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IoT Based Fetal Heart Rate Monitoring

Akshada Ravindra Patil, Prof. Soumitra Das

P.G. Student, Department of Computer Engineering, Dr.D.Y.Patil School of Engineering, Lohegaon, Pune, India
Professor, Department of Computer Engineering, Dr.D.Y.Patil School of Engineering, Lohegaon, Pune, India

ABSTRACT: IoT is the network of physical objects-devices, vehicles, buildings and other items embedded with electronics, sensors, software and network connectivity that enables these object to collect and exchange data This paper describe a new method to Fetal Heart Rate [FHR] monitoring using IoT where system can be connected with small Doppler device (mDoppler) by mobile phone for observing abdominal area fetal parameter e.g. heart rate remotely (i.e. home). Along with this the two other things will also be measured they are Wrist band mother parameters like heart beat, temperature. The goal of the system is to give the option for mothers in resource-poor locations for screening the regular fetus monitoring well-being and calculating current fetus risk conditions particularly for critical pregnancy situations via a mobile integrated small Doppler device.

KEY WORDS: Fetal Heart Rate Monitoring System, Doppler Device, Smart Phone, Wearable Wireless Sensor

I.INTRODUCTION

To eliminate the excess number of deaths in fetus, measuring the fetal heart rate is the most important method of medical assessment. Along with the safety of fetus the health parameter of mother is also important. This paper introduce a new approach to monitor the fetus heart rate with the labour parameters such as temperature and heart rate. Fetal cardiotocography can currently only be undertaken in a centre with the appropriate equipment and staff. Devices used ‘in the field’ are limited to producing either just the sound of the fetal heart beating, or displaying an instantaneous heart rate on an LCD screen. Accurate assessment of fetal well-being requires more than this in terms of examining heart rate over time to determine a baseline, variability, and response to fetal movement.

Nowadays hand held devices are present in market for the pregnant women. A smart e-health system gives the ability to trace and the report current fetus condition during the monitoring period. Therefore, for the responsible physician or staff the system is able to define or alert the last status of the fetus and labour too. Therefore the proposed system is able to provide the status of both labour and fetus.

In this paper we propose an end-to end and a low cost mDoppler device to monitor healthy gestation. For regular screening of fetus the labour has to put the mDoppler on her abdominal wall. Depending upon the analog signals sensed by the sensors is computed with IBI value and then it will interpret the result. If the serious condition occurs i.e if the FHR goes beyond the normal baseline then for alertation the yellow signal is depicted on mDoppler. Being a software solution, the system uses existing mobile phone hardware, and existing portable fetal monitors, vastly reducing the cost.

II. LITERATURE SURVEY

The clinical practice of auscultating fetal heart rate began in 1818. It was not until the 1970s, however, that recording continuous fetal heart rate and uterine activity became widely used in obstetric care. The electronic fetal monitoring (EFM) is primary technique for screening fetal well being during labour dramatically altered obstetric practice.

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In paper [2], Numerical analysis of the human fetus heart rate:the quality of ultrasound records, presented by G.S. Dawes, G.H. Visser, J.D. Goodman, and C.W. Redman [2], they described method for the computerized numerical analysis of fetus heart periods (pulse intervals). To separate the records of Low and High frequency components this method uses digital filter and the Doppler ultrasound is used in last 10 weeks of gestation. The difference between direct ECG and ultrasound records gives the problem of signal loss. Therefore system gives a particularly useful adjunct to the analysis of antenatal human fetus heart rate records.

In paper [3], Improvements in the analysis and registration of fetus heart rate hears at the bedside, presented by G.S. Dawes, C.W. Redman [3], in which for the purpose of online analysis of fetus heart rate a microprocessor system is described detected by conventional Doppler systems. On the instrumentation and program structure the main focus is given. By analysing abnormal and normal antenatal fetal heart rate records the system has been tested.

In paper [5], An algorithm based on the Dawes/Redman criteria for automated fetal heart rate analysis, presented by L.N. Erika [5], in which the equipment based on Dawes/Redman criteria as a product in STAN S31 is used for fetus heart rate measuring produced by Neoventa Medical AB in Mlndal. This involves problems like valid patents protecting the algorithms and practical problems like if relative publications involves enough details to implement a version with claims on similarity.

