# BLASTULA ECG EXTRACTION USING FTF BASED ADAPTIVE ALGORITHM

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***Abstract—*** *Clinically, Electrocardiograph plays a vital role in monitoring the human health. In today's clinical practice, Ultrasound technology is widely used for fetal heart rate (fHR) monitoring since it is both simple to use and cheap. Monitoring the blastula/fetal cardiac activity during pregnancy is of crucial importance for evaluating fetus health. The Fetal Electrocardiogram (FECG) is a diagnostic tool that measures and records the electrical activity of the heart of the fetus during pregnancy and provides exquisite details. Since past, there are lot of research work have been performed in this field. Some of these are filtering method, threshold method, and neural network method and so on. Fast Transversal Filter (FTF) method is the most popular and effective method for detecting ECG characteristic points. The proposed method consists of three steps: 1) Abdominal ECG signal (AECG) is acquired from mother's abdomen and decomposed to estimate maternal components (MECG signal) using FTF algorithm 2) FECG signal is extracted by removing MECG signal from AECG signal 3) Then fetal Heart Rate (fHR) in bpm is calculated from the obtained fetal ECG signal and it can be converted in time (sec) to find the R-R interval and also the defect of the fetal can be determined. This algorithm is implemented on direct recorded signals using MATLAB (Matrix Laboratory).*

## 1. INTRODUCTION

One of the major problems in modern obstetrics is the much reduce possibility to extract valid information about the health of the fetus from various monitoring methods during labor. On monitoring the fetal ECG, both the fetal heart rate and fetal condition can be determined.

The acquired ECG signals from the cardiac track of the mother, in which both mother and fetal signal is mixed. In addition to that some of the noise signal is also added to the acquired signal. These noise can be reduced by using a perfect filter which remove the whole noise and provides all the parameters which is used for defect identification.

In these, Fast Transversal Algorithm (FTF) based Adaptive algorithm is used which remove the noise and produce a accurate signal compared to others. In this paper, the task has been divided into two sections. First, the fetal ECG is extracted from the acquired abdominal ECG by totally eliminating the mother ECG. Second, the R-R interval time is identified by finding the beats per minute (bpm) of the fetal and from that it is converted into time period. The normal time interval range is 0.6 – 1.2 sec and normal heart beat range is 100 – 120 bpm. If the R-R interval crosses that range then the fetal has some of the defects which can be slightly identified. Major defects are identified from the R-R interval time because it has the highest peak value which will be useful to identify the defect easily. Whatever it is, the main challenge is elimination of mother ECG which overlaps the fetal ECG signal in time and frequency domain as well as its amplitude is many times higher. In this task, it is tested by FTF based adaptive algorithm for FECG extraction from composite abdominal signal. The main use of this algorithm is setting the parameters properly which is very useful to remove the mother ECG and additional noise. As up to now there is a lot of filtering method, technique used for fetal ECG extraction but this algorithm removes all the noise which produces more accurate and also suitable for further research purpose.

## 2. THE FETAL ELECTROCARDIOGRAM

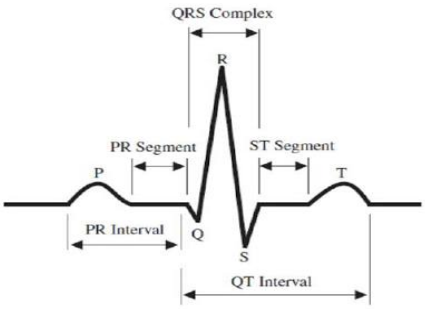


Fig.1. Normal ECG

The ECG intervals and segment are the one which indicate the electrical activity of the heart. They are P Wave, QRS Complex, ST segment, T Wave, PR Segment, and QT Segment. The normal duration of P wave is less than or equal to 0.11sec and the shape is generally smooth, not notched or peaked. The duration of QRS wave is less than or equal to 0.12sec and its upper limit of normal amplitude is 2.5 – 3.0mV. The PR interval normally is between 0.12 and 0.20seconds. The ST segment is isoelectric, slanting upwards to the T wave in the normal ECG and it never normally depressed greater than 0.5mm in any lead. The T wave deflection should be in the same direction as the QRS complex and the amplitude is normally between 0.1 – 0.2mV. The QT interval has duration normally less than or equal to 0.40 seconds for males and 0.44 for females. There are two methods of obtaining fetal ECG. The first one is obtaining FECG non-invasively by placing electrodes on the abdomen surface region of a pregnant woman, and the second one is invasive; that is, by placing electrodes inside the uterus of the mother on the scalp of the fetus during labor. Invasive extraction of fetal ECG is more accurate because of the recording electrode placed on the fetus' scalp but it can be done just during delivery.

