CONCLUSION

The original noisy speech and simulated noisy speech samples after subjecting to various filtering techniques such as FFT Filter, Noise reduction, Noise gate, Notch filter, Bandpass, Butterworth filter, Digital equalizer and Parametric equalizer for Speech recognition and Noise reduction, Noise gate, Notch filter, Band-pass and Butterworth filter for Speaker Identification. The outcome of the study on the basis of improvement in Signal to Noise ratio (SNR) and Mean Opinion Score Test (MOS Test) is significant.

For Speech Recognition preference is given to the intelligibility of the speech signal while carrying out the steps. In the case of Speaker Identification, limitation of filtering technique is also considered; depending on various parameters of the noise, which in turn can help in retaining the Speaker Dependent Features. The Specific filters for enhancement of recorded speech from different characterized noise for Speaker Identification is recommended based on their effect on perceptual and acoustic features. For Speech Recognition, the degree of efficiency of filters in enhancing the speech signal is found to be in a descending order; viz. FFT Filter, Noise reduction, Noise gate, Notch filter, Bandpass, Butterworth filter, Digital equalizer and Parametric equalizer. The degree of efficiency of filters in enhancing the speech signal for Speaker Identification is found to be in a descending order; viz. Noise Reduction, Noise Gate, Notch filter, Bandpass, and Butterworth filter. Though there is improvement in the auditory perceptual features, distortion in speaker dependent characteristics is observed when Digital Equalizer, Parametric Equalizer and FFT filter are applied.
Thus, the applications of Digital Equalizer, Parametric equalizer and FFT filter are not recommended for speaker identification task.

FFT filter is found to be the most promising technique when only speech has to be recognized from a noisy recorded speech in any of the three modes of recordings (direct, telephonic and mobile) by improvising the SNR and acoustic features of the recorded speech. Noise Reduction filtering technique for enhancing the noisy speech recorded in any of the three modes of recordings (direct, telephonic and mobile); proved to be efficient in terms of improving the SNR and preserving the Speaker Dependent Features of the speech signal and hence is the most appropriate filter capable of qualifying the noisy speech for Speaker Identification purpose. Intelligibility and Speaker Dependent Characteristics are found to be inversely proportional to each other in a non-linear manner when filters are applied. For better performance it is recommended to apply filter(s) for Speech Recognition and Speaker Identification both separately.

The credibility of increasing speech intelligibility on applying filters to the noisy speech samples is observed to be dependent on sample, each in a unique manner. The near perfection in this effort is achieved by treating their noise only counterparts with the same filters. When filter(s) is/are applied on noisy speech samples, the elimination of noisy part containing information is unpredictable. In addition, Speaker Dependent Characteristics and Intelligibility are found to be inversely proportional to each other in a non-linear way when filter(s) is/are applied. Noise Reduction filter is found to be the most promising technique for enhancing the noisy speech recorded in any of the three modes of recordings; Direct, Telephonic and Mobile by preserving the perceptual and acoustic features. By this study appropriate filter(s) can be decided to detect and reduce/eliminate the different class of noises embedded in the speech signal for Speaker Identification.

The number of samples qualified for Speech Recognition is found out based on SNR improvement and Mean Opinion Score Test (MOS Test) conducted on the filtered original noisy
speech and simulated noisy speech samples. Based on this study appropriate filters are identified for different types of embedded noise.

Noisy Speech-I which is predominantly of the convolutional noise as a product of transfer function embedded with the recorded speech signal falls in the white Gaussian Noise region. Random noise do occur in some of the noisy speech samples and application of filter on the Noisy Speech-I results comparatively least improvement in the Signal to Noise Ratio (SNR).

Noisy Speech–II characterized as a noise produced by the communication channel as well the additive random noise similar to the Noisy Speech-I. Application of Noise removal filters namely, FFT filter for Speech recognition and Noise Reduction filter for Speaker Identification respectively.

The results from the application of various filters indicate that FFT filter, Noise reduction filter and Notch filter are efficiently able to reduce the noise for Speech Recognition. In the case of Speaker Identification Noise Reduction filter and Noise Gate filter are able to enhance the speech most efficiently.

Thus the characterization of noise associated with forensic speech samples is possible for Speech Recognition purpose. The results from the Mean Opinion Score Test (MOS Test) are used to characterize the noise in terms of subjective quality of the speech. Thus it is also possible to find out appropriate filters for each group of noise recorded in three modes of recordings. Such characterization and the specific filters suitable for improving the intelligibility for efficient Speech Recognition is attained.

Thus a two fold approach of noise characterization is successfully carried out for efficient speech enhancement for Speech Recognition in noisy recordings produced from three modes of recordings, namely, Direct, Telephonic and Mobile.
Based on the inference from the subsequent study conducted upon the results of various analyses, namely, appropriate Filters for each class of noise associated with Forensic speech samples is identified and recommended for Speaker Identification. The characterization of noise associated with the forensic speech samples and their classification are performed. The result of the study is also relevant to other Forensic Audio problems such as Audibility analysis, Authenticity analysis, Event sequence analysis and other signal analysis.