

EHG Signal Classification for True and False Pregnancy Analysis

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Abstract – Normally pregnancy last for 40 week, in which babies are born normal and healthy. The babies which are born after 20th week and before 37th week of pregnancy are known as premature babies. This can cause deficiency in babies and high risk of death of child, to reduce neonatal death it is necessary to predict whether the labor is term or preterm one of the promising tool to measure the electrical activity of uterine muscle is EHG. Previous paper had done research in acquiring EHG signals, in this paper various EHG signal is acquired and linear and non-linear feature is extracted and is given to support vector machine (SVM) classifier to determine whether the signal is term or preterm.

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

I. INTRODUCTION

Premature birth of babies is one of the most common problems since long period of time. Normally pregnancy last for 40 week in which the babies are born normal and healthy, premature babies is one that are born after 20th week and before 37th week of pregnancy. Premature is divided in different categories, less than 28th week led to extremely preterm, very preterm is between 28th to 32nd weeks of pregnancy and the moderate to late preterm is 32nd to 37th weeks. There are many causes of premature birth it can be due to complication such as pre-eclampsia, premature rupture of membranes, kidney disease or growth restriction, prolapsed cord (when the umbilical cord exist the body before baby) and many time the reason is unknown. To avoid such cases 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. An alternative method to monitor the uterine activity is to measure the action potential generated by the uterine muscle during pregnancy and labor. The recorded electrical signal is called uterine electromyogram (uterine EMG) or electrohysterogram (EHG). The non invasive version of the technique consist of placing a matrix of electrodes on the maternal abdomen and recording the electrical potentials [9] 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 labor. [1] [5]. During pregnancy, EHG measurement has been proven to allow for accurate estimation of amplitude, frequency, direction, and velocity of uterine contractions, even outperforming the diagnostic value of methods currently used in clinical practice [3].

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. In this paper we have downloaded the data from the physionet databases it is clinically tested data, the linear feature (mean, median, root mean square and variance) and non-linear feature (entropy and cepstrum) is extracted from the acquired data, Once the feature is extracted SVM (support vector machine) is applied as classifier to get the result for true and false delivery labor.

II. 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 (F_s) was 20 Hz, The records were collected from the abdominal surface using four AgCl2 electrodes, 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 recording duration was approximately 30 minutes and the sampling rate of each signal was 20 HZ with 16-bit resolution over arrange of ±2.5 mV, signals were filtered by an analog three pole band pass Butterworth filter with the bandwidth from 0 to 5 Hz. The band-pass cut-off frequencies were:

- From 0.08Hz to 4Hz;
- From 0.3Hz to 3Hz and
- From 0.3Hz to 4Hz [4]

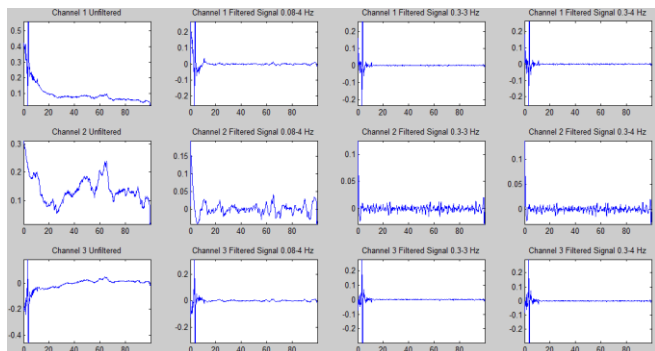


Fig-1: Snapshot of EHG signal filtered at different frequency

III. FEATURE DESCRIPTION

Physiobank 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;

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

3.3 Root mean square

Root mean square, commonly known as RMS is an important concept in electronics. RMS is a mathematical concept used to derive the average of constantly varying values. Given a signal, represented by a time-series $x(t)$; $t = 0, \dots, N-1$ of length N , the root mean square value of the signal, RMS, was calculated as the root of the mean of the squares of all samples in a signal:

$$x_{rms} = \sqrt{\frac{1}{n} (x_1^2 + x_2^2 + \dots + x_n^2)}.$$

3.4 Variance

To calculate variance of a set, calculate the average of your set of data then subtract the average away from each value then square it and add them up and then divide by the number of objects in your sample.

