A Review on Prediction of Preterm Deliveries from Uterine Electrohysterography (EHG) Signals Using Support Vector Machine (SVM)

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***Abstract*- The aim of this research work is to develop a system, which will classify between Prediction of Preterm and term Deliveries from Uterine Electrohysterography (EHG) signals using Support Vector Machine(SVM). For the said purpose statistical and non-linear features can be extracted and can be applied for classification with SVM based algorithm. This system will automate the diagnosis process with adequate accuracy and improvement in the treatment of preterm infants which will help to increase their chances of survival. Currently, majority of the methods to predict preterm birth are nonobjective. Further, an effective and powerful proof advocates the analysis of uterine electrical signals (Electrohysterography) that could come up with a feasible way of diagnosing true labor and predict preterm deliveries. In this work focus will be on to utilise Electrohysterography techniques to predict preterm delivery earlier in the pregnancy. This paper investigates above stated proposition forward and facilitates a method that includes machine learning method and clearly separates records of term and preterm using an open source dataset.**

***Index terms*- Birth, Electrohysterography, Deliveries, Prediction, Preterm**

I.INTRODUCTION

Premature Birth, also known as Preterm Birth means delivery of babies that are born alive, before 37 weeks of gestation. It can be considered as one of the vital reason behind high rate of infant mortality. On the other hand, term births are the live delivery of babies after 37 weeks, and before 42 weeks. As per the recent statistics about 7% of total babies born are premature and around 50% of all infant deaths are caused by preterm delivery of babies. In time prediction and treatment of Premature Birth can save many infant lives and with proper treatment, the consequences of premature birth like impairments to hearing, vision and non-communicable diseases can be avoided and treated in a proper manner. Approximately, 50% of all perinatal mortalities are caused by preterm delivery, with those surviving often suffering from various disorders, caused by the birth. Around 40% of the survivors of premature birth develop chronic lung diseases. In addition, preterm births also have a long term effect on families, the economy and society.

One of the major hurdles in successful prediction of premature labor is the unpredictable uterine contraction. However, research has shown that the most accurate method established till now is the classification of EHG signals. Electrohysterography (EHG) is the recording of changes in electric potential associated with contractions of the uterine muscle with respect to time. EHG signal is recorded inexpensively and noninvasively using biopotential electrodes from the abdominal wall of pregnant women. Earlier researches show that these signals can be useful to separate uterine records of term and pre-term deliveries.

II. MATERIAL

In this study the EHG records can be downloaded from physionet database included in the Term-Preterm EHG Database (TPEHGDB). These records are collected from general population as well as the patients admitted at the hospital. The EHG signals are fetched from the surface of the abdomen using four AgCl2 electrodes. The electrodes are placed in two horizontal rows, spaced 7 cm apart shown in fig1. Each record is a composition of multiple channels (say three channel signals in this case).

- Signal 1-E2-E1 (First channel)
- Signal 2-E2-E3 (Second channel)
- Signal 3- E4-E3 (Third channel)

Prior to sampling the signal is allowed to pass through some advance filters.

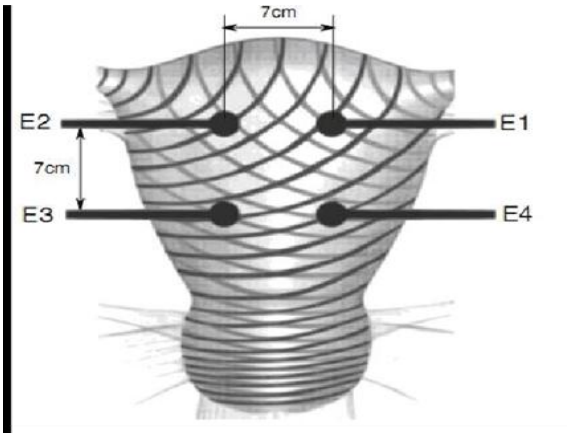

Fig.1.Arrangement of electrodes over the uterine surface near abdomen

A total of 300 EHG records were used in earlier research and study, which were divided in two groups:

1. Term Records (pregnancy duration 37 weeks): A total of 262 records were term, of which 143 were early (obtained before the 26th week of pregnancy) and 119 were later (obtained after the 26th week of pregnancy)
2. Pre-Term Records (pregnancy duration 37 weeks): A total of 38 records were term, of which 19 were early (obtained before the 26th week of pregnancy) and 19 were later (obtained after the 26th week of pregnancy)
3. Among these, the early records showed a relatively low frequency of contraction. So these records were given more importance, as they had lesser noise levels.

III. METHOD

Now, after acquisition of EHG data, the prediction of preterm labor primarily consists of three steps: Preprocessing, Feature extraction and Classification.

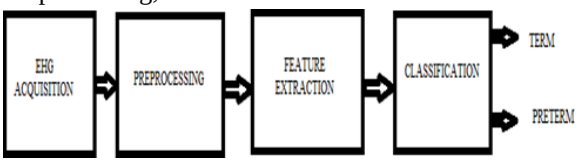

Fig.2.Block diagram representation using EHG signals for prediction of preterm birth.

A. Preprocessing.

The EHG signal is preprocessed using Butterworth digital filters and also SG Filter of different frequency bands, i.e. 0.08 – 4 Hz, 0.05 – 4 Hz and 0.2 – 4 Hz. The beginning and ending part of 90 seconds was also removed from them because of the presence of transient effects of the filters. The EHG signals are contaminated by different noises like respirational, abdominal EMG, and ECG components. To remove the noises, the three channel signals must be preprocessed as described above.

B. Feature Extraction

The factors like Root mean square (RMS), Standard deviation (SD), Mean absolute deviation (MAD), variance and various other parameters are calculated from the preprocessed data.

B-i. Root Mean Square(RMS)

The RMS value can be calculated every time after jth contractions. Below given equation can be used to calculate RMS value of a jth contraction,

$$RMS_j = \frac{\sqrt{\sum_i^c T_{sj} F_s X_{i2}}}{c}$$

Where,

C = (T_{sj}+T_{Dj}) F_s

T_{sj} is the time of j_{th} contraction, T_{Dj} is the duration and F_s sampling frequency.

B-ii. Variance

Variance is a statistical measure of how much a set of observations differ from each other. The variance of a random variable X is the expected value of the squared deviation from the mean of X,

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

B-iii. Standard Deviation (SD)

Standard deviation is a measure used to quantify the amount of variation of a set of data values or square root of its variance.

$$SD = \frac{\sqrt{\sum_{i=1}^{n} |X_i - Mean(X)|}}{n-1}$$

B-iv. Mean Absolute Deviation (MAD)

The MAD is the average distance between the mean of a set of numbers. The MAD of a set X_1, X_2 ,…… X_n is,

$$MAD = \frac{1}{n}\sum_{i=1}^{n} |X_i - Mean(X)|$$

C. Classification

The classification stage is used to differentiate between term and pre- term pregnancy state. A classifier plays a very significant role and therefore it should precisely separate the data into two groups. Classification is carried out with the help of Support Vector Machines (SVM). A classifier is an algorithm that utilizes some training data to understand how given input variables relate to a particular class. Out of total set of training examples that are given and all of them are marked for belonging to any one of the two categories, an SVM training algorithm builds a model that assigns new examples belonging to any one of the two categories.

IV. CONCLUSION

Preterm birth is demanding and testing real world problem. The birth of a preterm infant results in a noteworthy health hazard. Prediction of preterm birth can be obtained quite easily with the help of EHG signals. Different features are calculated from the EHG signal, among them MAD and variance give a higher accuracy. It shows that precision increases with increase in number of features. The focus of previous researches was to classify pre-term and term labor using EHG signals. It can be concluded that if both linear and non-linear features are extracted then accuracy increases with increased number of feature extraction and can be more effective for diagnosis of pre-term labor.

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