## 3. FECG DERIVATION METHODS

There are many methods for fetal elicitation in the past. They can be divided into two main groups – adaptive method and non-adaptive method.

A. Non- Adaptive methods

Non- Adaptive method are time-invariant in nature and have no ability to adapt to the unexpected circumstances. These methods includes Wavelet Transform based techniques, correlation and subtraction methods, Single Value Decomposition (SVD), Blind Subspace Separation (BSS) methods namely, Independent Component Analysis (ICA), and Principal Component Analysis (PCA).

B. Adaptive Methods

Adaptive methods are divided into two groups namely, linear adaptive method and non-linear method. Linear adaptive method includes Least Mean Square (LMS), Recursive Least Squares (RLS), Adaptive Voltera filter, Kalman filter, or Adaptive Linear Networks (ADALINE). Non –Linear techniques includes Genetic Algorithm, Fuzzy Logic, Bayesian adaptive filtering frameworks. In this paper, adaptive based FTF (Fast Transversal Filter) algorithm and from that R-R interval is identified.

## 4. EXISTING METHOD

The extraction of fetal ECG from the mother ECG which has been used to identify the fetal heart rate and to count the R-R interval. This method is executed in MATLAB using Simulink models. The mother ECG is removed from the maternal ECG by LMS algorithm. The peak corresponding to the R wave of the FECG are extracted by fixing the threshold value slightly around than the normal level. From the R-R interval the FHR can be obtained.Fig.2 shows that Existing block diagram. And Fig.5 shows the output of existing method. The disadvantages are

- Slow convergence due to Eigen values spread.
- Filter coefficient is less stable as compared to RLS & FTF.
- Complexity is more compared to others (2N+1).
- Mean Square Error is more compared to other (0.015).
- Noise variance is 0.02 and it is less than RLS and FTF.

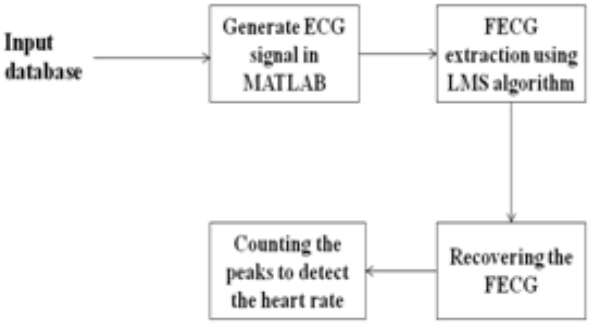


Fig.2. Block Diagram of Existing Method

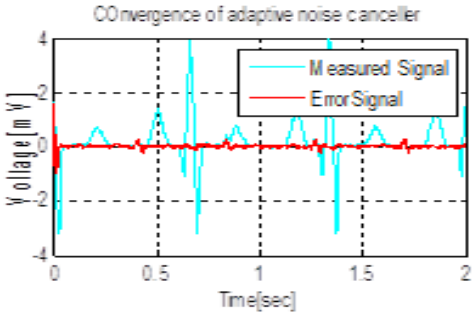


Fig.3. Output of Existing Method

## 5. DATA ACQUISITION

The abdominal electrocardiogram (AECG) signals used in this algorithm is were obtained from the Physionet Noninvasive fetal ECG database available in the website, taken for a single subject of 40 weeks pregnancy. The sampling rate is 4000 Hz which is used to simulate the mother and fetal ECG signal. The heart rate is approximately equal to 89 beats per minute and the peak voltage is 3.5mV. Always the heart rate of fetal is faster than mother with rates of value 20 to 160 beats per minute (bpm). The amplitude of the fetal ECG is always weaker than the mother ECG. The heart rate of the fetal electrocardiogram signal is 139 beats per minute and a peak voltage of 0.25mV.The measured fetal ECG signal is usually dominated by the mother's ECG that propagates from the chest to the abdomen, in addition to that, a small amount of uncorrelated Gaussian noise is added to simulate any broadband noise sources. The goal of the adaptive noise canceller is to adaptively remove the maternal ECG from the fetal ECG. This noise canceller needs a reference signal generated from the maternal ECG to perform this task. Thus the fetal ECG and maternal ECG signal will contain some additive noise.

