# Abstract

Glottal activity is the process of vibration of vocal folds which causes the significant excitation to vocal tract system. Analysis of glottal activity is essential in many speech processing applications such as speech analysis, speech recognition, speech synthesis, speaker recognition, prosodic modification, and analysis of vocal folds disorders. The vocal folds vibrate as air passes through them during exhalation of air from the lungs. The quasi-periodic signal is generated by vocal folds when they vibrate naturally. The vibration of the vocal folds is well captured by the Electroglottographic (EGG) signal. The time instant, when the vocal folds start to attempt to close from their open position is known as the glottal closing instant (GCI) and the time instant, when the vocal folds start to attempt to open or separate from each other from their closed position is known as glottal opening instant (GOI). Analysis of glottal activity consists of determining the glottal parameters using the GCI and GOI.

The detection process of the glottal instants using the EGG signal and first order derivative of the EGG (DEGG) signal is very accurate. In some vulnerable cases of voicing like transition in laryngeal mechanism, low voicing at the end of the sentences, the detection of glottal instants becomes erroneous. The performance in detection of the glottal instants is drastically reduced, if the EGG signals are noisy. At the time of recording the EGG signal, noise can be induced in the recorded signal due to improper connection of the recording devices, speaker's

head movement, inappropriate placement of electrodes through the neck, etc. In addition to above, the detection accuracy of glottal instants is affected by the presence of disorders in the speaker's vocal folds. Motivated by these facts, the work presented in this thesis is intended to improve the accuracy in the detection of the glottal instants in normal as well as vulnerable cases of voicing, induced noises, and vocal folds disorders.

The thesis begins with the exploration of the phase of the EGG signal for detecting the glottal instants. The unwrapped phase of the EGG signal is explored to detect the glottal instants from the vulnerable cases of voicing. The performance of phase based method has been affected by noisy EGG signals. To overcome this problem, total variation de-noising (TVD) method has been explored for the detection of the glottal instants from noisy EGG signal. The proposed TVD method has also been used for the detection of the glottal instants from the pathological EGG signal. Here, the pathological EGG signals refer to the EGG signals collected from the speakers suffering with different types of vocal folds disorders. For investigation and evaluation purpose, a pathological EGG signal database consists of five disorders, namely, polyp, nodule, cancerous, paralyzed, and thicken vocal folds has been collected. For classifying the above mentioned disorders, four glottal parameters, namely, contact quotient, open quotient, speed quotient, and jitter derived from each glottal cycle have been explored. For resolving the ambiguities in discriminating the polyp and nodule disorders, shape of the Hilbert plot has been explored.

The major contributions of the thesis are given below :

1. Unwrapped phase of the EGG signal has been explored for detection of the glottal instants from vulnerable cases of voicing.

2. TVD method has been explored for the detection of glottal instants from the noisy EGG signals as well as pathological EGG signals.

3. Pathological EGG signal database consists of five types of vocal folds disorders has been collected for investigation and evaluation purpose.

4. Glottal parameters derived from each glottal cycle have been explored for the classification of five types of vocal folds disorders.

5. Hilbert plot is explored to resolve the ambiguities in classification of polyp and nodule vocal folds disorders.

***Keywords***: Glottal activity, vocal folds, glottal instant, electroglottographic signal, phase unwrapping, vulnerable voicing, total variation denoising, hilbert plot, vocal folds disorders.