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Detection of Abnormalities in Fetal By Analyzing FECG

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***Abstract*— The main aim of this paper is to detect the Fetal heart rate. Fetal heart rate monitoring technique is important for obtaining the important information about the condition of the Fetal during pregnancy. This is obtained from the Fetal ECG Signal which is extracted from the composite Abdominal ECG. The reason for the interest in FECG signal analysis is in clinical diagnosis and biomedical applications. The extraction and detection of FECG signal from abdominal signals using powerful and advanced methods find wide applications in the field of biomedical. Here the primary noises are removed using various filtering techniques. Separation of FECG from Composite abdominal ECG signal is done using Least Mean Square (LMS) Adaptive Filtering technique and finally Fetal heart rate is detected.**

***Keywords*—abdominal ECG; MECG; FECG; LMS; MATLAB.**

I. INTRODUCTION

Fetal heart rate (FHR) variations during pregnancy and labor have commonly been observed as indirect indications of fetal conditions. An abnormal fetal heart rate or pattern may mean that the fetus is not getting enough oxygen or there are other problems. As a result FHR carries a significant importance of clinical perspectives. FHR is obtained from the fetal electrocardiogram (FECG). This test is used to check the fetal health condition and abnormalities and provides the solution to give better treatment to the patient during pregnancy stage [1]. From this checkup, the condition of the fetal can be detected early and suitable treatment or proper decision can be taken on time [2]. This paper will be helping the doctors to extract the fetal heart rate. Fetal heart rate detection can also be useful in other cases also like: detection of gestation age of the baby, monitor progress of labor detection of miscarriage rate for pregnancies, and monitor and evaluation of uterine contractions, etc. Electrocardiogram (ECG) is a simple noninvasive system for detecting the heart diseases [3]. Non invasive FECG is used to get valuable clinical information of fetal condition during pregnancy by placing electrodes on the maternal abdomen [4]. Abdominal ECG (AECG) is always affected by power line interference, electromyography (EMG), baseline wander and random electronic noise [5]. By using different techniques, these unwanted noises can be eliminated.

II. FETAL ECG

A. ECG Tracing

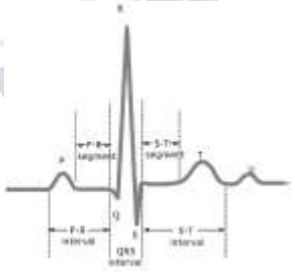

Fig. 1: typical ECG signal

A typical ECG waveform is shown in fig.1. The initial wave is the p-wave, it is small and rounded. Next a sharp combination wave known as QRS complex which is comprised of the sharp downward q-wave, followed by the upward r-wave and subsequently the downward s-wave. The final wave, t-wave is rounded. The r-r interval represents the period from the r-peak of one beat of the ECG signal to the next r-peak. The p-r interval represents the period from the start of the p-wave to the beginning of the QRS complex, q-t interval represents the period from the beginning of the QRS complex to the end of t-wave. QRS complex is very important to detect the heart rate.[6] There are 12-lead ECG system, which includes three limb leads (i, ii or (MLII), iii), three augmented leads (AVR, AVL, AVF) and six precordial leads (v1, v2, v3, v4, v5,

v6). It is the commonly used ECG system in clinic or health care centers.

B. ECG Signal Measurement

ECG signals can be measured at two places 1). Chest and 2). Abdomen [7]. Electrocardiogram measured in the chest contains the heart rate of the mother and the electrocardiogram measured at the abdomen consists of composite signal of the maternal electrocardiogram (mECG) and the fetal electrocardiogram (FECG). Fetal heart rate (fhr) can be calculated by determining the r-r intervals from the fetal ECG signal [8]. Number of heart beats per minute is higher than the mother heart beats but the amplitude of the fetal ECG is much weaker than the mother's ECG [9]. For the extraction of FECG adaptive algorithm is used to improve the reliability. As extracted FECG is always fluctuated, r peaks cannot be detected correctly in previous works this research work overcomes the difficulty of amplitude threshold and detect the overlapped peaks [10].

C. Preprocessing of ECG signal

The electrocardiogram is a test that is used to record the heart's electrical potential versus time. ECG signal commonly contains three types of predominant noise that are baseline wander (BW) noise, electromyography (EMG) interference, and 50/60 HZ power line interference. Among them power line interference is an important noise that affects the ECG signal since it affects the cables carrying ECG signals from the patients to the monitoring.

D. Hum eliminator

Hum noise created by poor power supplies, transformers, or electromagnetic interference sourced by a main power supply is characterized by a frequency of 60 HZ and its harmonics. If this noise interferes with a desired electrocardiography [ECG], the desired signal could be corrupted. The corrupted signal is useless without signal processing. It is sufficient to eliminate the 60-HZ hum frequency with its second and third harmonics. It is done by cascading with notch filters having notch frequencies of 60 HZ, 120 HZ, and 180 HZ, respectively. Fig. 2 depicts the functional block diagram.

