International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 04 Issue: 06 | June -2017 www.irjet.net p-ISSN: 2395-0072

Analysis of Various Signals Acquired from Uterine Contraction to determine true and false labor

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Abstract – *Prediction of premature labor is very important factor in this century as the neonatal death ratio is increasing day by day. For the prediction of labor it is necessary to have uterine contraction signals. Analysis of EHG is Consider proper tool for this aim. EHG record the electric activity of uterine muscle. In this paper the signals is downloaded from the Physionet dataset, the work presented in this paper is to determine True and False labour from the Analysis of various signals which is acquired from Uterine Contraction. Linear (mean, median) and non-linear (entropy) feature is extracted from EHG signals and support vector machine (SVM) is applied for classification to get the result whether the labour is term or pre-term.*

Key Words: Labor, EHG signals, linear feature, non-linear feature, SVM classifier.

INTRODUCTION

Prediction of premature labor is extremely important. Factor, as it can reduce neonatal death and the babies which are born abnormal. Premature birth is a term in which babies are born after 20th week of pregnancy and before 37th week of pregnancy. Normally pregnancy last for 40th week for majority of women. In certain case babies which are born before 37th week are normal and healthy but in maximum case premature birth cause many deficiency in babies such as hypocalcaemia (suffering from calcium deficiency), loss of phosphorus in urine, low sodium level , lower haemoglobin level, pneumonia (infection of lungs), meningitis (infection of brain), hearing loss, retinopathy (vision problem), Autism (group of disorder that affect a child speech, social skills and behaviour), Bronchopulmonary dysplasia (lung disease that causes the lung to b inflamed). To avoid such abnormalities in babies, prediction and precaution is necessary. Prediction process required the uterine contraction signals which is acquired during active labour.

The promising technique is Electrohysterogram (EHG). As for the process of recording the electrical activity of heart, Electrocardiography (ECG) is use and to record electrical activity of brain, Electroencephylography (EEG) is recommended. Likewise to record the electric activity of uterine muscles EHG is use.

EHG records correspond to the activity of the uterine muscles and might therefore be use to predict the premature onset of labour [1] [6]. The signal acquisition does not require an incision or surgical operation therefore any hospital can take it into practice. Using the EHG it is possible to detect uterine activity related to contractions during both gestation and active labour. [1] [5].

In this paper we have downloaded the data from the physionet databases it is clinically tested data, the linear feature (mean, median) and non-linear feature (entropy) is extracted from the acquired data.

Fele-zors [1] has work on the comparison of various linear and non linear signals processing technique for classification of term and preterm labour and it was concluded that the nonlinear techniques have a better accuracy than linear techniques. Once the feature is extracted SVM (support vector machine) is applied as classifier to get the result for true and false delivery labor.

2. MATERIAL AND METHOD

2.1 Data acquisition

The EHG records used in this research were downloaded From Physionet database included in the Term-Preterm Electrohysterogram database (TPEHGDB). These records are collected from 1997 until 2005 at the Department of Obstetrics and Genecology, Medical Centre Ljubljana, Slovenia [4]. Records were collected from the general population as well as from the patients admitted to the hospital with the diagnosis of impending pre-term labor. One record per pregnancy was recorded [1]. The records are of 30-min duration and consist of three channels. The sampling frequency (Fs) was 20 Hz, The records were collected from the abdominal surface using four AgCl2 electrodes (seeFig.1), the electrodes were placed in two horizontal rows, symmetrically under and above the navel, spaced 7 cm Apart [1]. Three channels are made by using four electrodes, first channel acquired one signal which combine electrode (E2-E1) second channel acquired second signal which combine electrode (E2-E3) third channel acquired third signal which combine electrode (E4-E3).

2.2 Preprocessing

During recording of signals there are many causes which can corrupt original signal. The raw EHG signal consist of noise it has to be pre processed to remove noise hence it is digitally filter by using band pass filter, as it was recognize that the range of EHG is from 0 to < 5 hence band pass filter is use. The band-pass cut-off frequencies were:

From 0.08Hz to 4Hz;

From 0.3Hz to 3Hz;

From 0.3Hz to 4Hz [4]

The filtered and unfiltered EHG signal is shown in fig 2.

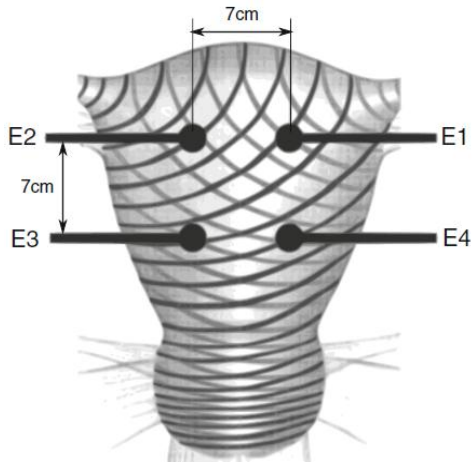

Fig- 1: The placement of the electrodes on the abdomen, above the uterine surface. Channel 1: E2–E1, channel 2: E2–E3, channel 3: E4–E3 [1].

