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# PREDICTIVE ANALYSIS OF FETAL ECG :A SERVEY

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## ABSTRACT

In this project an approach is presented to analyze the fetal health through the study of fetus electrocardiogram(ECG). As fetus and adult heart is having variations in their features, they also have their different techniques to process the ECG. In this project a hybride approach is presented to study the fetus ECG. Processing the ECG includes pre-processing, feature extraction, beat detection and classification. Here, we have implemented Pan tompkin algorithm for feature extraction, and PTE algorithm for beat detection. For simulation, Abdominal and direct Fetal ECG dataset of various time samples of different frequencies are taken from physionet.org database. Among the huge database we have processed Noninvasive fetal ECG database of 10 minute at 1000Hz frequency. By this we get 98.32% predictivity and 2.47% DER(detection error rate).

## INTRODUCTION

Fetal health is an important constrain to consider during pregnancy. As fetal mortality and morbidity are increasing, it is necessary to analyze fetus at early stages of pregnancy. So that diagnosis of the abnormalities or any other cardiac diseases detected can be done. Fetal electrocardiogram (fECG) is the way by which one can know about every detail of fetus health. Fetal ECG can tell about fetus heart rate as well as any abnormalities can be known by observing fetal ECG. As we know, it is difficult to measure direct fetal ECG due to its low signal to noise ratio(SNR), one way to measure fetal ECG is to record abdominal ECG and extract fetal ECG from it, by canceling maternal ECG. Once we get fetal ECG, we can then analyze it by observing various features and parameters, like Q-R-S complex, R-R interval, segment, QT interval, R-peak location, R-magnitude, width of R-peak FHR and so other. From these observations doctors can tell about fetus health or can detect any abnormalities present, so that proper action can be taken.

## LITERATURE REVIEW

In developing nations like India particularly in rural and downtrodden areas, pregnant women are not conscious about the balanced nutrition diet and their health care during earliest stage of pregnancy which causes maternal mortality, fetus morbidity, early infant death or handicapped child. To address this issue several researchers have published their work to simplify the study of mother and fetus heart through analysis of ECG.

G.J.J.Warmerdam , R. Vullings , L. Schmitt, J.O.E.H. Van Laar and J.W.M. Bergmans[1] presented The multichannel hierarchical probabilistic framework was developed for fetal R-peak detection. It also detects heart rate reliably for ECG recording recorded with low SNR and having non stationary nature. The developed method combines predictive models of the ECG waveform and heart rate, and can be used for multichannel recordings.

Giulia Da Poian, Riccardo Bernardini and Roberto Rinaldo [4] proposes The system will become more useful when design with telemonitoring. Wireless body sensor networks can be used to detect fetal arrhythmia along with the use of compressive sensing theory, compression and joint detection and classification of mother and fetal heart beats can be done. This framework is design for low power CS compression of FECG and to detect heart beats.

Reza Sameni and Gari D Clifford [8] proposes It is quite difficult to measure fetal ECG directly, so one method to measure fetal ECG is to record mother abdominal ECG(aECG) and extract fetal ECG from aECG. That is separate maternal ECG(mECG) and fetal ECG(aECG) from abdominal ECG(aECG). Various methods are there to extract fetal ECG from abdominal ECG such as Direct fetal ECG analysis, Adaptive filtering, Linear decomposition, Nonlinear decomposition, Forward modeling.

S.Karpagachelvi, Dr.M.Arthanari, and M.Sivakuma [12] proposes In diagnosis cardiac diseases, ECG feature extraction plays an significant role. Amplitude and interval of P-QRS-T wave of ECG signal tell us about health of human. One cardiac cycle consist of P-QRS-T wave. Feature extraction techniques includes Fuzzy Logic Methods, Artificial Neural Network (ANN), Genetic Algorithm (GA),Support Vector Machine (SVM), and other Signal Analysis techniques.

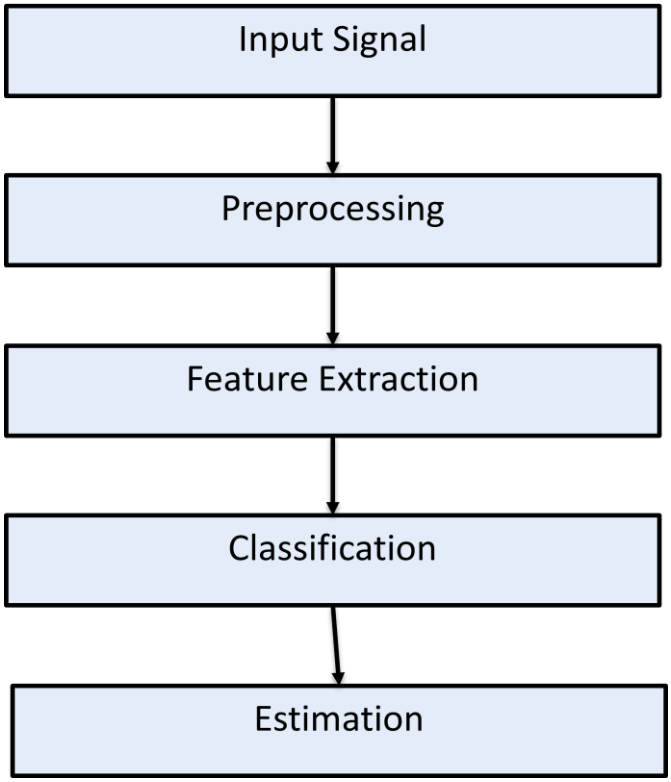
## PROPOSED SYSTEM

Fetus examination is critical and crucial area. Cardiac deformalities are manifested with an average of one in every hundred infants conceived in a year. Fetus heart features are necessary to calculate in order to know the health of fetus and mother. Due to low SNR(signal to noise ratio) fetal ECG, it is difficult to separate it

from maternal ECG and that too detect abnormal heart beats. So, it is crucial to implement an algorithm which will correctly obtain FECG, extract all the features and will detect abnormal heart beats as well, before it poses a threat to the fetus or mother.

