

Title of Project: Development and Implementation of software based Automatic Heart Monitoring System through Speech Signal Analysis.

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Objective of Research Project:

PI and Co- PI of the present proposed project had been involved in establishing a correlation between extracted speech parameters and the functioning of human heart since year 2008. Recently, in the month of August 2014, Co-Pi has been awarded with a Ph.D. degree by PT. RSU, Raipur in the topic “A Correlation between Speech Features and Functioning of Human Heart” under supervision of PI. They have found that both the speech parameters and functioning of human heart are highly correlated .They have used speech signal analysis techniques for the assessment of human heart functioning. The required speech information has been extracted from the normal speech of a person and analyzed through GOLD WAVE and PRRAT software. The results of different analysis techniques can be used for detection of heart functioning of the particular.

The two basic techniques which provide the medical diagnosis of human Heart are Phonocardiography and Electrocardiography. Electro-cardiograph (ECG) is the most commonly used technique for the diagnosis of the heart in which moment to moment electrical activity of heart is recorded on a graph. Through speech signal analysis mainly formant frequency, an equivalent plot of ECG of a particular man/woman has been plotted and named as Acoustic-cardiograph (ACG). The formant frequency analysis have been used to assess the functioning of human heart as the formant frequency is important frequency pattern in our speech signal which reflects the physical, mental and intricate features of the speaker .

In the proposed project, both PI and Co-PI will be aimed at developing a Mat-lab based compact, automated system for monitoring the heart activity through speech analysis. Before that we must have to test the correlation established by us for over at least 5000 heart patient's .It is a challenging task to collect such a big data set. For this we would like to take help of CCOST in the form of Project Fellow. Later on we will apply the strong statistical analysis over the big data set thus generated. Keeping the False Rejection Rate (FFR) and False acceptance Rate (FAR) within the limit, a compact, Mat-lab based software system will be developed for establishing a precise and accurate correlation between speech parameters and human heart. Moreover we would also in search of some speech parameters like LPC coefficients, MFCC, PSD etc. other than formant frequencies and amplitude that will also establish a correlation with functioning of human heart, which will help us to monitor the functioning of human heart as well as to assess various cardiac disorders.

Present knowledge with the gap in the existing knowledge in the field:

Phonocardiography and Electrocardiography (ECG) are the two most commonly used techniques for the diagnosis of the heart. Phonocardiography is the technique of recording the cardiac sounds. The phonocardiograph is composed of a stethoscope like chest piece with a piezoelectric, crystal microphone, which picks up the vibrations of the heart sounds and transforms them into a varying electrical output according to the stresses imposed by sound waves. It is particularly helpful in timing cardiac sounds and murmurs.

Electrocardiography is the recording of moment – to – moment electromotive forces of the heart on a continuous time voltage graph. It requires an instrument called electrocardiograph which records the electrical activity of heart. Electrodes placement on the body surface and interpretation of the electrocardiogram have been based on the idealized concept that the heart produces the electric field of a point dipole in a homogeneous volume conductor. ECG provides the valuable information about a wide range of cardiac disorders such as the presence of an infraction or enlargement of heart muscle etc.

The ECG reveals the heart rate and rhythm only during the time that the ECG is taken. If cardiac rhythm abnormalities are present, the ECG is likely to miss them. Also clinical expertise is required in recording and analyzing the ECG.

In view of above limitation an alternative method using speech features can be developed. Speech recording is much easier process than ECG recording. No expertise is required to record the speech as required to record an ECG. The speech is a rhythmic content in itself as well as it has the inclusive effects of body function as such the speech analysis seems to be a better alternative to ECG for dynamic results which are not possible in ECG.

The patient can easily transfer his speech samples (the biometric parameter) to expert on telephone, while ECG cannot be transferred very easily. This method will be reliable, cheaper and convenient in case of rural area or distant treatment / consultation with medical experts.

Mental cases such as aisimika mental retardation have been analyzed using the speech features. Also speech processing is applied to chest diagnosis, acoustical speech method for monitoring foetus growth has been done but the use of speech analysis for diagnosis of human heart functioning has not been done so far.

It is known that the speech signal analysis has been useful in the study of mental and physical status of human beings. A classical example is represented by Berstein & Cohen (Berstein A. & Cohen A, [Speech processing applied for chest diagnosis, 14th conv. of Elect. & Electronics Engineering, Tel Aviv, Israel, p2.4.4 \(1985\)](#)) by titled as speech processing applied for chest diagnosis. Further it has been shown that emotions

and speech has some acoustical correlations. Also a rule based emotion dependent feature extraction method for emotion from speech has been developed.

We know that different emotional states affect the physical condition of our body. So heart is also getting affected. The heart parameters like blood pressure or heart beat rate gets changed. Also the RR-cycle is affected.

A research study has been made on study of face and speech parameters and identification of their relationship for emotional status recognition. Some work has been done on study of speech recognition of speech under stress and acoustic study of emotions expressed in speech. A new technique for non invasive assessment of volume gain of foetus using formant frequency has been developed.