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Review Article

Use of Machine Learning and Sensors for Monitoring Pregnancy

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Abstract

The experience of pregnancy and birthing is different for every mother and her baby. Unfortunately this experience may not always be very smooth due to various complications that may occur during delivering the baby. Premature babies even if kept in neonatal care are susceptible to a lot of hazardous health conditions. Underdeveloped brain and lungs, smaller or weaker babies resulting in feeding inabilities and being prone to diseases, are a few problems babies may face if born early. Also mothers can face problems due to high blood pressure, gestational or preexisting diabetes, infection or other medical conditions. Some mothers may face problems if induced with labour before time such as rupturing of placenta, and increased chances of C section [16].

There is thus a need to identify or if possible predict the risk associated with pregnancy and the mode of delivery. Different medical indicators or parameters can be used for monitoring pregnancy, predicting delivery time and mode of delivery [16]. These can be studied and can be analyzed using machine learning algorithms. The analysis can be used to predict the appropriate time and mode of childbirth along with the risks and it will be less error-prone. To support this wearable sensor device which senses abnormalities can be used remotely to monitor the patients health and take necessary actions in case of emergencies. The devices worn during delivery time can indicate or predict abnormalities while in labour to help prevent unfortunate events.

Keywords: Lactic Acid; Pregnancy; MRI Scans

Introduction

The known parameters for monitoring pregnancy, predicting delivery time and mode of delivery are ECG, doppler, use of lactic acid sensors, counting baby kicks and movements, MRI scans, and knowing the muscle contractions [16]. Experienced doctors can also estimate the delivery time and gauge the possible signs of abnormality by checking the baby position with bare hands.

The parameters that can be measured using different methods are ECG, doppler, use of lactic acid sensors, counting baby kicks and movements, MRI scans, and knowing the muscle contractions etc. and their normal ranges. Along with the above parameters a few more conditions like comorbidities; living with vulnerable people; body mass index; duration of symptoms before hospital evaluation ; CRP ; month of pregnancy and age etc. also should be considered [16]. Signs that indicate whether a pregnant lady is going into labour can include cramping or tightening and amniotic fluid index [16].

Wearable sensors and other smart technology may be especially beneficial in providing remote monitoring of sub-clinical changes in pregnancy health status. Smartphone and digital technology use

is high among patients. Patients can consider wearing a mobile sensor during pregnancy. The device during the monitoring phase can sense abnormalities and share information with their doctors. During labour these devices can predict hazardous health conditions such as rise in BP, stress, heartrate of baby and mother, sugar (HBA1C) and Hemoglobin.

Definition of terms

At this point, we present the definition of several keywords to guide this review. They include wearable sensors, datasets, ML, DL.

- **Wearable sensors:** Wearable sensors have diagnostic, as well as monitoring applications. They are capable of biochemical sensing, as well as motion sensing [14].
- **Datasets:** Is an assemblage of raw facts and figures. Examples of classical datasets include; Iris flower data set, Modified National Institute of Standards and Technology database, Categorical data analysis, Robust statistics and Time series.
- **Machine Learning (ML):** Applies to any computer software that can "learn" and "adapt" intelligently. This is done by algorithms and statistical models and inferences are drawn from patterns in data [15].
- **Deep Learning (DL):** Deep learning is a kind of machine learning that may use supervised, unsupervised, or both methods. It is used for more complex computer problems. Faster and accurate results are obtained using deep learning [15].

Deficiencies of existing solutions

Different solutions using machine learning have been proposed for monitoring pregnancy and labour.

Many wearable sensor devices are present in the market which monitors pregnancy and labour. But the learnings from ML algorithms have not been combined with data from wearable sensor devices to make prediction and analysis more efficient.

Methodology for the review

Relevant literature for wearable devices available in today's market and the methodology used for sensing and measurement that can be used was studied.

Table 1 describes the study done based on indicators/parameters sensed, type of patient, method of measurement and predictions that can be made [1-16].

	Authors	Parameters/indicators sensed	Type of patients	Method of measurement	Predictions
1.	[1] KONINKLIJKE PHILIPS N.V.,	Lactic acid in the sweat produced by the body	The monitoring of the descent of the fetus is imperative to make clinical decision during the child birth.	Exhaustion or fatigue cause of the anaerobic metabolism can be characterized by the presence of lactic acid in the sweat produced by the body	Stress, exhaustion
2.	[2] Kok Beng Gan 1, Edmond Zahedi, Mohd Alauddin Mohd Ali	Transabdominal fetal heart rate	37 +/- 2 gestational weeks	A beam of IR-LED (890 nm) measures the fetal signal, whereas the PPG from the mother's index finger is the reference input	Fetal heart disorders
3.	[3] Mohammad Reza Mohebbian*, Seyed Shahim Vedaei, Khan A. WahidAnh Dinh, Hamid Reza Marateb, Kouhyar Tavakolian,	The combination of utero-placental Doppler and fetal or umbilical Doppler in normal pregnancies	Any	Synthetic dataset is generated for investigating the effect of maternal and fetal heart rates on the performance which showed that the proposed method can be used in various fetal and maternal heart rate variations.	Maternal heart disorders

4.	[4] Maha Messawa, Ehsan Ma'ajeni,1 Maazin H. Daghistani,2 Aqueela Ayaz,3 and Mian Usman Farooq 4	Doppler ultrasound of fetal blood vessels in normal pregnancies	Females with viable singleton pregnancy with regular antenatal visits and gestational age 28 or more weeks were included. Moreover, females with high-risk pregnancy, e.g., with diabetes, cancer, high blood pressure, kidney disease, epilepsy, past history of three or more miscarriages, preterm delivery, preeclampsia or seizures, heart valve problems, asthma, and rheumatoid arthritis, were also included.	Doppler ultrasound study of umbilical artery waveforms	Fetus status in 'high-risk' pregnancies
5.	[5] (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5937742/)	Fetal movements (FM) a specificity of 0.99 and a sensitivity of 0.77 for fetal movement time series signal classification.	24+3 to 34+6 weeks	Acoustic sensors	Fetus status
6.	[6] Xin Zhaoa, Xianyi Zenga,∗, Ludovic Koehla, Guillaume Tartarea, Julien de Jonckheereba	Fetal movement	Not specified	Microcontroller via BLE (Bluetooth Low Energy)	Fetal status using statistical information related to fetal movements in an intelligible way.

Table 1: Measurement of parameters by wearable devices.

Conclusion and Future Directions

Use of different indicators or parameters for monitoring pregnancy, predicting delivery time and mode of delivery can be done. Also Analysis and prediction using machine learning algorithms can be done for the monitoring and calculation of appropriate time and mode of childbirth. The analysis can be used to identify problems in pregnancy if any. A wearable device for monitoring pregnancy and labor during childbirth can be used which can be integrated with machine learning algorithms for more specific and accurate outcomes.

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