© April 2021| IJIRT | Volume 7 Issue 11 | ISSN: 2349-6002

Fetal ECG Extraction from Noisy Environment

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Abstract **- The extraction of this fetal electrocargram (FECG) signal from non-invasive ECG recordings to obtain the fetal heart rate and to eliminate noise from it remains a big challenge. Non-invasive fetal electrocardiogram is emerging as a low cost and high-accuracy technology for fetal cardiac monitoring. The fetal ECG records the electrical movement of the heart. The signal contains precise information that can help doctors during pregnancy and labour. Fetal means the baby that will be in the mother womb during the pregnancy. The proposed system for extracting the signal, processing it and detecting heart rate of it was implemented in Matlab. The extracted FECG signal is a noise free signal. The present approach is based on the using of Fast ICA algorithm for FECG extraction. In order to improve FECG extraction performance, it was applied here with a Fast Fourier Transform (FFT), Inverse Fast Fouridioer Transform (IFFT) algorithm. The peaks of T/QRS ratio and QT interval could be estimated from FECG post-processed signals of two patients and the heart rate of the baby can be calculated based on the results.**

I.INTRODUCTION

Fetal ECG can provide fetal health information to determine whether the fetal development is healthy or not. Cardiac abnormalities are manifested with an average of one in every hundred infants conceived in a year. These imperfections happen because of organic disorder, abuse of medications and other issues. Before the birth of the fetus, indirect methods are usually used to obtain the abdomen electrocardiogram of pregnant women. However, due to the influence of maternal ECG and noise, blind source separation of fetal ECG without noise has been implemented. All the Fetal ECG Extraction methods and filtering of noise is implemented in Matlab Environment.

To Eliminate the noise from this signal, FFT filtering is used which converts the time domain in frequency domain and gives better calculations. The Extraction algorithm for detecting the peaks is Fast ICA algorithm where it correctly finds two vectors and conserves the QRS fetal complex. In fast ICA algorithm the abdominal ECG and one pectoral ECG is collected and then the separated signal is reconstructed by principal component analysis.

FFT is a fast algorithm for execution of DFT. The multiplication of two DFTs is equivalently a circular convolution of the two sequences. We can make use of DFT for computation of convolution as the circular convolution in time domain is equivalently a multiplication in the DFT domain using a property of convolution. We need to convert the linear convolution to a circular convolution and then make use of FFT algorithm to reduce the number of computations for filtering. The procedure to convert the linear convolution to a circular convolution is increase length of each sequence by appending zeros so that it is equal to the length of the resulting convolved sequence. Then circularly convolve the resulting appended sequences. The result is same as that of linear convolution.

II.EXISTING SYSTEM

One of the methods is by using adaptive filter. Adaptive filters are time variable filters whose characteristics can be varied with time. This incorporate adaptation mechanism by which filter coefficients can be adjusted. LMS is a type of adaptive filter that extracts the signal by finding the filter co-efficient that correlate to produce LMS of error signal differentiated between desired and actual signal.

Another method is FECG extraction using Wavelet Transform. It is basically a convolution operation of the subjective signal and wavelet function. The Wavelet Transform decomposes a signal into two sub signals such as detail signal and approximation signal. The upper half of the frequency component contains in detail signal and lower half of the frequency component contains in approximation signals. Thus, multi resolution analysis can be performed in discrete wavelet domain.

Automatic detection of different types of heart abnormality is very useful for physicians and patients.it reduces the time for diagnosis. Most of the abnormality of heart diseases are detected from the ST segment variation in the ECG signal. (Hypercalcemia, Hypocalcemia, and ischemia). In this paper, the different types of diseases are classified by using ST segment variation in the ECG signal. The method includes several steps; ECG signal database loading, signal preprocessing, feature extracting using wavelet transform based on ST segment variation, finally display the classification results. Our system has been tested on the European ST-T Database for classifying four major groups includes Normal, hypocalcaemia, Hypercalcemia, ischemia, conduction loss.

III.PROPOSED SYSTEM

In order to solve this problem, an improved FastICA method was proposed to extract fetal ECG.

