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Preterm Birth Prediction Using EHG Signals

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***Abstract*-The delivery of the baby is a physiological process. Uterine contraction is one of the most vital indications in the labor development. Electro hysterogram (EHG) is an efficient approach for tracking uterine contraction. We analyse the EHG signalstopredictthepretermlaborbyapplyingFeatureExtractionfollowedbyclassification. EHG signals obtained from open dataset (300), which contains 262 records for women who delivered at term and 38 who delivered prematurely. This paper discusses feature extraction methods such as RMS, Mean frequency, Variance, Standard deviation, Mean absolute deviation, Inter quartile range of uterine electromyography are used to detect term and preterm data and followed by LDA, KNN and SVM classifier. The selection of best classifier provides best accuracy. LDA provides 92.5% accuracy, KNN provides 88.6% accuracy and SVM provides 93.8% accuracy. SVM classifier has more accuracy compared to other two classifiers and maximum accuracy is provided from the combination of IQR and MAD.**

***Keywords* – uterine EMG, wavelet function, IQR, MAD, LDA, KNN, SVM .**

I. INTRODUCTION

In the labor process new life is coming to the world. This is a kind of physiological process which reaches to child birth. During this process placenta, membrane and umbilical cord also delivered through vagina. Up to delivery process baby where located in the uterus [1]. Gestation time is from the time of pregnancy until thebaby is born. During this time the baby's growth will be in the mother's womb. It is possible to know when the time of delivery is through the gestation time. A normal pregnancy can range from 38 to 42 weeks. Infants born earlier than37 weeks are taken into consideration premature. Babies born after 42 weeks are taken into consideration post mature. Main role of the uterus is to protect baby and provide nutrition to the baby and also helps in the development of a baby. Uterine smooth is build up by myometrial cell. The electrical activity of cells leads to obtain uterine contraction. This uterine contraction helps to predict term preterm birth[2].

Pregnancy duration normally termed as gestation period. It is the time duration between conceptions to birth. This time period used to find when delivery occurs [3]. Normal pregnancy duration is 38-42 weeks. If a baby born earlier than37weektermedaspretermbirth.Childbirthoccursafter 42 week termed as preterm birth [4]. The increasing rate of preterm birth results in significant health, development and economic problems. According to WHO observations preterm delivery cases go through with Neuro developmental or behavioral defects, inclusive of cerebral palsy, motor and cognitive impairment. Main risk is neonatal death[5].

Early prediction of preterm birth may reduce the death rate. Uterine contraction measured by using different methods, those are toco dynamometry, IUPC and EHG [6]. More effective method to predict preterm birth is EHG signal processing. In this method, place electrode on the abdominal surface of pregnant women. Due to the electrical activity of cells, uterus produces ionic current. Here electrodes act as transducers which convert ionic current into electrical current. From this signal extract features; it is the vital information to predict term and preterm delivery [7]. Aim of this paper for predicting preterm birth by using features of EHG signals and it followed by classification algorithms and finally compares the classifier performances.

II. METHODOLOGY/APPROACH

Figure illustrates the generalized block diagram of the proposed approach. This paper uses the TPEHG dataset, this data has been pre-processed the usage of feature extraction and classification. Illustrates how EHG signals may be pre-processed using various frequency parameters. The examine uses numerous linear and non-linear signal pre-processing strategies, through 3 exclusive channels, to distinguish term and preterm deliveries. The pre- processing method utilized in handed the EHG signal through a Butterworth filter configured to filter 0.8–4 Hz, 0.3–4 Hz, and 0.3–3 Hz frequencies

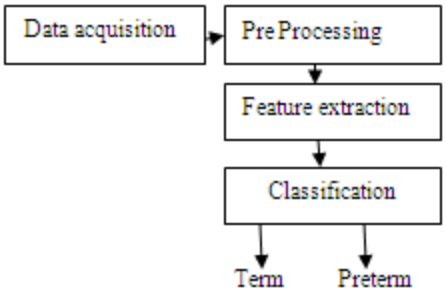

Fig. 1 Block diagram of preterm birth prediction

III.DATA ACQUISITION

In the prediction of term preterm birth prediction mainly two types of database used. Icelandic 16 and TPEHG databases were used. In this paper use TPEHG database. This is available from publically free databases of physionet. TPEHG database contain 300 uterine EMG records which is collected by regular check-up during 22nd and 32nd week of gestation. Sampling frequency is 20Hz. EHG signal were collected by placing 2*2 grid on the abdomen surface of pregnant women 7cm apart. The collected EHG signal is unipolar. By taking the difference between the electrode to get bipolar signal. The TPEHG database contain both original and filtered signal. The database also contain record number, pregnancy duration gestational age at the time of recording (rec.time), maternal age, previous abortions, weight at the time of recording etc[8].

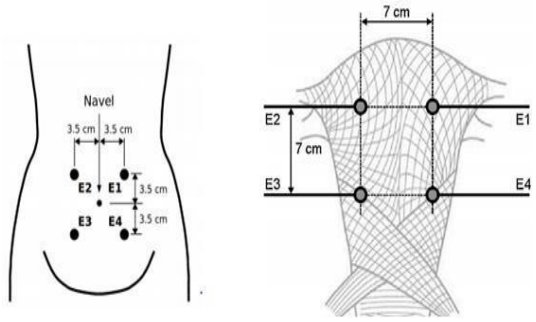

Fig. 2 Placement of electrodes.