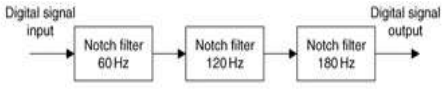

Fig. 2: 60 HZ hum eliminator

The fir notch filter is designed to suppress 60 HZ power line noise. The sampling frequency is 600. Simulation is done using matlab.

E. Adaptive filter

An adaptive filter is a filter which is used to separate the signals according to the adaptive algorithm. This has the advantage of user can adjust the filter coefficients as per their need.

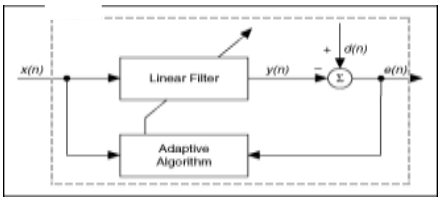

Fig. 3: typical adaptive filter.

Here in fig 3 x(n) is the input signal, y(n) is the corresponding output signal, d(n) is an additional input signal to the adaptive filter, e(n) is the error signal that denotes the difference between d(n) and y(n).

F. LMS adaptive filter

The aim is to extract the fetal heart from the maternal heart rate by using least mean square (LMS) adaptive filtering technique. Here LMS adaptive filter with 12 coefficients and a step size of 0.001 is used to extract the fetal ECG from the maternal abdomen ECG. For this task adaptive filter needs a reference signal, the ECG signal obtained from the chest of the mother. The estimated maternal signal is taken from the output signal y (n) of the adaptive filter. The remaining signal which is located in the adaptive filter is the error signal e (n) which contains the fetal ECG signal.

G. Peak detection

The 60 HZ hum eliminator removes 60 HZ interference and has capability to reduce its second and third harmonics of 120 HZ and 180 HZ respectively. The next objective is to detect the heart rate using enhanced ECG signal. The dc drift and filter noise muscle which may occur at approximately 40 HZ or more need to be removed. After the enhancement of ECG signal, bilinear transformation of bandpass filter type chebyshev fourth order is designed. This signal is used only for heart rate detection and is of no use for general ECG applications.

H. Heart rate detection

With the processed ECG signal, a simple zero-crossing is designed to detect the heart rate. Here the threshold value of 0.5 used and is continuously compared with each of two consecutive samples. If both results are opposite, then zero crossing is detected. Each zero-crossing measure is given by

$$\text{Zero-crossing} = \frac{|cur\_sign - pre\_sign|}{2} \quad (1)$$

Where cur_sign and pre_sign are determined based on the current input x(n) and past input x(n-1) and the threshold is given by

If x(n) ≥ threshold cur_sign = 1 else cur_sign = -1
If x(n-1) ≥ threshold pre_sign = 1 else pre_sign = -1

After detecting the total number of zero crossings, the number of peaks will be half the number of the zero-crossings. The heart rate in terms of pulses per minute can be determined by

$$\text{Heart Rate} = \frac{60}{\left(\frac{Number\ \ of\ enhanced\ \ ECG\ Data}{f_s}\right)} \times \frac{zero-crossing}{2} \quad (2)$$

III. METHODOLGY

MECG and AECG is measured and the power line interference noise is eliminated using hum eliminator. The MECG contains the ECG signal of maternal and AECG contains the composite ECG signal of maternal and fetal. After signal enhancement LMS adaptive filter technique is applied by setting the fir filter coefficients. Here the error signal obtained is the FECG. Bilinear transformation having chebyshev fourth order pass band type is applied to remove dc drift and to filter muscle noise. Peaks are detected using simple zero-crossing algorithm to detect the fetal heart rate.

