Effect of 0dB and 20dB Vehicle Noise on Stuttered Speech: A study

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ABSTRACT
This paper describes the effect of 0dB and 20dB vehicle noise on stuttered speech. 100 samples are collected from the subjects (stutterer), among which 80 samples are used for training and 20 samples for testing. The samples are trained using Mel Frequency Cepstral Coefficients (MFCC) feature extraction and statistical parameters such as mean, max, min, standard deviation (SD), power spectrum density (PSD), then the testing samples are analyzed by adding vehicle noise of 0dB and 20dB. Using sparse matrix enhancement technique the vehicle noise is degraded. The results obtained after enhancement are 45-95% depending on the samples used for analysis.

Keywords
Stutter, vehicle noise, MFCC.

1. INTRODUCTION
Stuttering is a disorder in speech, also known as stammering in the United Kingdom[1].

The types of Stuttering are: (1) Interjections, (2) Revisions, (3) Incomplete Phrases (4) Word repetitions (5) Part-word-repetitions (6) Prolonged sounds (7) Broken words [2].

Stammering is often associated with "Repetitions". Part-word-repetition / syllabic repetitions are one of the defining elements of early stammering. The dominant features of speech reported are: (1) Word Repetitions, but not part-word-repetition is a prevalent feature of early stammering [3]. (2) In early stammering, there is a high proportion of repetition in general, as compared to other types of disfluency like prolongation [4]. Stuttering is also called as stammering or disfluent speech, in speech disorder. This is different when compare with normal repetition of words that children may do when learning to speak. Normal developmental stuttering / disfluent may occur when the child is between the ages of 18 months to 5 years. This may include repeating words / phrases, poor pronunciation of words, leaving out words or sounds. There are different types of stuttering, that include the following: 1) Developmental Stuttering 2) Neurogenic stuttering 3) psychogenic stuttering. Although stuttering may cause emotional problems, but it cannot believed to be the result of emotional problems [5]. This paper considers repetition as the major characteristics feature of stuttering for studying the effect of 0dB and 20dB vehicle noise on stutterer.

Noise which is an unwanted signal will interfere with the communication, measurement / processing of an information bearing signals [12].

Vehicle is also called as Volvo or Car interior noise. The vehicle is in 4th gear, on an asphalt road, in rainy condition. During recording the vehicle is at 120 km per hour [20].
According to the researchers' sometimes noises reduce stuttering but sometimes it increases [16 - 19].

2. DATA DESCRIPTION
100 Stuttered speech samples are collected from the subjects or patients. 80% of the samples are used for training and remaining 20% for testing. Speech processing is often difficult for speech recognizers and the stuttered speech will be more difficult. In this work the subjects were made to read a given text aloud. Recognizing the read speech is easier for recognition system, hence the system has the prior knowledge about the subjects / patients. Although read speech by the subject is not typically as rich in disfluencies as spontaneous speech, the stutters are often disfluent when reading aloud [13,14]. In stuttering assessments the read speech is one of the most important task [14,15].

The speech samples were recorded by making them to read English "All Phoneme passage". In this passage some of the possible part word and whole word repetition are as follows:

Table 1. Part Words and Whole Words

Part words	Whole words
gra	Grand
dre	Dresses
co	Coat
ba	Banana

3. METHODOLOGY
3.1 Train Dictionary
Out of 100 samples collected, 80% of it i,e. 80 samples are used for training. These 80 samples are loaded to dictionary and MFCC of each samples are taken to obtain MFCC coefficient. For these MFCC coefficients, the statistical properties are applied to obtain output in the form of vector.

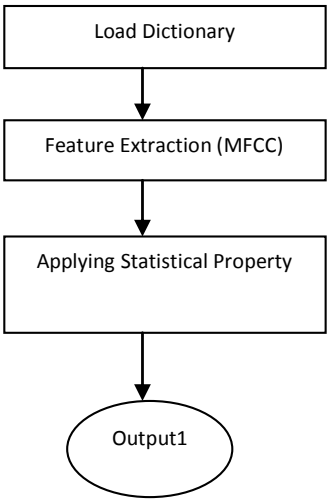

Fig 1: Flow chart of Training Dictionary words

3.1.1 Mel Frequency Cepstrum Coefficients

The block diagrams for calculating MFCCs are as shown in Fig. 2.