## 6. PROPOSED ALGORITHM

In this proposed algorithm, FTF algorithm with recorded signal is performed. Here, the FTF algorithm is used in order to reduce the noise and also to eliminate the mother ECG from the abdominal ECG.

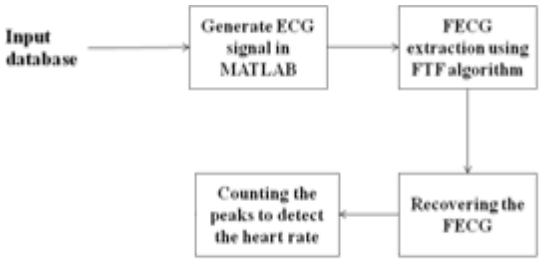


Fig.3. Block Diagram of Proposed Method

A. Generation of ECG signals in MATLAB

By using MATLAB, both the mother ECG and fetal ECG is simulated which is of same shape. The maternal signal is generated by using the sampling rate of 4000Hz and 89 beats per minute and the peak voltage of the signal is 3.5 mV.

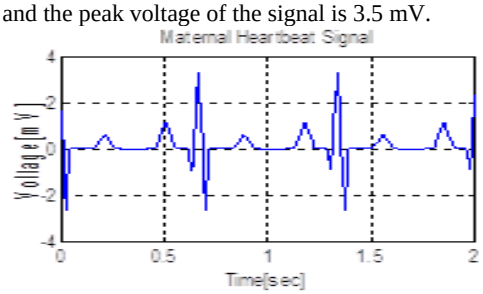


Fig.4. Maternal heartbeat signal

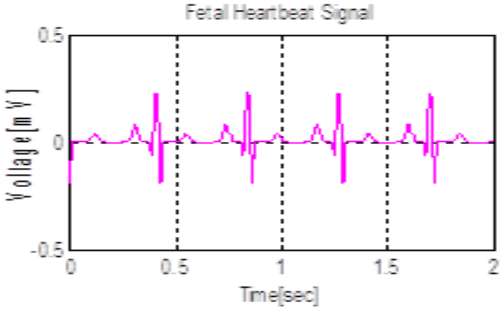


Fig.5. Fetal Electrocardiogram signal

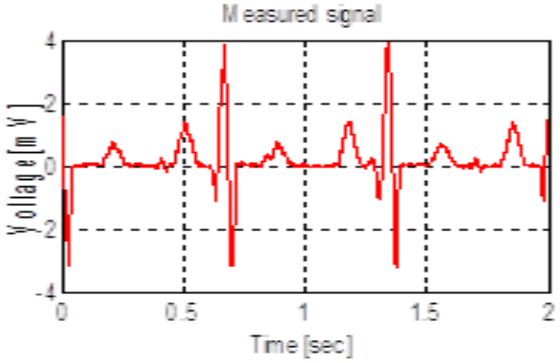


Fig.6. Measured FECG signal from abdomen of mother

Fig.4. shows the maternal ECG signal generated from the sampling rate 4000Hz. Fig.5. shows the fetal electrocardiogram signal generated from the same sampling rate. Fig.6. shows the measured FECG signal from the abdomen of mother.

B. Adaptive Algorithm

An adaptive filter is a filter that self adjusts its transfer function according to an optimizing algorithm. It adapts the performance based on the input signal. Such filters incorporate algorithms that allow the filter coefficients to adapt to the signal statics. There are different approaches used in adaptive filtering, which are as follows

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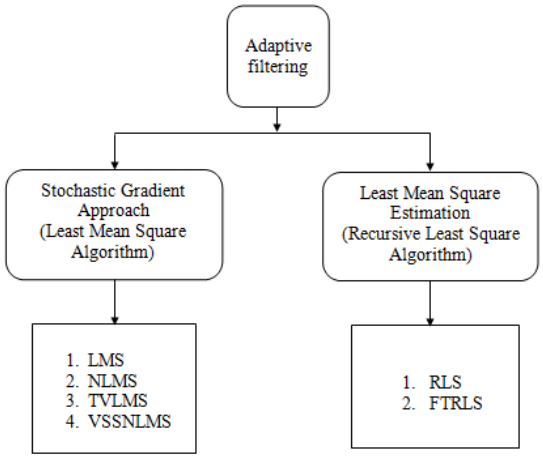


Fig.7. Hierarchy of adaptive filtering

FTF algorithm is one of the adaptive algorithms which are used to reduce the complexity and fast convergence as compared to others. This is used to estimate time varying signal by adjusting the filter coefficients so as to minimize the error. It reduces the error signal as better as compared to LMS (Least Mean Square), NLMS (Normalized Least Mean Square), and RLS (Recursive Least Square).