The average of the squared differences from the Mean:

$$\text{Var}(X) = E[(X - \mu)^2]$$

3.5 Zero crossing

Zero crossing is a point where the sign of function changes from positive to negative.

3.6 Entropy

The exact description of the randomness in the System

$$H(X) = \sum_{i=1}^n P(x_i) \log_2 P(x_i) = - \sum_{i=1}^n P(x_i) \log_b P(x_i)$$

3.6 Cepstrum

A cepstrum is defined as the inverse Fourier transforms (IFT) of the logarithm of the magnitude of the Fourier transform (FT) of the data sequence.

$$|\mathcal{F}^{-1} \{ \log(|\mathcal{F} \{f(t)\}|^2) \}|^2$$

IV. 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 X_1 and X_2 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:

$$f(x) = w^T x + b$$

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.

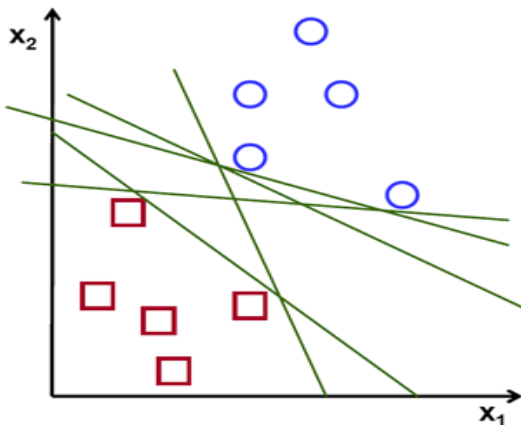


Fig-2: Two class separated by no of hyperplane.

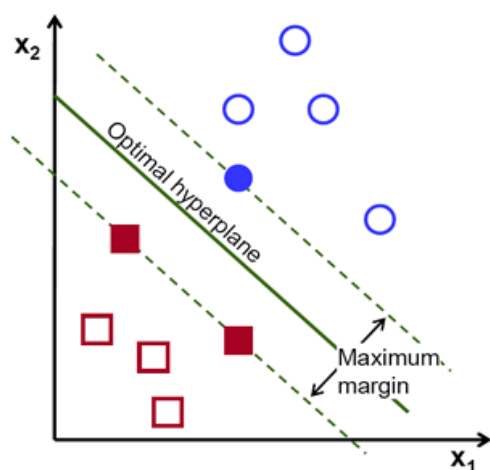


Fig-3: Optimal hyperplane

V. RESULTS AND DISCUSSION

In order to separate two group of pregnancy, linear feature (mean, median, RMS, variance) zero crossing and two

non-linear feature (entropy and cepstrum) are extracted. In fig 3, 4, 5 and 6 snapshot of linear and non-linear feature extraction is shown. The aim of this paper is analysis of signal to determine the term or preterm labor so that it can be use in every hospital easily.

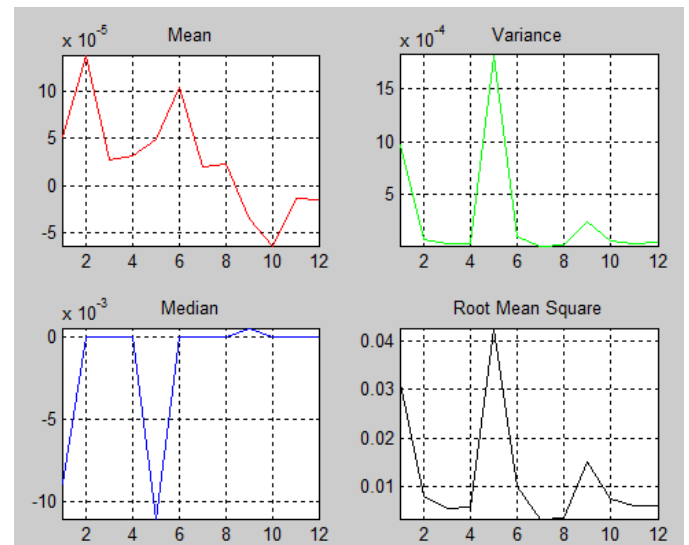


Fig-3: Linear feature (mean, median, variance and RMS).