- First electrode (E1) was placed 3.5 cm to the left and 3.5 cm above thenavel.
- Second electrode (E2) was placed 3.5 cm to the right and 3.5 cm above thenavel.
- Third electrode (E3) was placed 3.5 cm to the right and 3.5 cm below thenavel.
- Fourth electrode (E4) was placed 3.5 cm to the left and 3.5 cm below thenavel.

IV.PRE PROCESSING

EHG signal contains noise components due to respiration, motion artifacts, and maternal ECG. Main step of the preprocessing is removing noise component. Main noise component can be removed by used 0.34 to 1 Hz [9]. TPEHG database is already filtered. So before feature extraction step first avoid transient effect of the signal. Then framing the signal into small frames for increasing database and make signal into stationary. We use 0.3-3Hz filtered signals for this work.

Table 1 Noises in the EHG signal

Type of noises		Frequency range
Respiration		0.20 - 0.34 Hz
ECG components	Maternal ECG	1.38 – 1.5 Hz
	Foetal ECG	1.83 – 2.83 Hz
Foetus movement		0 – 0.5 Hz
Abdominal EMG		About 30Hz

V. FEATUREEXTRACTION

Process of transforming features into lower dimension space. The following features are extracted from the EHG signal.

- Root meansquare
- Meanfrequency
- Variance
- Standard deviation
- Inter quartilerange
- Mean absolutedeviation

Inter quartile range (IQR) is the measure of variability, based on division of data set into quartiles. The range gives us a measurement of spreading of our data set. The interquartile range, show how far apart the first and third quartile are interquartile range is not sensitive to outliers. The interquartile range (IQR) is the difference between the first quartile and third quartile. It is the average distance of all of the elements in a data set from mean of the samedata set. MAD also indicates that spread out our dataset. Large value of MAD indicates a dataset that is more spread out from the mean. Small value of MAD shows dataset less spread out and located near to mean. It also describes variation in a dataset. Apply feature selection on these features. Every feature has great importance for the prediction preterm birth. They help you by choosing features that will give you as good or betteraccuracy.

VI. CLASSIFICATION

This is the simulation results of LDA classifier performance. From this we can say that IQR make more accuracy. We use only 0.3-3Hz filter because major noises are lies between 0.34-1Hz, so 0.3-3Hz helps to avoid almost all noises. LDA is not working when

unbalanced. In this paper EHG signals were framed then extract features from this signal and apply LDA, KNN and SVM classifier algorithm. There are two type of data analysis that can be used for classifying the data or to predict future data trends.

These two forms are classification and prediction. Classification models predict categorical class labels (Term Preterm) and prediction models predict the continuous valued functions. The Data Classification process includes two steps building the classifier or model using classifier for classification. LDA technique is used to reduce the dimension of a dataset so it also termed as dimensionality reduction techniques. In this process project our dataset onto a lower dimension space. K-NN algorithm is very simple to understand and equally easy to implement. To classify the new data point K-NN algorithm reads through whole dataset to find out K nearest neighbors. SVM works really well with clear margin of separation. It is effective in high dimensional spaces. It is effective in cases where number of dimensions is greater than the number of samples.

VII.RESULTS

In this section used to express Simulation results classification algorithm and its performance. Classifier is simple in use and computationally easy. Feature selection methods can be used to identify and remove irrelevant and redundant attributes from data that do not contribute to the accuracy of our system.data set. So we use KNN classifier which is easy to understand and easy to apply new data entry cases. It is a non parametric method, simulation results of KNN classifier is shown below.

Table 2 All channel-0.3-3Hz (KNN)

Features used	Accuracy (%)
RMS	83.7
Mean frequency	68.3
Variance	78.3
Standard deviation	78.3
IQR	87.7
MAD	88.6

KNN also shows IQR and MAD give more accuracy than other features. There is some limitation in the case of KNN classifier is that large no of dataset makes the system more complex due to the selection of K value. So we follow SVM classifier algorithm. Most accurate method when the number of dimensions is greater than the number of samples. From these 3 classifier performances SVM show more accuracy than others.

Table 3 All channel-0.3-3Hz (SVM).

Features used	Accuracy (%)
RMS	87.1
Mean frequency	81.5
Variance	82.5
Standard deviation	83.6
IQR	92.1
MAD	93.8

VIII.CONCLUSION

The rate of preterm births has multiplied globally, which can result in intense scientific conditions and an increase in societal and economical charges. But, a better knowledge of preterm births, and a strategic attention on prevention, probably to enhance fitness outcomes and decrease healthcare carrier costs. Evaluation of uterine electric signals from the abdominal surface (EHG) should provide a possible way of diagnosing true labour, or even predict preterm deliveries. Different features from uterine electromyography are used to detect preterm birth, in addition to feature ranking strategies to determine their discriminative abilities in detecting term and preterm data. The goal of this paper is to predict preterm birth using EHG signals by applying proper dataset and extract features and followed by LDA, KNN, SVM classification algorithms. From these three classifiers that I have selected the SVM classifier has more accuracy compared to other two classifiers. And also maximum accuracy is provided from the features IQR and MAD. IQR and MAD provide more accuracy because of these features is not sensitive to outliers.

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