IV. SYSTEM ARCHITECTURE

System Design

In this section, the monitoring system architecture is proposed firstly. Then the sensor of the mDoppler device for fetal heart rate monitoring is described separately.

A. Monitoring System Architecture

The system for fetal heart rate monitoring has the following features:

- Low power consumption and long-term monitoring
- Ease of operation

The system architecture is shown in Fig, 1, which is composed of the sensors, actuators, controller. A smartphone or computer system for data uploading and displaying of result.

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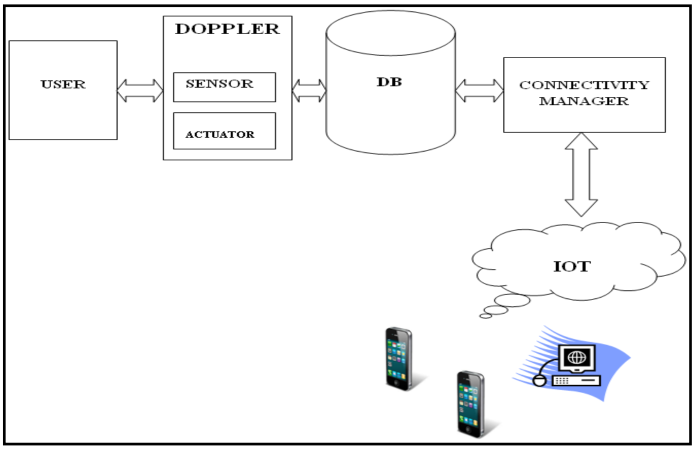

Fig. 1: System Architecture

The mDoppler can be attached to a computer through a USB cable and communication can be done using ESP8566. ESP8266 is micro controller and having self-contained WiFi network act as a bridge between existing micro controller and WiFi. ThingSpeak which is an open source Internet of Things (IoT) application and API is used to store and retrieve data from things using HTTP protocol over Internet.

From the beginning of 9^{th} week the fetus heart beat start to beat and till now the fetus heart beat is similar to the mothers heart beat i.e. about 70bpm to 85bpm.

B. Sensors

mDoppler device contained the three major components for gathering the fetus and labour parameter.

- HB100 is used for the fetus monitoring parameters like heart rate, length and weight of baby. HB100 has a built-in Dielectric Resonator Oscillator (DRO) and is a Miniature Microwave Motion Sensor is a X-Band Bi-Static Doppler transceiver module and a pair of Microstrip patch antenna array, making HB100 ideal for usage in motion detection equipment. For alarms, vehicle speed measurement, lighting control, motion detectors and automatic doors the Hb100 module is used.
- LM35 is used to measure the labour temperature. More correctly it can calculate temperature as compare to thermistor.
- And Pulse sensor is used to calculate the labour heart rate over time.

C. Program Flow

The setup is done in such way that there are seven serial byte Out of which the X, Y and Z serial are used to locate the graph and the P,Q and R are used to print the first reading of the sensed data. The O represent the online mode in which the obtained values are updated on Thing speak software to show the result and the same will display on smart phone.

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Algorithm

1. Put on wearables and start the system.
2. Setup GPIO and Serial
3. Read the serial byte
4. For plotting graph

    if (serial = x)
    x = Labour temperature
    if(serial = y)
    y= Labour heart rate
    if(serial = x)
    x= Fetus heart rate

5. For getting the current value of parameter

    if (serial = p)
    p = Labour temperature
    if(serial = q)
    q= Labour heart rate
    if(serial = r)
    r= Fetus heart rate

6. And if(serial = o)

    o = online mode

7. End.

The switch is used to change the serial mode from one module to another.

V. EXPERIMENTAL RESULTS

To show the experimental results of this work, fetal heart rate signals are recorded from 9^{th} to 10^{th} week of gestation. One of the records is taken as an example to depict how to display the result.