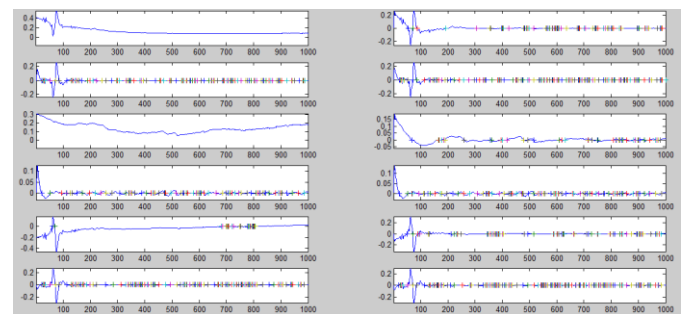


Fig-4: Zero crossing feature.

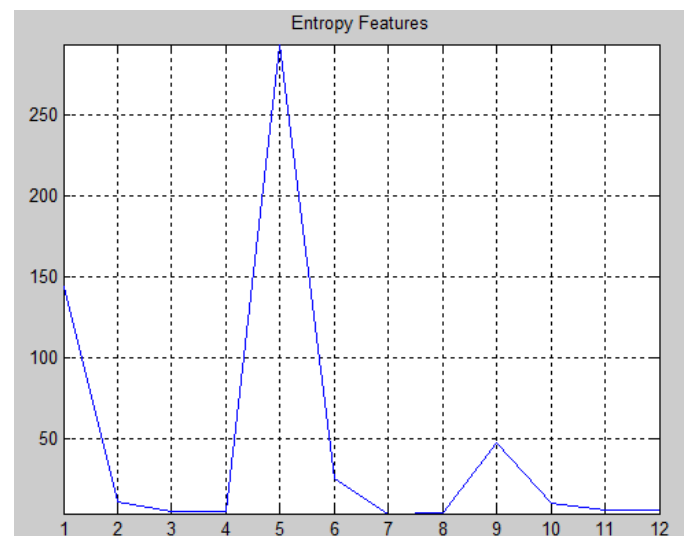


Fig-5: Entropy feature.

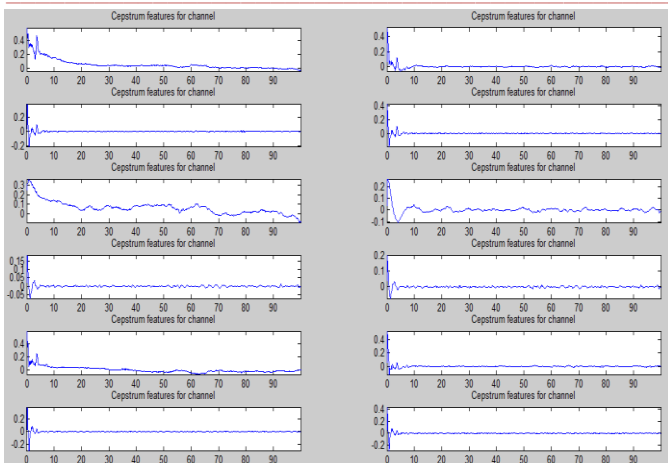


Fig-5: Cepstrum feature

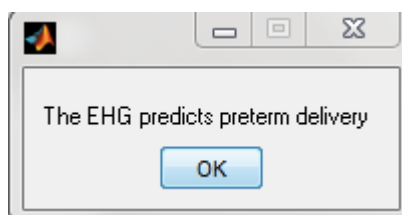


Fig-6 Classifier result

CONCLUSION

We have successfully Determine the data using SVM classifier to predict whether the signal is term or preterm. This method can easily be applied in every hospital. The proposed work may be use to study the relation between uterine cell and uterine related problem.

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