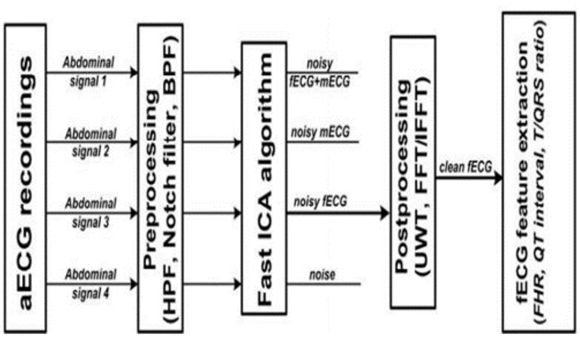

Fig 1: Processing of Fetal ECG Extraction

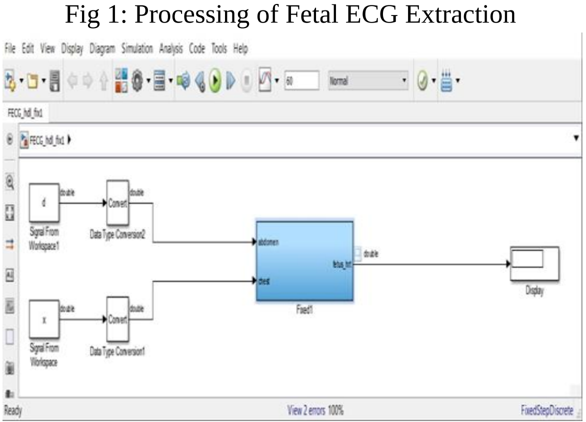

Fig 2: Block diagram

aECG RECORDING:

In this project, it we used a collection of multichannel electrocardiograms (ECG) recordings obtained from two different women in labor between 38 and 41 weeks of gestation, referred from now on as patient I and patient 2. Those recordings were accessed from Abdominal and Direct Fetal Electrocardiogram Database available on PhysioNet, being acquired in the Department of Obstetrics at the Medical University of Silesia by means of the KOMPOREL system for acquisition and analysis of the fetal electrocardiogram. Each recording comprises four different signals acquired from maternal abdomen and the reference direct fetal electrocardiogram registered from the fetal head.

PREPROCESSING:

The spectrum of EHG signal presented in each typically ranges between 0.1 Hz and 3Hz [13]. For a suppression of baseline wandering and cancellation of most of EHG we used a high pass FIR digital filter based on Kaiser Window with stop band edge frequency of 0.5 Hz and passband edge frequency of 3Hz, implemented using FFT Filtering Vi Matlab module. In order to suppress this type of noise, we used a sharp notch filter (with Q-factor equal to 30) at 50 Hz, selected from DFD HR Notch peak design VI of Matlab Digital Filter Design Toolkit. Next, for reducing high frequency noises coming from motion artifacts we implemented a 100th order IIR Butterworth band-pass filter from DFD Kaiser Design VI, with a bandwidth range of 0.5 — 34 Hz because the frequencies of interest for PQRST wave extraction are located mainly in this domain.

INDEPENDENT COMPONENT ANALYSIS:

The FastICA has most of the advantages of neural algorithms: it is parallel, distributed, computationally simple, and requires little memory space and the independent components can be estimated one by one, which is roughly equivalent to doing projection pursuing. The Advanced Signal Processing Toolbox provided TSA (Time Sample Analysis) Independent Component Analysis VI with which fastlCA algorithm was easily adopted due to its convergence speed.

POST PROCESSING STAGE:

Wavelets transform de-noising stage using biorthogonal 4.4. wavelet function at five levels of decomposition improved the FastICA extraction quality for ECG signals. In order to suppress wideband noise from ICA extracted fECG signals we used Undecimated Wavelet Transform (UWT) from Wavelet Denoise Express VI. Unfortunately, after successfully wavelet transforms de-noising, some noise component was still present and in order to improve signal-to-noise (SNR) value further filtering technique is absolutely necessary. For this purpose, we implemented a signal processing pair formed by Fast Fourier Transform (FFT) and Inverse Fast Fourier Transform (IFFT) using FFT VI and Inverse FFT VI from Signal Processing Palette. Using FFT transform, signals were converted from time to frequency domain, high and low frequency components being sorted out to indicate the unwanted noise components. Applying after that IFFT, filtered signal is reconverted to the time domain and Activate became ready for the feature extraction process.

FEATURE EXTRACTION:

For FECG feature extraction with the purpose of detecting RT and QS time locations and maximum amplitudes, we used a combination of Peak Detector from Signal Operation Palette and WA Multiscale Peak Detection from Wavelet Analysis Palette. FHR could be detected automatically for various time intervals of recordings using Extract Heart Rate.

IV.MATLAB SOFTWARE

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation.

MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. This allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar non-interactive language such as C or Fortran.

The name MATLAB stands for matrix laboratory. MATLAB was originally written to provide easy access to matrix software developed by the LINPACK and EISPACK projects, which together represent the state- of-the-art in software for matrix computation.

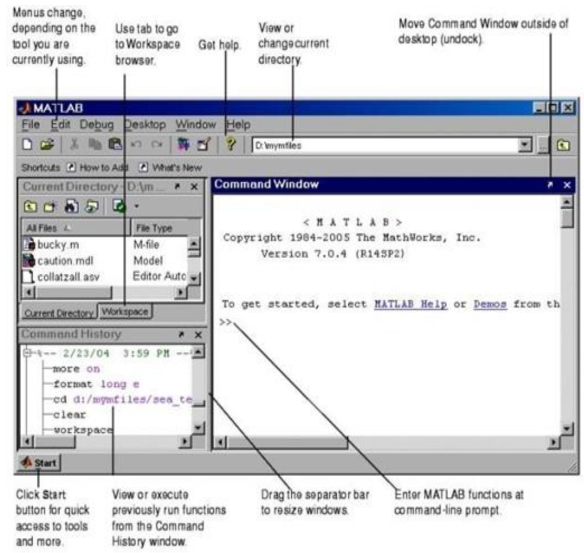

FIG 3: OVERVIEW OF MATLAB TOOL

By finding the fetal heart rate it will help us to know about the growth of fetus and also about any abnormalities present. Hence it is very necessary to extract the FECG signal without any noise and finding heart rate will help s to give proper medications. All these extraction process and filtering methods we have implemented this in MATLAB.

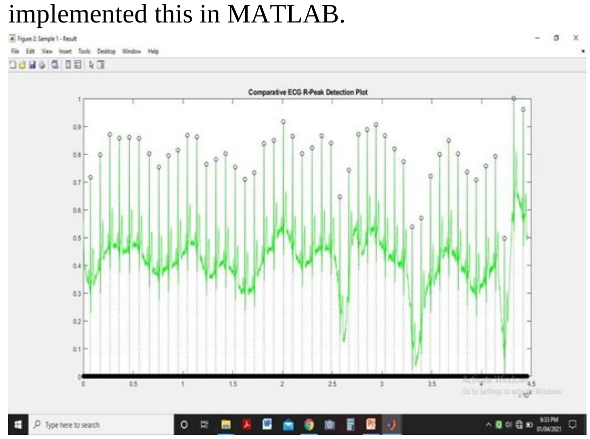

Fig 4: Sample Input

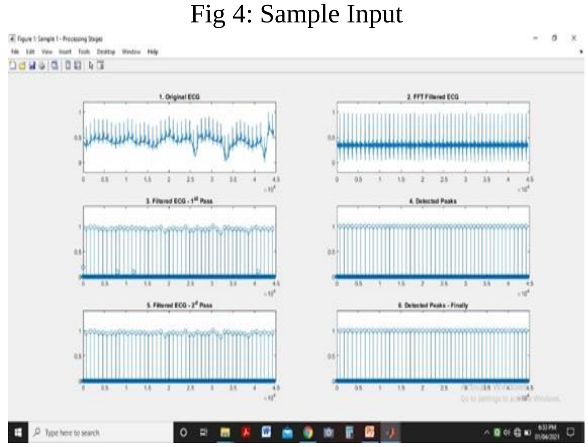

Fig 5: Sample Input Processing Stage

V.CONCLUSION

The results of this project have shown that fetal electrocardiogram morphological parameters can be successively estimated after an extraction of fetal ECG signals from a collection of aECG recordings using Fast ICA algorithm and after a post-processing stage with wavelet transform and an FFT/IFFT pair. For very weak fECG signals, FFT/IFFT processing system can be very useful, filtering noises up to 1 itV in amplitude which can affect the correct estimation of R-R intervals. In conclusion, Fetal ECG (FECG) was successfully detected throughout the developed Independent Component Analysis (ICA) algorithm. It was found that the ICA technique had successfully separated the components contained within each recording. Characteristics matching between each source signal and ICA components yielded automatic separation between the recordings components. FECG helps clinicians in identifying the overall health condition of the fetus during pregnancy non-invasively. In future works, further fetal health measurements can be applied on the processed and smoothed FECG to extract fetal health conditions. In addition, characteristics matching technique can be improved even further in future ICA experiments by integrating more prior information about the source signals and data recordings.

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