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Adaptive Signal Processing Techniques for Extracting Fetal Electrocardiograms

Swapnali Moon[1], Dr. N.K Choudhari[2], Dr. D.M. Kate[3]

[1]PG Student, Department of Electronics & Communication Engineering, PBCOE, Nagpur.
[2]Principal & Guide, PBCOE, Nagpur.
[3]Head of Department, Co-guide, Department of Electronics & Communication Engineering, PBCOE Maharashtra, India

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Abstract:- *This investigation introduces a robotized and non-intrusive innovation utilizing a coordinated fetal transabdominal electrocardiogram framework and Doppler cardiogram (DCG) to distinguish fetal heart oddities. Multiresolution wavelet investigation and Jensen-Shannon disparity (JSD) techniques were utilized to recognize the recurrence substance of the Doppler signs to be connected to the opening and shutting of the heart's valves (Aortic and mitral). For the typical babies, PEP (Pre-discharge period), VET (Ventricular launch time), ICT(Isovolumic constriction time) and IVRT (Isovolumic unwinding time) were observed to be 75.0±11.9 (msec), 153.2±18.9 (msec), 50.0±15.9 (msec) and 69.6±9.7 (msec) separately. Then again, for hatchlings with heart inconsistencies, these planning interims were observed to be 89.0±10.3 (msec), 168.6±25.0 (msec), 52.2±17.2 (msec) and 51.6±13.7 (msec) separately. Punch, VET and IVRT values are altogether (p< 0.01) diverse between the two gatherings.*

***KeyWords*:-** Fetal, Transabdominal, Electrocardiogram, Multiresoltion, Doppler Cardiogram, Heartvalves, Multiresolution Wavelet

1. INTRODUCTION

Fetal well being is basic to peri-and post-natal ordinariness with ramifications for general wellbeing status of later life. In any case, notwithstanding when pregnancies demonstrate no recognizable dangers, 100% solid births don't occur. The central point of antenatal fetal welfare testing is to distinguish hatchlings in danger of intrauterine bargain or demise, with the goal that these unfriendly results can be avoided. In ongoing decades, numerous strategies for evaluation of fetal prosperity have been brought into clinical practice. Notwithstanding across the board utilization of these methods, there is restricted proof to manage their ideal use or to show their adequacy at enhancing perinatal results. In created countries, current perinatal death rates are around 10/1000 births and fetal passings represent roughly half of passings between 20 weeks of pregnancy and 1 year of age [1], with inborn mutations and perinatal hypoxia being the foremost causes. Despite the fact that fetal observation (performed all the more every now and again on "high-chance" pregnant gatherings) may fundamentally decrease the frequency of fetal passings, perinatal dreariness and maternal pain in such gatherings, most of stillbirths and distortions currently happen in "generally safe" pregnancies (i.e., those with no recognized hazard factor) [1]. This clear inconsistency underscores the dire need to grow progressively powerful methods for recognizing "in danger" babies in "okay" gatherings. In "high-hazard" pregnancies, ultrasound-based advancements are the most well-known demonstrative methodology for distinguishing fetal bargain, while in "generally safe" bunches diminished fetal movement is the main evaluation appeared to recognize babies in danger, but with poor positive prescient esteem.

Cardiotocography (CTG), which is a record of the fetal pulse (FHR) and uterine constriction action estimated by means of transducer on the belly, is regularly utilized for fetal welfare assessment. In some cases strange inconstancy in fetal pulse may not really speak to the traded off embryo. As detailed in a few late investigations, the records embraced in CTG don't seem to have achieved a decrease in fetal mortalities [2]. Fetal development, especially in beginning time hatchlings, regularly results in flag misfortune and thus mis-finding. All things considered, no bound together wellbeing appraisal technique for the baby as of now exists. The interim between the beginning of the QRS complex of fetal ECG and the beginning of ventricular launch (i.e., the opening of aortic valve) and the interim from opening to conclusion of aortic valve, are known to be extremely delicate pointers of fetal myocardial execution [3-5]. Be that as it may, the test of dependably assessing fetal cardiovascular valves' timings under fetal developments still exists. Along these lines, the present examination intends to address the test by dissecting the Doppler signs to recognize cardiovascular valve (aortic and mitral) opening and shutting timings with reference to fetal ECG in typical just as babies with heart irregularitie.

