ISSN (Online) 2321 – 2004
ISSN (Print) 2321 – 5526

IJIREEICE

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

Nitte Conference on Advances in Electrical Engineering NCAEE-2016

NMAM Institute of Technology, Nitte

Vol. 4, Special Issue 2, April 2016

Extraction of Fetal ECG Parameterfrom the Composite Abdominal Signal

Adpaikar Shruthi Vasudev[1], **Amita Dessai**[2]

M.E Student, Electronics Communication and Instrumentation, Goa College of Engineering, Farmagudi, India[1]

Assistant Professor, Electronics and Telecommunication, Goa College of Engineering, Farmagudi, India [2]

Abstract: The electrical activity of the fetus heart is basically the fetal electrocardiogram.FECG is a weak signal which is measured indirectly by placing the electrode on the surface abdomen of the mother. The Fetal signals contains many other interfering signal. Extraction of the fetal ECG parameters from the abdominal signal has an important value in clinical application and also enables continuous monitoring of the fetus status by means of analysing its cardiac activity. This paper proposes a non-invasive method for the FECG extraction by using a template for the cancellation of maternal QRS complex. The final results specify that the fetal R peaks can be easily detected under various circumstances without using the reference maternal thoracic signal.

Keywords: FECG (fetal electrocardiogram), FHR (fetal heart rate), MECG (maternal electrocardiogram),AECG (abdominal electrocardiogram),SNR(signal to noise ratio).

I. INTRODUCTION

The electrocardiogram is basically a non-invasive test that is used to detect the proper functioning of the heart. The heart's rhythmic contraction is due to the depolarization and re-polarization phenomenon which results in generation of the ECG waveform. The ECG signal is measured by placing the electrode based on the ethovian triangle. But for measuring the FECG there are no such exact position available. The signal are available by placing the electrode on the mother's abdomen. The FECG is obtained by two ways one invasive and other non-invasive. In invasive case the electrode is directly placed on the fetal scalp during labor.The disadvantage in this case is that the fetal as well as the mother is prone to infection [1] where as in non-invasive there are no such difficulties. By monitoring the FECG various diseases belonging to fetus cardiac can be determine [2] [3] and also can have a long term monitoring of the fetus[4].Other non-invasive method such as Doppler ultrasound can be used only for diagnostics purpose and not for monitoring[5] [8].However, in spite of various recent advances in the extraction of fetal ECG, there are still intrinsic technical restrictions due to high order statistics as a result such technique are not suited for the real time applications[6] [7].To cope with this limitations a customized FECG extraction method is proposed in the paper using various signal processing techniques.

II. PROPOSED SYSTEM

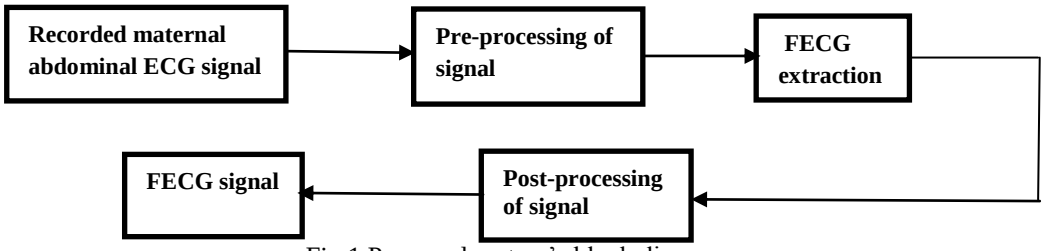

Fig.1 Proposed system's block diagram.

The proposed system for the extraction of FECG consisted of 3 steps: Pre-processing of AECG signal; FECG extraction; Post-processing of the FECG signal andfetal R peaks detection.

A. Database

Physio Net Non-invasive fetal ECG database is used to extract the FECG signal [9].It consist of 55 signal recording which were taken from a subject between 21 to 41 weeks of pregnancy. The database consists of 2 thoracic signals and 4 abdominal signals. The transducer used is Ag-AgCl where electrode positions are varied so that the SNR value is improved. The bandwidth of the recorded signal is from 0.01-100Hz having a bit resolution of 16 bits and sampling

IJIREEICE
ISSN (Online) 2321 – 2004
ISSN (Print) 2321 – 5526
International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering
Nitte Conference on Advances in Electrical Engineering NCAEE-2016
NMAM Institute of Technology, Nitte
Vol. 4, Special Issue 2, April 2016

rate of 1 kHz.Each signal has a duration of 10 sec. This database is introduced into MATLAB so as to separate the maternal and fetal signal.

B. PRE-PROCESSING OF AECG SIGNAL

1)Averaging of the Signal:

In which multiple abdominal signals are averaged to remove the disturbance and disclose small dissimilarities in the QRS complex.

2) Removal of Baseline Drift:

The baseline drift is a low-frequency activity in the AECG signal which may affect the signal analysis. It is mainly due to the respiration, artefacts and electrical noise.

