CAD for Detection of Fetal Electrocardiogram from Multivariate Abdominal Recordings by using Wavelets and Neuro-Fuzzy Systems

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Abstract: The fetal electrocardiogram (FECG) signal is outcome of the electrical activity of the fetal heart after 21 days of the pregnancy. It contains information about the health status of the fetus and so, an early diagnosis of any cardiac defects before delivery (Specially in case of labour pain) increases the chance of the appropriate treatment. In this paper we consider one signal from the thoracic and another from abdomen of the mother. The artificial neural network fuzzy inference system (ANFIS) is used to obtain the FECG component from abdominal ECG recording and reference thoracic maternal electrocardiogram (MECG) signal. The obtained FECG is being enhanced by using wavelet transform.

Key words: ECG, MECG, FECG, Neural network, Fuzzy logic, Membership function and Wavelet transform.

I. INTRODUCTION

Fetal electrocardiography provides a unique method to watch the fetal cardiac cycle. Generally two systems are being used :the first method is direct, in which the fetal ECG is recorded using an electrode attached to the scalp, and second method is indirect, in which the fetal ECG is sensed at the maternal abdominal [1] wall. The former technique is invasive and more risky and can only be performed during labour. As per survey, it is found that in the United Kingdom about 5 fetuses per 1000 die unexpectedly before birth and about 2 per 1000 result from congenital abnormality. If it is not taken seriously then child death rate will increase very soon.

The electrocardiogram (ECG) gives a graphic recording of the electric forces generated by the heart during polarization and depolarization [2]. In this paper we propose non-invasive technique, in which ANFIS is used to obtain FECG from the contaminated abdomen signal and wavelet transform to obtain enhanced FECG. This paper is organised as: section II deals about proposed system, section III discuss about results and section IV consists of conclusion.

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II. THE PROPOSED SYSTEM

In our propose system, which is shown in fig.1. we generate two ECG signals with the help of two leads. One ECG is obtained from thoracic and another from the abdomen area of the pregnant women, which is represented by x(n) and w(n) respectively. The MECG is going through non-linear transform after its generation. On the other side same MECG is passed through neuro-fuzzy system [4] and filter to obtain noise free and better ECG.

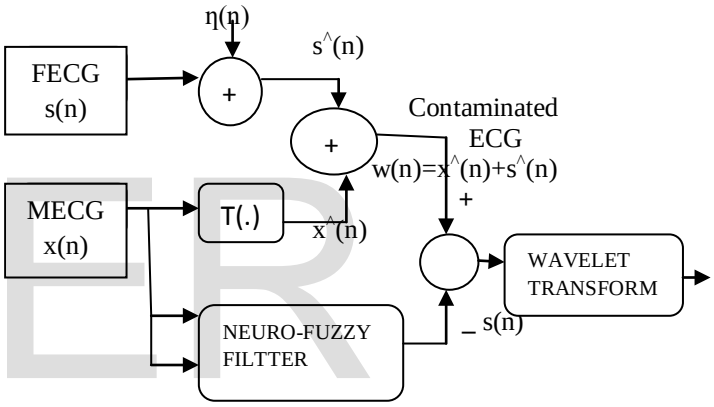

Fig. 1. The proposed system

The abdominal signal w (n) is embedded with three signals: One is a deformed version of x(n) as it travels from the chest to the abdomen, another is the fetal ECG and a third is additive noise from other sources. The abdominal signal, w (n), can be expressed as the sum of a deformed version of the maternal ECG, $\hat{x}(n)$, and some noise with the fetal ECG, such that

$$w(n) = \hat{x}(n) + \hat{s}(n) \quad (1)$$
$$\hat{x}(n) = T(x(n)) \quad (2)$$
$$\hat{s}(n) = s(n) + \eta(n) \quad (3)$$

The deformation of the maternal ECG component happens since the signal is measured far away from the mother's heart, and consequently it is effected by some nonlinear transformation as it travels to the abdominal area. The thoracic signal x(n) is predominantly maternal, and hence the fetal component in it is ignored.