2. METHODS

Concurrent account of the stomach ECG signs and Doppler ultrasound signals from 5 pregnant ladies at the gestational period of 28~36 weeks with typical single pregnancies and five pregnant ladies who were analyzed to have fetal heart abnormalities were gathered from Hospital. An aggregate of 10 chronicles (every one of 1 moment's length) were inspected at 1000 Hz with 16-bit goals. The examination convention was affirmed by Tohoku University Institutional Review Board and composed educated assent was gotten from all subjects. FECG follows were extricated utilizing a

technique that consolidates abrogation of the mother's ECG flag and the visually impaired source

2.1 Wavelet analysis and feature extraction

Fig. 1 demonstrates the relative opening and shutting timings of the heart's aortic and mitral valves in connection to the FECG. Doppler recurrence shifts related with cardiovascular movement can be imagined. Understanding of DUS motions in connection to cardiovascular valve developments has been performed utilizing time recurrence wavelet analysis[4,5]. One case of DUS flags together with and their reproduced signs from point by point coefficients after wavelet deterioration are appeared in Fig. 2. A sliding window (50 tests) given by the situation of its middle was moved along the arrangement of reproduced Doppler sound flag and Jensen-Shannon Divergence (JSD) values between progressive windows were determined. The general Jensen-Shannon Divergence (JSD) is a data hypothetical capacity that measures the contrast between (at least two) likelihood conveyances [10]. JSD can be better assessed by evaluating the contrast between two likelihood conveyances when it achieves its most extreme esteem precisely at the point that the time arrangement prompts distinctive likelihood appropriations. Here for our situation we looked at the likelihood dispersions of the left and right side as appeared inFig.2

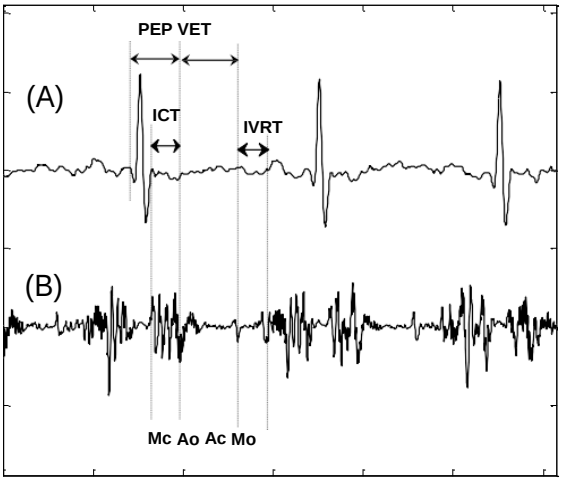

Figure 1. Example of simultaneously recorded fetal ECG and Doppler ultrasound data. (A) fetal ECG signal extracted from maternal abdominal signals using blind source separation with the reference signal [6]. (B) Data from the non-directional channel of the ultrasound from the fetal heart. Aortic opening/closing (Ao, Ac), Mitral opening/closing (Mo, Mc), pre-ejection period (PEP), left ventricular ejection time (VET) in relation to the ECG[3]. Isovolumic contraction time (ICT), isovolumic relaxation time (IVRT).