IBI value is nothing but Interbeat interval is a scientific term used in reference to the time interval between individual beats of the mammalian heart. It is also sometimes referred to as "beat-to-beat" interval. Based on the IBI value the pulses can be measured. For LHR pin A5 is set for read the analog signal and IBI = 600. Fetus heart rate analog signal is read by using pin A3 and for this IBI = 520. For temperature monitoring pin A4 of controller is set to sense analog signal from LM35. The conversion will be done by following way:

Temp=analogRead(A4)

Temp=(temp/1024.0)*5.0

Temp=temp*100.0

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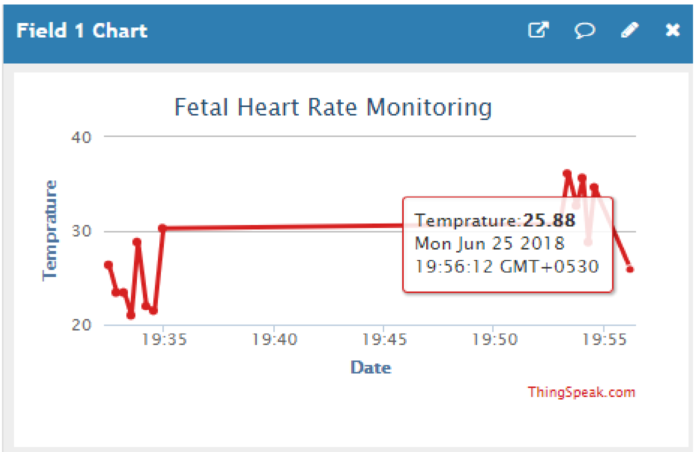

Fig. 2 : Labour Temperature

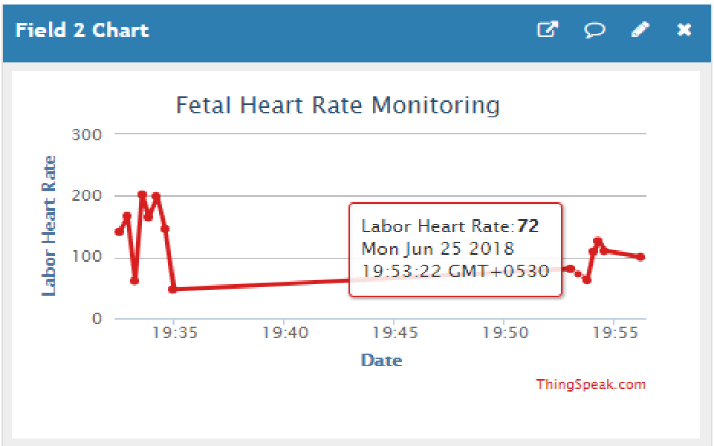

Fig. 3 : Labour Heart Rate(bpm)

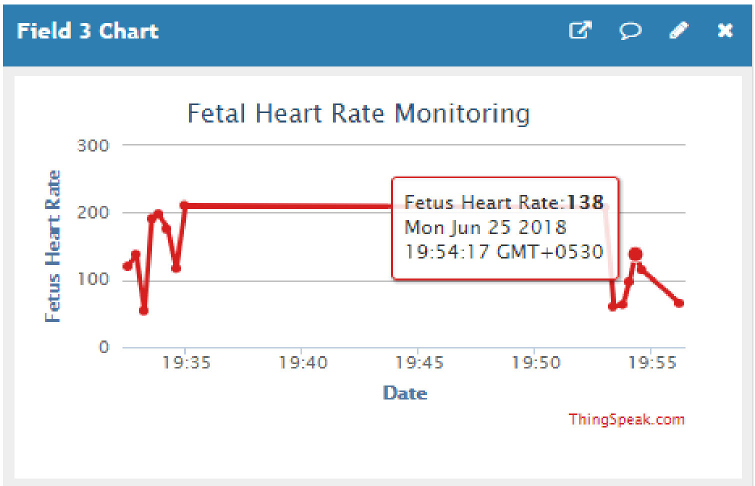

Fig. 4 : Fetus Heart Rate(bpm)

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VI. CONCLUSION

We have presented an prototype for monitoring the heart beats of fetus. Our system will also associates with the wrist band mothers parameters like temperature and heart rate. Using the sensors the data can be acquire and analog to digital conversion is computed for getting an appropriate value of sensed data. The system will work on real time object i.e. labour can also able to screening the previous results of their healthy fetus at any time and any location on mobile phone. As every coin has two sides it also has some drawback. Accuracy is a main issue for FHR. To ensure that the accuracy has been mitigated a variety of techniques that may be used in order to achieve it. As discussed with Doctors, the result obtained from their equipments our systems result is comparatively give the value which is nearby similar but is not 100% similar. Thus to obtained accuracy, we need to enhanced our hardware, so that it can give netter performance result as compare to previous one

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