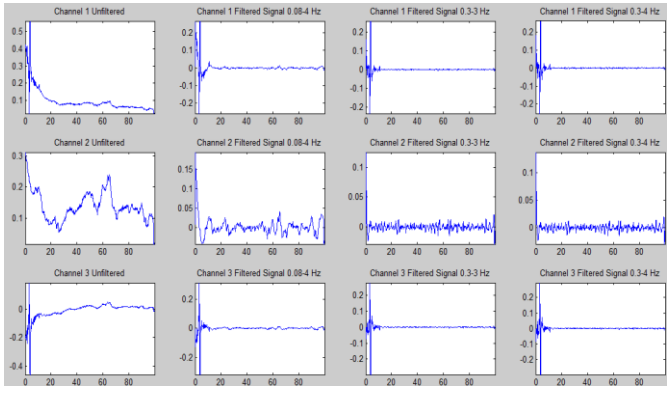

Fig- 2: Snapshot of EHG signal filtered at different frequency.

3. FEATURE DESCRIPTION

Physio bank consist of 300 records of pregnant women from which 262 has full-term pregnancy and 38 record of premature birth and 162 record where taken before 26th week of pregnancy and 138 record where taken later [4]. We have use 60 record from this in which 30 record is of term pregnancy and 30 record of premature birth. Once the data is acquired linear and nonlinear feature is extracted from each signal. As three channels is use to record EHG signals linear and nonlinear feature will be extracted from all three channels. In this Paper four linear features mean, median, root mean square, and variance, and two nonlinear features Entropy and Cepstrum is extracted.

3.1 Mean

Mean is one of the easiest method when we are working with no of data set it can be use to describe the entire data set with single value that describe mean of entire set. Mean is calculated as, add all sampled value and divide it by the number of values. The sum of the sampled values divided by the number of items in the sample;

$$\mu = \sum xP(x)$$

3.2 Median

Median is the middle number and the data set when set is written from least to greatest. Median is the middle value of a sequence;

$$E(|X - c| - |X|)$$

3.6 Entropy

The exact description of the randomness in the System

$$\mathrm{H}(X) = \sum_{i=1}^{n} \mathrm{P}(x_i)\,\mathrm{I}(x_i) = -\sum_{i=1}^{n} \mathrm{P}(x_i)\log_b \mathrm{P}(x_i)$$

4. CLASSIFIER

One of the most popular types of classifier is support vector machine. In SVM we are first training the classifier for a set of data and then testing it .There may be no of classifiers that will separate the data, in other words have no training error however in this paper SVM is used. Support vector machine algorithm is explain in such a way that suppose we have this two feature X1 and X2 as shown in fig 2, here we want to classify all this elements, there is class square and class circle so the goal of SVM is to design a hyperplane. There can be numbers of hyperplane made to separate the classes but the best choice will be the hyperplane that leaves the maximum margin from both classes, here we define the green line as shown in fig 3 as the hyperplane, that classifies all the training vectors in two classes. This hyperplane is Define by one equation:

$$f(\mathbf{x}) = \mathbf{w}^\top \mathbf{x} + b$$

This equation will deliver values greater than 1 for all the input vector which belongs to class 1, in this case the circles and also, we scale this hyperplane so that it will deliver values smaller than -1 for all values which belong to class number 2,the rectangles. Basic SVM is linear but it can be used for nonlinear data by using kernel function to first indirectly map non-linear data into linear feature space. Basic SVM is also a two-class classifier however; with some modification, multiclass classifier can be obtained [10]. Once the classifier is train then we can test it, the unknown EHG signal is acquired from uterine contraction, linear feature non-linear feature is extracted and given to SVM classifier to get the output result for term and pre term labor.

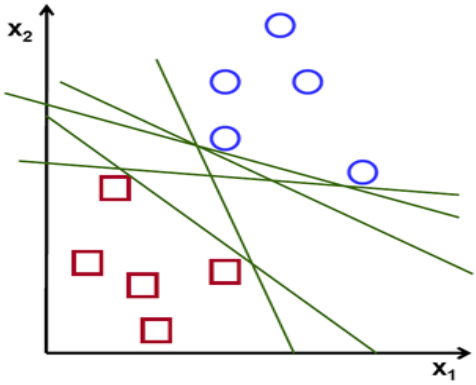

Fig-2: Two class separated by no of hyperplane.

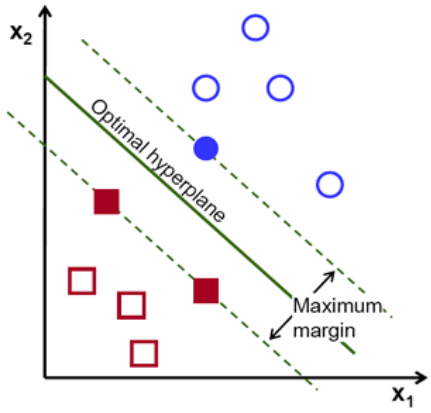

Fig-3: Optimal hyperplane

5. RESULTS AND DISCUSSION

In order to find whether the pregnancy is term or preterm two type of feature has been applied firstly, two linear features which include mean and median and one non-linear feature entropy. The feature is extracted from EHG signals and then to separate the two group of pregnancy support vector machine (SVM) classifier is applied .first support vector machine is train with known signal and once it has been set then unknown signal is applied to classifier. The (SVM) classifier predicts whether the pregnancy is true or false. SVM is the best classifier it separate two classes very properly to give the specific results.

6. Conclusion

The aim of this paper was to determine the term and preterm labor from various signals which is obtain from uterine contraction. The feature is extracted and (SVM) classifier is applied .The SVM based classifier presented has a good performance in classifying the 2 stages of labor and can be easily implemented on hardware for real time response.

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