3) Removal of Powerline Interference:

A notch filter with 50 Hz frequency is applied to attenuate the coupling with the mains

4) Butterworth Bandpass Filtering:

4-100Hz filter is applied to attenuate the low and high frequency noises.

C. FECG EXTRACTION

1) Maternal QRS Complex Detection:

In the proposed system a discrete wavelet transform is used to decompose the recorded AECG signal. The AECG signal is decomposed by applying a high and low pass filter followed by down sampling operation. Output of this provides detail as well as approximate values. The approximate values of the decomposed signal is used to detect the maternal QRS complex.

2)Cancellation of the MECG:

The exact position of the QRS complexes are known by dividing the whole signal into frames which are then analysed individually. The positions are then used to generate the maternal template.The generated template is correlated with the maternal signal and the one with the highestcorrelation is used. Before subtraction of the template with the signal proper aligning of the template to each of the maternal QRS complex is done. For proper alignment the template is scaled with respect to amplitude and width. The subtraction of the best correlating template allows the cancellation of the MECG. Thegained output after the removal of MECG is fetal signal.

D. POST-PROCESSING OF THE SIGNAL

In post-processing wavelet de-noising is performed on the extracted FECG signal to remove the residual maternal ECG.A median filter is then applied to remove other noises so as to enhance the signal. The peak detection algorithm is then applied to detect fetal R peak in order to calculate the RR interval. This RR interval is used to calculate the fetal heart rate (FHR).