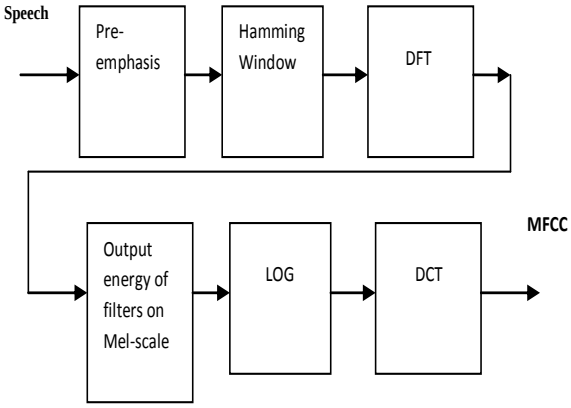

Fig 2: MFCC calculation

3.2 Test and Classify

20 samples are select for testing; it will be passed one by one to MFCC and then statistical property and stored in a vector output2. As shown in fig.3.

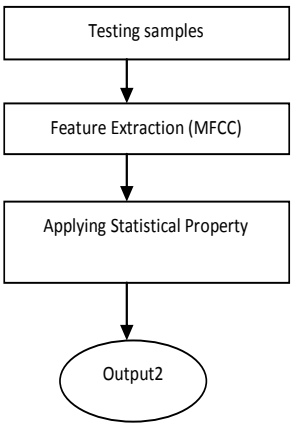

Fig 3: Flow chart of testing data

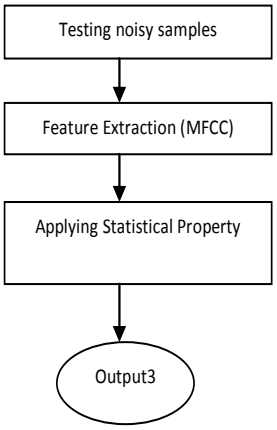

Fig 4: Flow chart of testing data with vehicle noise

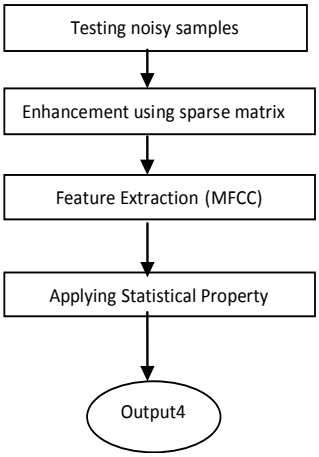

Fig 5: Flow chart of enhancement samples

Comparing output1 with output2; output1 with output3; and output1 with output4; using Euclidean distance, gives Pair wise distance between two sets of observations. The expression for Euclidean Distance measuring is given by equation 1. Later classification is done using KNN.

$$dE(a,b) = \sum_{i=0}^{N} \sqrt{a^2 i - b^2 i} \quad \text{---------- } 1$$

Where a1….an are the training Set with the class label b1….bn.

3.2.1 K-nearest neighbor (k-NN)

Instance-based classifiers such as the KNN can be a simple matter of locating the nearest neighbor in instance space and labeling the unknown instance with the same class label as that of the located (known) neighbor.

Given a set A of n points and a distance function D, k-nearest neighbor (kNN) search allows user to find the k closest points in A to a query point or set of points. The kNN search technique and kNN-based algorithms are widely used as benchmark learning rules — the relative simplicity of the kNN search technique makes it easy to compare the results from other classification techniques to kNN results.