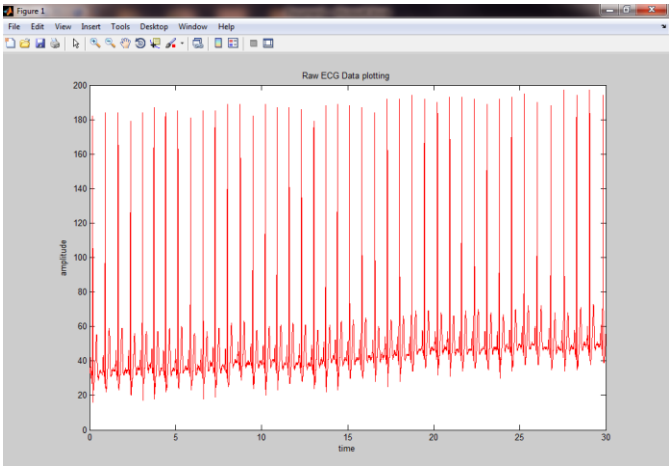

Figure 2

3. RESULTS

Two examples of the FECG for several cardiac cycles together with DUS signals and their details signals at level 2 wavelet decomposition are shown in Fig. 3&4 The timings of aortic valve motions (in Fig. 3) and mitral valve motions (in Fig. 4) with respect to the ECG, the origin of the events highlighted within the DUS were elucidated and verified by pulsed Doppler ultrasound in the bottom panel. In order to detect the peak timings of aortic valve's motion events, the time durations from R wave within each RR interval chosen for each event were 0.05~0.10 sec for Ao and 0.14~0.26 sec for Ac. On the other hand, for mitral valve's relative timings, 0.00~0.05 sec for Mc and 0.26~0.33 sec for Mo were used in calculation.

Table 1. Mean and SD values of PEP (Pre-ejection period), VET (Ventricular ejection time), ICT(Isovolumic contraction time) and IVRT (Isovolumic relaxation time) of normal fetuses and fetuses with heart anomalies. Total cardiac cycles analysed were 840. * indicates p<0.05

Table -1: MEAN and SD Values of PEP

		Mean	SD
Normal fetuses(5)	PEP	75.0	11.9
	VET	153.2	18.9
	ICT	50.0	15.9
	IVRT	69.6	9.7
Heart Anomalies(5)	PEP	89.0*	10.3
	VET	168.6*	25.0
	ICT	52.2*	17.2
	IVRT	51.6*	13.7

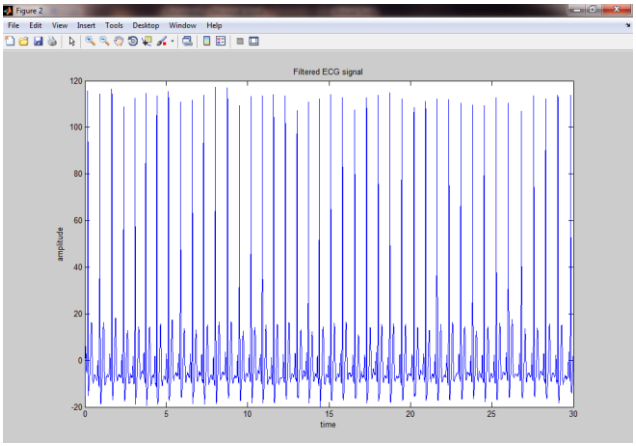

Figure 3. Panel (A) shows an example of fetal electrocardiogram signals extracted from abdominal ECG signals using BSSR [6]. Panel (B) shows the detailed signal after wavelet decomposition of DUS signal at level 2. Panel (C) shows the JSD values of the detailed signal in panel (B). Panel (D) shows the example of Pulsed- wave Doppler signals of fetal aortic valve movements annotated to show how the specific signals are linked with opening and closing events. Ao and Ac represent the opening and closing of aortic valve.

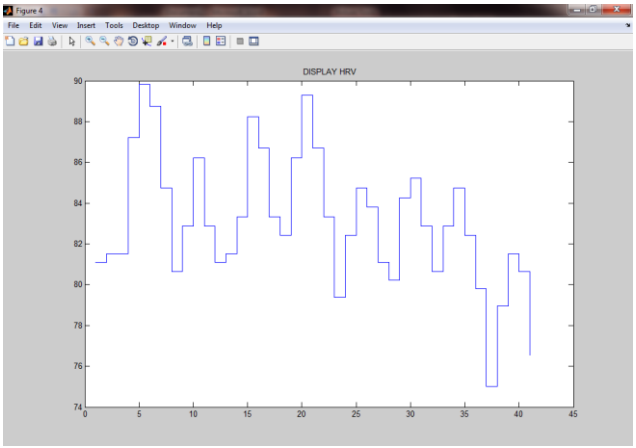

Figure 4. Panel (A) shows an example of fetal electrocardiogram signals extracted from abdominal ECG signals using BSSR [6]. Panel (B) shows the detailed signal after wavelet decomposition of DUS signal at level

2. Panel (C) shows the JSD values of the detailed signal in panel (B). Panel (D) shows the example of Pulsed- wave Doppler signals of fetal mitral valve movements annotated to show how the specific signals are linked with opening and closing events. Mo and Mc represent the opening and closing of mitral valve.