III. RESULTS

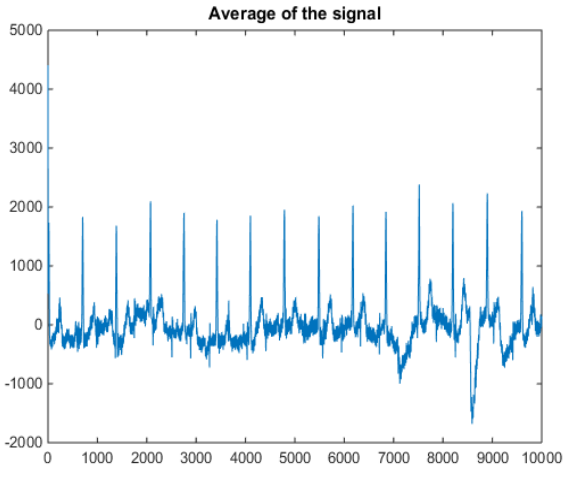

Fig.2 Averaged AECG signal

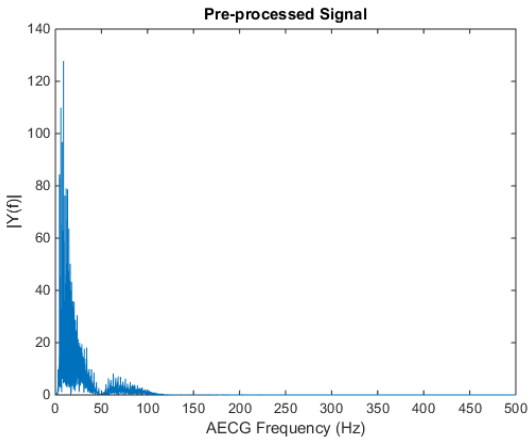

Fig.3 Pre-processed AECG signal in frequency domain

ISSN (Online) 2321 – 2004
ISSN (Print) 2321 – 5526

IJIREEICE

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

Nitte Conference on Advances in Electrical Engineering NCAEE-2016

NMAM Institute of Technology, Nitte

Vol. 4, Special Issue 2, April 2016

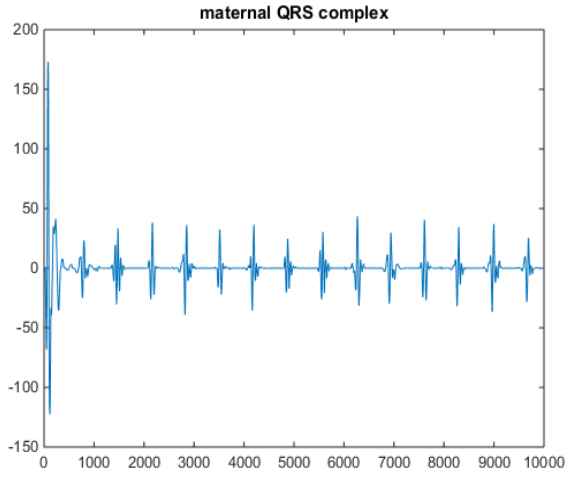

Fig.4 Detected maternal QRS complex after DWT

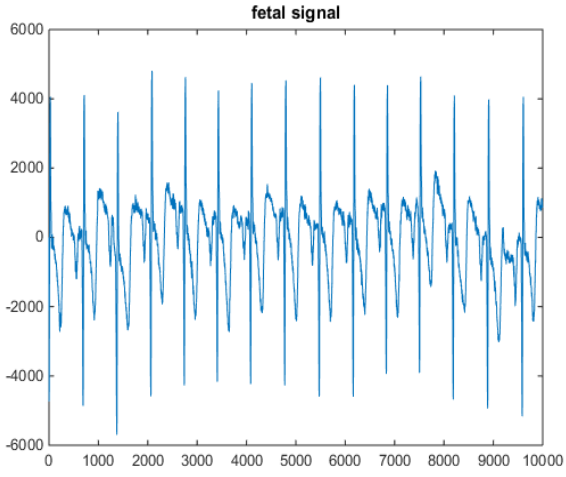

Fig.5 FECG signal after cancellation of MECG

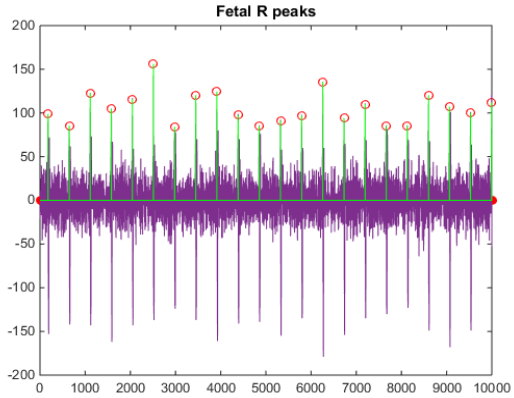

Fig.6 Detected fetal R peaks

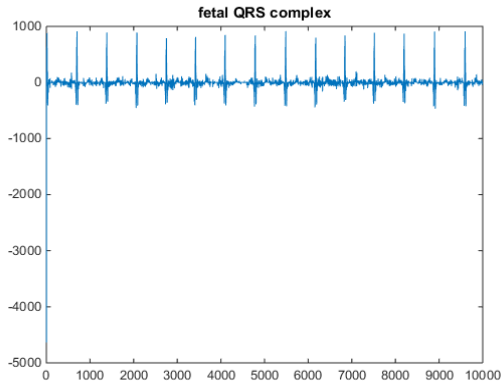

Fig.7 Post-processed FECG signal

IV. CONCLUSION

The proposed system is developed for the extraction of the FECG parameters from the composite abdominal signal. The system deals with the identification of the maternal QRS complex by using wavelet transform. The identified maternal QRS complex is then subtracted by template generation and matching. On the obtained signal the fetal R peaks are been detected. The procedure is implemented on MATLAB platform with the intension to extract the fetal ECG in best possible way.

REFERENCES

[1]. Kiranjit Kaur," Extraction of fetal heart rate by invasive method"Journal of Research in Electrical and Electronics Engineering (ISTP-JREEE)
[2]. G. Camps-Valls et al., "Foetal ECG Recovery using dynamic neural networks," in Artificial Intelligence in Medicine, vol. 31(3), pp. 197-209,2004.
[3]. Reza Sameni1 and Gari D. Cliord ,"A Review of Fetal ECG Signal Processing;Issues and Promising Directions"Open Pacing ElectrophysiolTher J. 2010 January 1; 3: 4–20. doi:10.2174/1876536X01003010004.
[4]. Fanelli A, Ferrario M, Piccini L, Andreoni G, Matrone G, Magenes G, Signorini M. Prototype of a wearable system for remote fetal monitoring during pregnancy. In Proc. IEEE Int. Conf of the Engineering in Medicine and Biology Society(EMBC). 2010; 5815–5818.
[5]. YusufSevim and AytenAtasoy, "Performance Evaluation of Nonparametric ICA Algorithm for Fetal ECG Extraction", Dept of EEE, Karadeniz Technical University, Trabzon-Turkey, Vol. 19, No. 4, pp. 657-666, 2011.
[6]. Roman I. Martin-ClementeR.Elena M. M. and Camargo-Olivares J. L."The Maternal Abdominal ECG as Input to MICA in the Fetal ECG Extraction Problem,'' IEEE Trans.Biomed. Eng., vol. 18, no. 3, pp. 161-164, March 2011.
[7]. Evaggelos C. Markos G. and Dimitrios I. Fotiadis, Senior Member, IEEE, "Detection of Fetal Heart Rate Through 3-D Phase Space Analysis from Multivariate Abdominal Recordings'', IEEE Transactions on Biomedical Engg, Vol. 56, No. 5, pp. 1394-1406, May 2009.
[8]. Australian Society for Ultrasound in Medicine. Policies and Statements A1, Statement on the Safety of Ultrasound in Grey Scale Imaging In Obstetrics http://www.asum.com.au/newsite/files/documents/policies /PS/A1_policy.pdf, accessed April 5, 2012.
[9]. Non-invasive fetal ECG database(http://www .physionet.org)