4. RESULTS

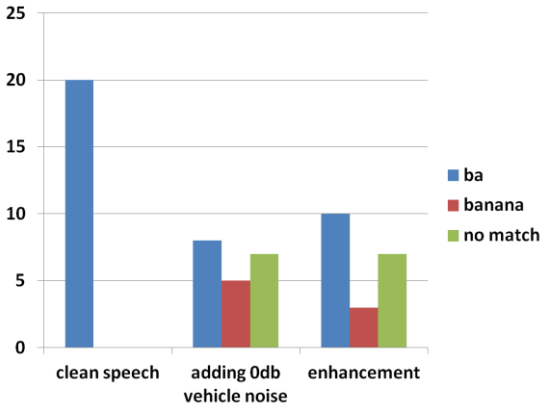

Fig 6(a): ba and banana with 0dB vehicle noise & enhancement

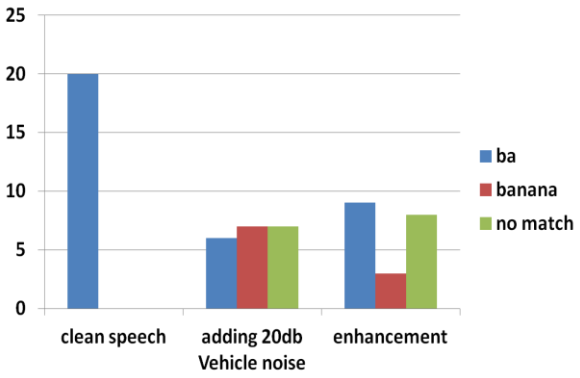

Fig 6(b): ba and banana with 20dB vehicle noise & enhancement

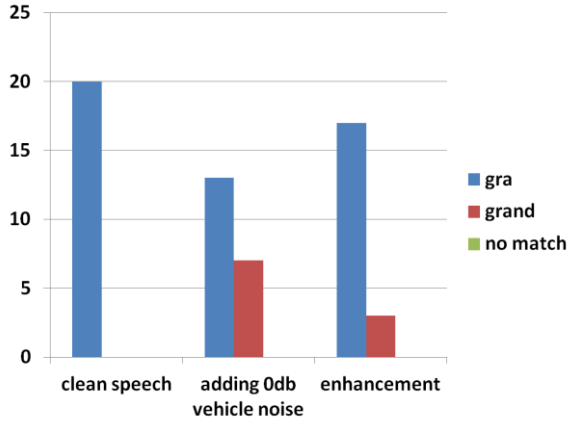

Fig 6(c): gra and grand with 0dB vehicle noise & enhancement

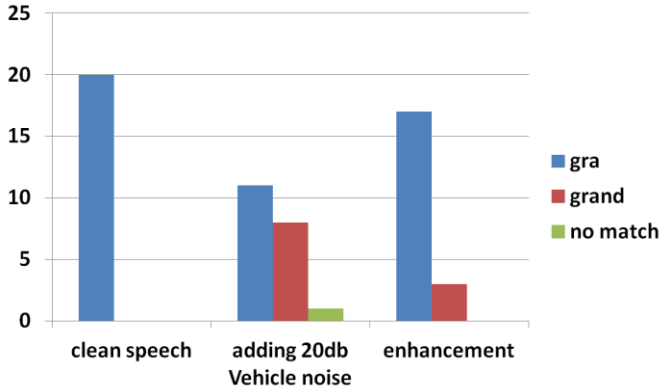

Fig 6(d): gra and grand with 20dB vehicle noise & enhancement

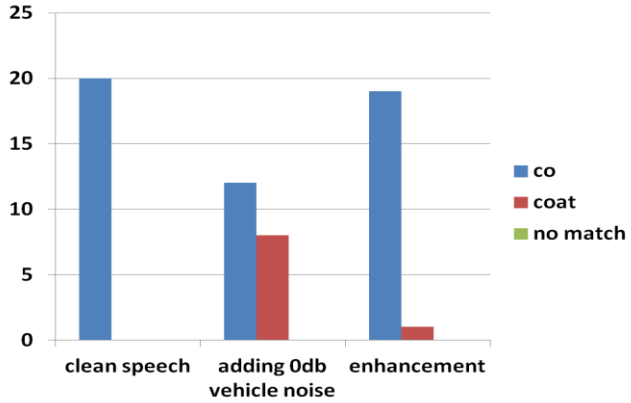

Fig 6(e): co and coat with 0dB vehicle noise & enhancement

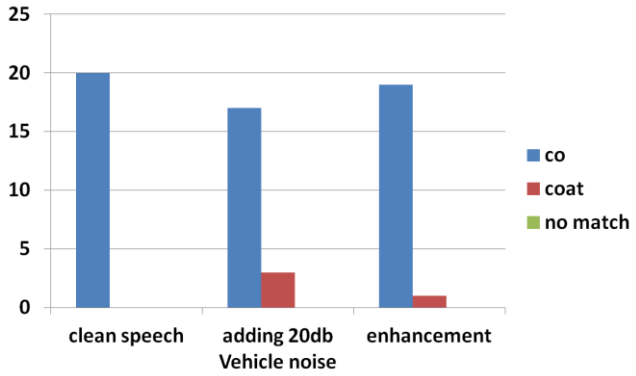

Fig 6(f): co and coat with 20dB vehicle noise & enhancement

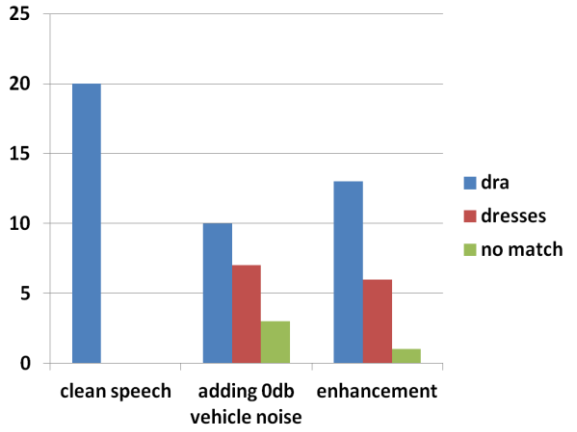

Fig 6(g): dra and dresses with 0dB vehicle noise & enhancement

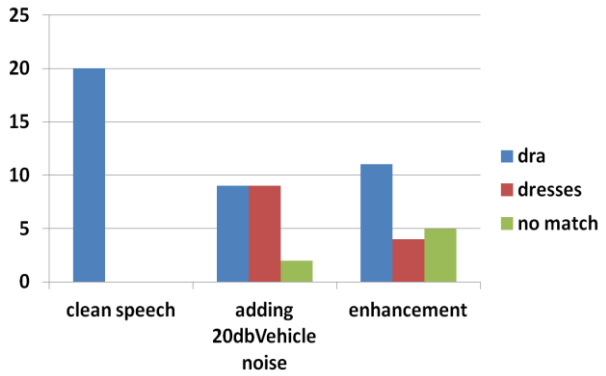

Fig 6(h): dra and dresses with 20dB vehicle noise & enhancement

Fig 6 shows the graphical representation of results of fig 3, 4 and 5. Number of testing samples is show in y-axis. In fig 6(a) (c) (e) (g) represents the results of part word and whole word with 0dB vehicle noise. In fig 6(b) (d) (f) (h) represents the results of part word and whole word with 20dB vehicle noise. The blue bar represents the part word results, The red bar represents the whole word results, The green bar represents the no match results.

From table II it can be observed that, the recognition result is 100% for clean speech, irrespective of sound repeated. When noise is added the percentage reduces to the range of 30% to 85%, depending on the sound and the type of noise added. Similarly after enhancement the result is improved towards 45% to 95% depending on the sound used.

