health-topics/topics/asthma/

[5] Pal, Ranabir, Sanjay Dahal, and Shrayan Pal. "Prevalence of bronchial asthma in Indian children." *Indian Journal of Community Medicine* 34.4 (2009): 310.

[6] Hossan, Md Afzal, Sheeraz Memon, and Mark A. Gregory. "A novel approach for MFCC feature extraction." *Signal Processing and Communication Systems (ICSPCS), 2010 4th International Conference on*. IEEE, 2010.

[7] Kopparapu, Sunil Kumar, and M. Laxminarayana. "Choice of Mel filter bank in computing MFCC of a resampled speech." *Information Sciences Signal Processing and their Applications (ISSPA), 2010 10th International Conference on*. IEEE, 2010.

[8] Joshi, Siddhant C., and A. N. Cheeran. "MATLAB Based Feature Extraction Using Mel Frequency Cepstrum Coefficients for Automatic Speech Recognition." *International Journal of Science, Engineering and Technology Research (IJSETR)* 3.6 (2014): 1820-1823.

[9] Ahmad, Khan Suhail, et al. "A unique approach in text independent speaker recognition using MFCC feature sets and probabilistic neural network."*Advances in Pattern Recognition (ICAPR), 2015 Eighth International Conference on*. IEEE, 2015.

[10] Lokhande, N. N., N. S. Nehe, and P. S. Vikhe. "MFCC based Robust features for English word Recognition." *India Conference (INDICON), 2012 Annual IEEE*. IEEE, 2012.