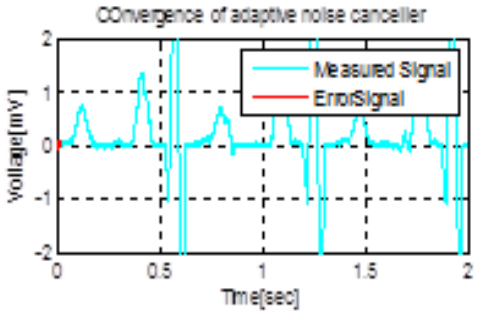


Fig. 8.Output of Proposed Method

## 7. RESULTS

The Proposed algorithm is implemented on direct different recorded ECG signal and at last FECG is extracted at the end of procedure. The R-R interval is calculated from the extracted FECG by the help of bpm.

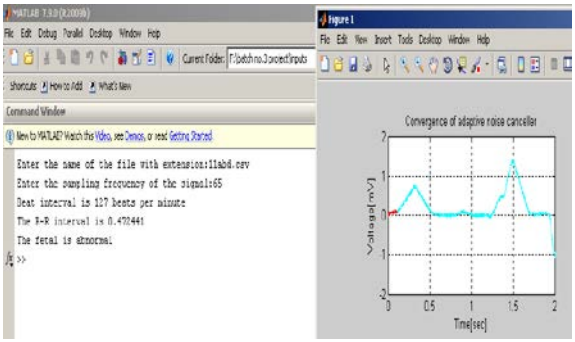


Fig.9. Output of Abnormal Fetal's R-R interval

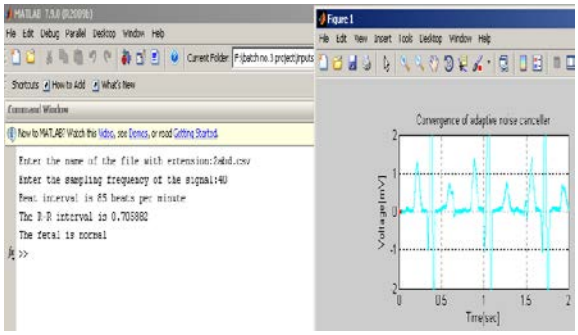


Fig.9. Output of Normal Fetal's R-R interval

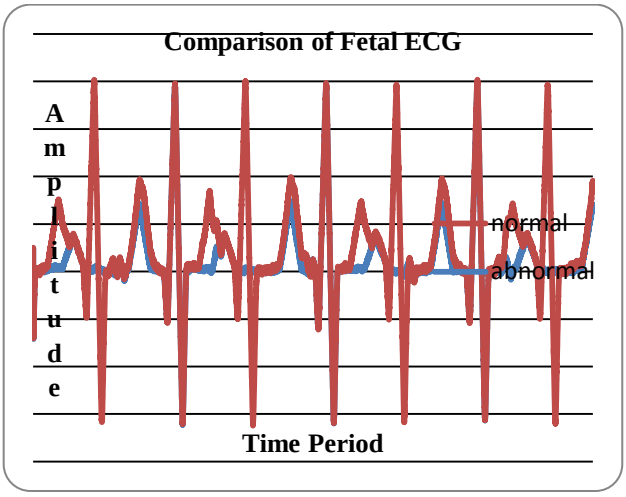


Fig. 11 Comparison of Fetal ECG

## 8. CONCLUSION

An adaptive noise canceller based fetal electrocardiogram extraction method is proposed and implanted. From the simulation results we can conclude that FECG signal can be extracted from the abdominal electrocardiogram signals using FTF algorithm. Software implementation of FTF algorithm is presented to implement the ANC system. Fetal heart rate signal are extracted from the peaks of R-R interval. From this simulation result, fetal disease can also be detected using the R-R peak value. If the threshold value decreases below the average then the fetal is affected by some disorder. So the value of the ECG can be used for the diseases detection.

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[6] Program: https://in.mathworks.com/matlabcental/answer/103000-fetal-ecg- extraction
[7] https://googleweblight.com/i?u=https://en.m.wikipedia.org/wiki/Adaptive _filter&s=l&hl+en-IN

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