Part words	% of result for clean speech	% of result with 0dB vehicle noise	% of Enhancement from noisy result(0dB)	% of result with 20dB vehicle noise	% of Enhancement from noisy result(20dB)
ba	100%	40%	50%	30%	45%
gra	100%	65%	85%	55%	85%
co	100%	60%	95%	85%	95%
dra	100%	50%	65%	45%	55%

Table 2. Results of analysis in percentage

5. FUTURE WORK

The number of samples can be increase and the variation of result may be analyzed.

The effect of other standard noise with different dB of SNR can be analyzed.

6. CONCLUSION

In this study the effect of 0dB and 20dB vehicle noise on stutter speech such as repetition is analyzed the result obtained for the noisy stutter speech samples are 30-85%. The same noisy stutter speech samples are enhanced by degrading the noise effect to some extent, the result obtained after enhancement are 45-95%. The effect of other standard noises such as babble noise, factory noise, pink noise etc., with different dB of SNR can be analyzed. The present work will help the clinician to objectively assess the stutterer in noisy environment for early treatment.

Although different Altered Auditory Feedback systems are available for the treatment of adult stutter [7], there is a need for better recognition and identification of the source of stuttering. Many methods are proposed for the recognition and objective assessment of stuttered speech [7-10], yet there is a wide scope for improvement.

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