**Spectral Subtraction with Time-Frequency Filtering for Speech Enhancement**

***Abstract***

To develop a speech-to-text (STT) system using Kaldi speech recognition toolkit for continuous Kannada language/dialects. A continuous Kannada speech data is collected from 100 speakers/farmers of Karnataka state in field. The lexicon/dictionary and set of phonemes for Kannada language/dialects are created and transcribed the collected speech data using transcriber tool. The ASR models are developed at different phoneme levels using Kaldi. In this work, an effort is made to develop a robust small vocabulary STT system for continuous Kannada language using Kaldi. The various acoustic modelling techniques are used ad achieved a word error rate (WER) of 0.23%. The performance of the to develop a robust ASR model and achieved a ASR model is analysed by offline speech recognition.

***Keywords:*** Spectral subtraction, time-frequency, PESQ, SNR, NCM.

**1**. **Introduction**

Speech enhancement is the fundamental application of speech processing. Spectral subtraction (SS) [1] is by far the most popular method in speech enhancement, possibly because of its simplicity. A well-known shortcoming of the SS algorithms is the resulting residual noise consisting of musical tones. To overcome the musical noise problem, spectral smoothing has been suggested but it results in low resolution and variance [2]. In our previous work, an amalgamation of SS-VAD and linear predictive coding system to advance the SNR and enhanced audibility features of encoded speech data was proposed [3]. It was observed that the resulting musical noise due to SS had an adverse effect on encoding performance.

**2. Methodology**

The Fourier transform of the above equation is

The Hanning window can be mathematically represented as

All these parameters were used for calculating the factor Z is given by

Z=E(1-ZCR)(1-NLPE) (4)

The spectral subtraction output can be written as follows:

The residual noise by mathematical shown below.

The Block diagram of proposed Technique for background noise reduction is shown here

**Attenuation during non speech activity**

**Overlap and Add**

**Time – Frequency filtering**

**Half wave rectification**

**Noise estimation**

**FFT**

**Hamming window**

**-**

**µ(w)**

**Noisy speech**

**C(w)**

**+**

**Enhanced speech**

**From SS method**

Figure 1: Block diagram of proposed speech enhancement techniques

Table 1: PESQ values for proposed and existing methods for the assessment of speech quality.

|  |
| --- |
| **Algorithm Types of Noise 0 dB 5 dB** |
| Airport 1.9085 2.1752  Exhibition 1.6571 1.9992  **SS-VAD** Restaurant 1.9950 2.0314  Station1.6517 2.1396 |
| Airport 1.9501 2.1758  Exhibition 1.6614 2.0123  Proposed (SS-TF) Restaurant 2.0900 2.0364  Station 1.6801 2.1294 |

**3**. **Conclusion**

We proposed the SS-TF filtering method for speech enhancement with promising for different noise types and SNR levels was observed.

**References**

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