In our propose method, we do so by an ANFIS network with multi-input and a single output. The input in this case would be the MECG signal x(n) and a finite number of its derivatives or delays along with the desired signal being the composite signal w(n). The ANFIS network will find a nonlinear transformation that operates on x(n)and aligns it with w(n) . The right ANFIS network should, therefore,

output an estimate of the maternal component in w(n). The fuzzy inference system (FIS) [3] is helpful to provide ANFIS, in which an initial set of membership functions is used for training. The ANFIS output is subtracted from the contaminated signal to obtain the fetus signal. The FECG is enhanced by using wavelet transform [5] to get the more clear FECG.

III. RESULTS

The ECG, which can be obtained from the pregnant women abdomen is generated by Matlab code. Which is shown in fig.2.

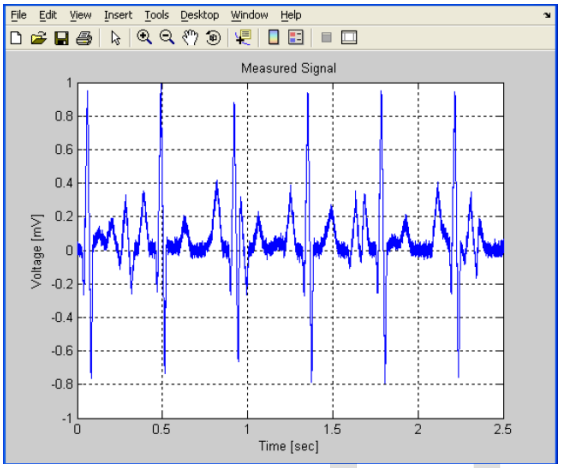

Fig. 2. The measured abdomen signal

The MECG, which is shown in fig.3 is obtained from the thoracic of pregnant women. It is also generated by coding.

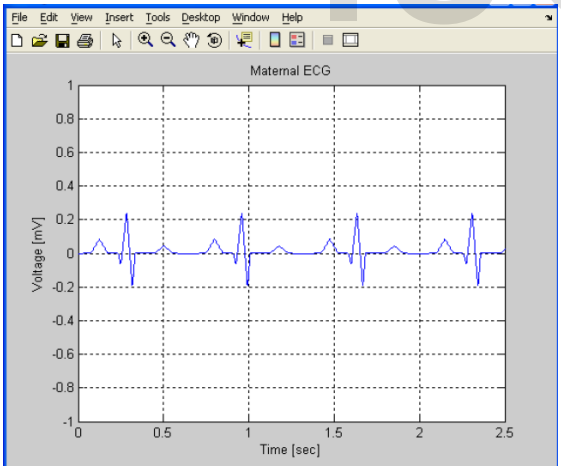

Fig. 3. The Maternal ECG

We can find the FECG as shown in fig.4 by using ANFIS and wavelet transform, which is far better than previous other methods in all aspects.

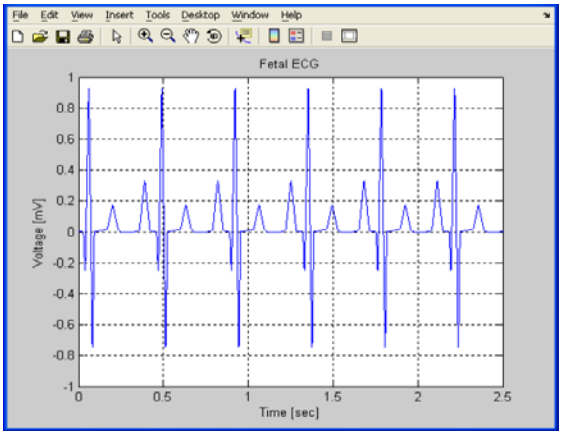

Fig. 4. The Fetal ECG

IV. CONCLUSION

The obtained result is far better than previous other methods in all aspects specially in the region of QRS. Different types of membership functions and wavelets transform's diff. levels are tried, in which best one is selected to obtain desire result.

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