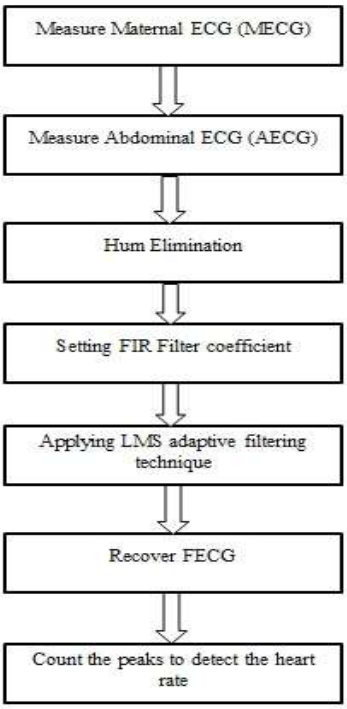

Fig. 4: flow diagram representation

IV. BLOCK DIAGRAM

To design digital filters, approved specifications with fixed coefficients are needed. When these specifications are not accessible or time varying, then this problem can be overcome by adaptive coefficient this is called as adaptive filter. In modern times, digital signal processing is used for the applications of biomedical engineering where the unwanted signal from the original ECG signal can be removed by using digital filters. But now adaptive signal processing is used to implement different algorithms. Noise cancellation is main problem in the biomedical system which is considered as adaptive noise cancellation. Adaptive filtering method can be operated by setting the parameters. The filters are important part of the system which performs any kind of manipulation or signal processing to neglect any unwanted signal or noise created in the signal. So the digital filters having same appearance such as adaptive filtering, which provide better performance by adjusting the filter coefficients. Here LMS adaptive filter is used to extract FECG from aECG. AECG signal is treated as the desired signal and mECG signal is treated as noise. By applying this filter technique the mECG signal is cancelled from the aECG signal. As shown in fig.5 obtained error signal is the FECG signal which is required signal.

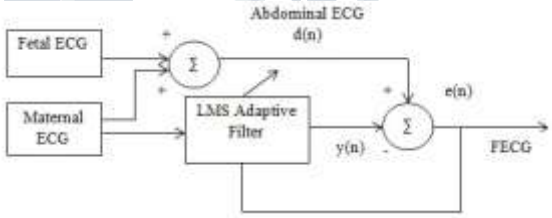

FIG.5: Cancellation of MECG From AECG

a. Matlab Results

Filters are designed and simulated using matlab. The database is obtained from mit – bih database. Fig.6 shows the matlab output of the ECG signal after passing through hum eliminator. The obtained ECG signal is enhanced by removing power line interference. This enhanced ECG signal is used to perform LMS adaptive filtering technique for the extraction of FECG from composite aECG. Fig.7 shows the simulation result of extraction of FECG from aECG using LMS adaptive filtering technique.

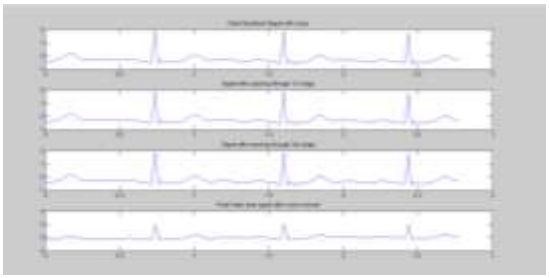

Fig.6 : Simulation Result Of Hum Eliminator

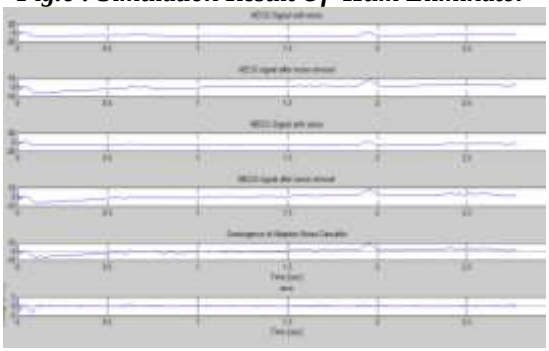

Fig.7 : Simulation Result Of Extraction Of FECG From AECG Using LMS Adaptive Filtering Technique

V. CONCLUSION

An advanced fetal electrocardiogram (FECG) signal monitoring for both the mother and fetal analysis system has been designed by using an LMS adaptive algorithm based on fir filter. This is used to estimate the fetal heart rate and calculate the period of the signal. The FECG signals have been extracted from the abdominal electrocardiogram signals using matlab software.

REFERENCES

[1] M.ravi kumar "electrocardiogram (ECG) signal processing on fpga for emerging healthcare applications", international journal of electronics signals and systems (ijess) issn: 2231-5969, vol-1 iss-3, 2012.

[2] Manish kansal, hardeep singh saini, dinesh arora "designing & fpga implementation of iir filter used for detecting clinical information from ECG", international journal of engineering and advanced technology (ijeat) issn: 2249 – 8958, volume-1, issue-1, october 2011.

[3] Channappabhyri, kalpana.v, s.t.hamde, and l.m.waghmare "estimation of ECG features using labview", international journal of computing science and communication technologies, vol. 2, no. 1, july 2009. (issn 0974-3375)

[4] Digvijay j. Pawar, p. C. Bhaskar "fpga based fir filter design for enhancement of ECG signal by minimizing base- line drift interference", international journal of current engineering and technology, vol.3, no.5 (december 2013).

[5] Rupalimadhukarnarsale, dhanashrigawali and amitkulkarni " fpga based design & implementation of low power fir filter for ECG