4. Discussion

In growing new systems for fetal welfare evaluation, it is sensible to look at parameters of fetal cardiovascular movement and capacity, given the essential job the fetal heart plays in fetal welfare and the limit of fetal heart parameters to reflect trading off circumstances. Cardiovascular valves' opening and shutting time interims have long appeared for evaluation of fetal heart work. The pre-launch period (PEP–QRS beginning until aortic valve opening) and isovolumic withdrawal time (ICT– mitral valve conclusion until aortic valve opening) are known to connect with highest quality level obtrusive lists of cardiovascular contractile capacity [3]. They are known to be touchy markers of fetal myocardial performance[3], and in this way permit separation of embryos with fetal development confinement (FGR) and other perinatal issues [7,8]. Isovolumic unwinding time (IVRT – aortic valve conclusion until mitral valve opening) measures ventricular unwinding. In the embryo, prolongation of the IVRT precisely distinguished embryos with FGR optional to unusual placental capacity as long as about two months preceding variations from the norm of ordinary Doppler haemodynamic indices[9].

As of not long ago these time interims have been overwhelmingly surveyed by ultrasound with manual estimation of valve movement occasions. As a result, they have remained to a great extent examine apparatuses. Improvement of coordinated fetal ECG and cardiovascular Doppler signals from heart valve and divider movement occasions gives the possibility to robotized non-intrusive evaluation without obstetric ultrasonography ability. Across the board utilization of this innovation may along these lines be conceivable, empowering evaluation of its incentive in antenatal screening of both fetal prosperity and cardiovascular capacity.

References

[1] CESDI. Confidential Enquiry into Stillbirths and Deaths in Infancy. London: Maternal and Child Health Research Consortium, www.cesdi.org.au, 2001.

[2] Ferrario M, Signorini MG, Magenes G. Comparison between fetal heart rate standard parameters and complexity indexes for the identification of severe intrauterine growth. Methods Inf Med 2007; 46(2):186-90.

[3] Murata Y and Martin, CB. Systolic time intervals of the fetal cardiac cycle, Obstet Gynecol, 1974; 44: 224-232.

[4] Khandoker AH, Kimura Y, Ito T, Palaniswami M. Non-Invasive Determination of Electromechanical Time Intervals of Cardiac Cycle Using Abdominal ECG and Doppler Ultrasound Signals from Fetal Hearts. Computers in Cardiology 2007; 34: 657–660. October 1-3, 2007, Durham, USA.

[5] Khandoker AH, Kimura Y, Ito Y, Sato N, Okamura K, Palaniswami M. Antepartum non-invasive evaluation of opening and closing timings of the cardiac valves in fetal cardiac cycle", Medical & Biological Engineering & Computing 2009; 47:1075–82.

[6] Sato M, Kimura Y, Chida S, Ito T, Katayama N, Okamura K, Nakao M. A Novel Extraction Method of Fetal Electrocardiogram From the Composite Abdominal Signal. IEEE Trans on Biomed Engg 2007; 54 (1): 49-58.

[7] Organ LW, Bernstein A, Hawrylyshyn PA.. The pre-ejection period as an antepartum indicator of fetal well- being. Am J Obstet Gynecol 1980: 137: 810-9.

[8] Koga T, Athayde N, Trudinger B.. The fetal cardiac isovolumetric contraction time in normal pregnancy and in pregnancy with placental vascular disease. BJOG 2001: 08: 179-85.

[9] Tsyvian PB, Markova TV, Mikhailova SV, Hop WC, Wladimiroff JW. Left ventricular isovolumic relaxation in the growth restricted fetus. Eur J Obstet Gynecol Reprod Biol 2008:140:33-7.

[10] Pereyra ME, Lamberti PW, Rosso OA, Wavelet Jensen-Shannon divergence as a tool for studying the dynamics of frequency band components in EEG epileptic seizures, Physica A: Statistical Mechanics and its Applications 2007:379:122-32.