Chapter - 5

SUMMARY AND CONCLUSION

Inverse filtering is an acoustic method of recording the vibration of the vocal folds. The microphone signal of a sustained sound is passed through acoustic filters, which are set to match the inverse effect to that of the vocal tract. This eliminates the formants and results in a graphic representation of the voice source in the form of the glottal volume velocity waveform.

VAGHMI, a personal computer based, digital signal processor, designed to derive Inverse Filtered Signal (IFS). Inverse Filtered Signal waveform derived by this technique is explored on the Model voice of non-abrupt closure of the vocal fold proposed by Ananthapadmanabha.

Ananthapadmanabha (1982, 1984, 1993), proposed to model the ‘derivative’ of the glottal pulses (voice source pulses). He gave emphasis to the modeling of the non-abrupt glottal closure component and proposed to extract the voice source parameters in the time domain from the inverse filtered signal.
Figure 5.1 shows the 'instants' of laryngeal waveform. Intervals between the instants are described as CLOSED PHASE, OPENING PHASE, CLOSING PHASE and RETURN PHASE.

Normal laryngeal waveform and the abnormal laryngeal waveform are described based on these intervals.

Different pathological conditions that results in 'dysphonia' are classified as

- dysphonia due to structural variation
- dysphonia due to neurological variation
- functional voice disorder
- bowing of vocal cords

Lx wave morphology seen in these pathological conditions are different and each pathological condition show a unique pattern of their own.
Voice samples of sustained vowel /a/ at comfortable frequency and intensity were recorded directly on to the computer using Analog digital converter (A/D converter). Voice samples were recorded in a sound treated room using AKG D-80 microphone. 1050 millisecond digitized samples were processed and analyzed.

Glottogram derived by inverse filtered signal of NORMAL and CLINICAL group showed difference in wave pattern and wave morphology. When compared to normal voice, Clinical group 1 showed the deviation in closing phase of the cycle, Clinical group 2 showed the deviation in opening phase and closure of the vocal folds, Clinical group 3 showed the deviation in closed phase of the cycle, Clinical group 4 showed the deviation in adequate closure of the vocal folds.

Pitch perturbation are measured using Inverse Filtered Signal. Measurement of mean fundamental frequency, pitch sigma, Jitter factor, Period variability index, directional perturbation factor, Relative average perturbation, Deviation from linear tendency, Jitter ratio, jitter sigma, Shimmer dB, amplitude variability index, Amplitude perturbation quotient are used to explain and discriminate normal and abnormal conditions. Also discriminates and differentiates with in abnormal conditions.
Statistical analysis reveals the perturbation measurements related with jitter are more significant than the perturbation measurements related with shimmer.

Inverse filtered signal, a non invasive technique of eliciting glottal pulse is least anxiety provoking and can be used for understanding the vocal fold behavior.

Recommendations:

1. Present investigation is limited to adult population. However this study can be extended to different age groups.

2. Wave morphology and pitch perturbation may be explored to understand the extent, severity and duration of laryngeal pathology.

3. IX wave morphology and vocal fold behavior may be used as a reference in voice therapy. Progress by voice therapy may be documented and assessed periodically.