In this process abdominal ECG is taken as an input. Here, we have collected database from physionet.org ATM. We have collected, abdominal and direct fetal ecg database, fetal ecg synthetic database, fetal pcg database, non-invasive fetal ecg database etc. Among these databases, we further process Non-invasive fetal ecg database, which has 20 records of 10seconds, 1minute, 1hour time periods each. Among these we have taken ecgca record of 1hour time period having sampling frequency of 1000Hz.In this process abdominal ECG is taken as an input. Here, we have collected database from physionet.org ATM and tried to collect database from DaIsy (Dataset Identification System) also. We have collected, abdominal and direct fetal ecg databases, fetal ecg synthetic databases, fetal pcg databases, non-invasive fetal ecg databases (ecgca) etc which are having different number of records of 10seconds, 1minute, 1hour and signal up to end time periods each at frequencies like 500Hz, 1000Hz etc. As this data cannot be sufficient for processing, we have segmented the dataset signals in different time periods s(slots) and used these segmented signals for processing. By giving sufficient training to dataset, we have then tested the known as well as unknown signals. We further process Non-invasive fetal ECG dataset oh 10minutes and 1 hour record of frequency 1000Hz.

Preprocessing is applied to remove noise from ECG signal which can include baseline wander, electromyographic signal, power line interference etc. The techniques to de-noise ECG are RC low pass filter, Low pass filter using Butterworth filter, Low pass filer using Chebyshev approximation, RLC notch filter, Butterworth band reject filter[29], A fix lag Kalman smoother to remove powerline interference, non-linear Bayesian filter, Savitzky-Golay filter, adaptive least mean square (LMS) cancellation technique, FIR(finite impulse response) to remove baseline wander, IIR(infinite impulse response) to remove power line interference etc. To eliminate power-line interference, narrow band-stop filter centered at 50 Hz is used. To deal with other sources of noise, band pass filter with frequency range 0.5 to 100 Hz has been used.




For feature extraction some proposed techniques are PCA/ICA based feature extraction techniques, Wavelet transforms techniques, FPGA based separation techniques, techniques using compressed sensing, linear and non-linear decomposition techniques, feature extraction algorithms like MICA algorithm, pan-Tompkins algorithm, PTE algorithm. Among these many techniques of feature extraction, it is seen that wavelet transform used in earned significant predictivity and accuracy around 92-99.68% when used with SVM and ANN classifiers. Whereas, variations of wavelet transform proposed in uses mathematical approach and DWT thus found more complex and gives less predictivity. Once the signal is de-noised, feature extraction algorithm is applied on signal to get various essential features. There are various feature extraction techniques stated by researchers which on application on ECG signal give features like P-wave amplitude, QRS complex, T-wave amplitude, segment intervals like RR interval, fetal heart axis. These features can also be used to diagnose diseases. These techniques differ in feature selection techniques like PCA/ICA, wavelet transform based techniques, compressed sensing based techniques, method of adaptive noise canceller, high frequency removal using digital filter etc. Among these here we are using PTE algorithm for fetal QRS detection. By PTE we have calculated QRS complex(R-amplitude), R-R interval, P-wave amplitude, Q-wave amplitude and S-wave amplitude.

R-peak detection: For peak detection, PTE (polar teager energy) algorithm is implemented, which is the advancement in TE (teager energy) algorithm. This works on the non-linear energy of QRS complex. Polarization of teager energy (non linear energy of ECG signal) has been utilized for detection of R-peak. Processing of algorithm involves preprocessing, R-peak detection and P, Q, S, T wave detection. According to the morphology of ECG, QRS complex contains highest non-linear energy. This property has been utilized for detection of R peak. Polarization of Teager Energy (TE) yields

remarkable decrease in false positive of R peaks and hence that of other morphological points. Although these methods have been proposed, most of them have used limited data set (mitdb arrhythmia database). It may cause lack of variety in the data set, leaving particular type of beats unattained. Also most of them are complex and require more computational power. Even if any such computationally efficient and accurate method has been reported, it is not yet universally accepted. Hence, efforts towards it are still in progress. In the proposed method, Polarized Teager Energy (PTE) has been used to detect R peak of an ECG beat. Use of un-polarized TE operator causes false detection of R peak if S wave amplitude is greater than or equal to R wave amplitude typically in the paced beats. Therefore, PTE function has been used to differentiate R peak from S wave. The algorithm consists of three stages such as pre-processing, R peak detection and P, Q, S, T detection. In pre-processing stage

different filters are used. To eliminate baseline wandering and high frequency noise, band pass filter has been used. To eliminate power-line interference, notch filter has been used. Second stage consists of R peak detection. In the third stage, other morphological points are detected. Different search windows, proportional to RR interval, are applied to the sampled ECG signal for detection of other morphological points.

## CONCLUSION

Now a days fetal mortality and morbidity are increasing, it is necessary to analyze fetus at early stages of pregnancy. In this paper, we proposed to implemented Pan tompkin algorithm for feature extraction, and PTE algorithm for beat detection this process include preprocessing, feature extraction to extract fetus ECG(fECG) and subtract maternal ECG(mECG) from abdominal ECG. Also fetal diagnosis of the abnormalities or any other cardiac diseases can be detected.

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