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Fetal Monitoring System

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ABSTRACT

Monitoring of fetal movements (FM) is considered an important part of fetal wellbeing assessment due to its association with several fetal health conditions, e.g. fetal distress, fetal growth restriction, hypoxia, etc. However, the current standard methods of FM quantification, e.g. ultrasonography, MRI, and cardiotocography, are limited to their use in clinical environments. In this proposed system, it evaluates the performance of an acoustic sensor-based, cheap, wearable FM monitor that can be used by pregnant women at home. For data analysis, a thresholding based signal processing algorithm that fuses outputs from all the sensors to detect FM automatically is developed. Finally, a spike-like morphology of acoustic signals corresponding to true detected movements is found in the time-frequency domain through spectrogram analysis, which is expected to be useful for developing a more advanced signal processing algorithm to further improve the accuracy of detection.

Keywords - Acoustic sensor, spectrogram analysis, accuracy of detection, FM methods, fetal condtions.

I. INTRODUCTION

Fetal monitoring is the process of checking the heart rate of an unborn baby. Doctors usually perform fetal monitoring during labor, but may also need it during late pregnancy. The baby's heart rate can help doctors determine whether the pregnancy and birth are progressing normally. Changes in the baby's heart rate can be a sign of a potential problem. The average heart rate of an unborn child ranges from 110 to 160 beats per minute. This rate can normally vary from 5 to 25 beats per minute. Changes outside of this range may mean your baby has a problem, such as a lack of oxygen.

Fetal monitoring during labor is particularly useful in high-risk pregnancies. It can help your doctor decide if there is a treatable problem or if a C-section is necessary for safety reasons. Fetal heart monitors measure the fetal heart rate and rhythm. Doctors may recommend fetal heart rate monitoring during late pregnancy or labor to monitor fetal health.

Monitors used by doctors can measure heart rate, heart rate variability, acoustic sensor, spectrogram analysis, detection accuracy, FM methods, fetal status, acceleration and deceleration. This gives doctors important information about the health of the fetus. Hand-held heart monitoring devices can be purchased for home use. However, these are different from the monitors used by doctors. Unlike professional monitors, home devices can only measure heart rate.

II. LITERATURE SURVEY

The clinical routine with regards to auscultating fetal pulse rate started in 1818. After 1970s, recording of nonstop fetal pulse rate and uterine movement turned out to be generally utilized in obstetric care considerations. The electronic fetal monitoring (EFM) is essential strategy for screening fetal health during labor. In paper [1], Numerical examination of the human fetal pulse: which gives the quality ultrasound records, are introduced by G.S. Dawes, G.H. Visser, J.D. Goodman, and

C.W. Redman [2], they portrayed technique for the PC driven numerical analysis of fetal heart periods (beat interims). To isolate the records of Low recurrence and High recurrence segments of the signal this strategy uses digital filter. Along with that a Doppler ultrasound is utilized in remaining 10 weeks of incubation. A framework gives especially helpful adjunct to the investigation of antenatal human fetal pulse records. In paper [3], Improvements in the examination and registration of fetal heart rate can be seen, introduced by G.S. Dawes, C.W. Redman [4], in which a microprocessor based regular Doppler framework is structured with the end goal of online examination of fetus pulse. Accentuation is fundamentally given on the instrumentation and program structure. The framework is tried by checking unusual and typical fetal pulse records. In paper [5], an algorithm based on the Dawes/Redman criteria for computerized fetal pulse checking, is exhibited by

L.N. Erika [6], in which the hardware dependent on Dawes/Redman criteria as an item in STAN S31 is used for fetal pulse checking delivered by Neoventa Medical AB in Mlndal.

III. PROPOSED SYSTEM

This represents a new approach to monitor fetal heart rate using maternal parameters such as movement and heart rate. It is a comprehensive and inexpensive doppler device for monitoring a healthy fetus. A Doppler-based system must be placed on the mother's abdominal wall to monitor and obtain a graphic representation.

Depending on the analog signals sensed by the sensors, it calculates the sensed value and then interprets the result. If the fetal heart rate exceeds the normal baseline (increases or decreases) or when normally pregnant women move on the accelerometer1 sensing fetal movement capturing on the accelerometer 2 no motion detecting the accelerometer sensors 2, a yellow signal will be displayed to immediately indicate momentum via UART-based IoT and PC.

The sensed information of the user is collected, processed by the arduino microcontroller and the information is stored in the cloud. The system is a fetal heart rate monitoring system that is operated using a software application that can be installed on a mobile phone or PC.

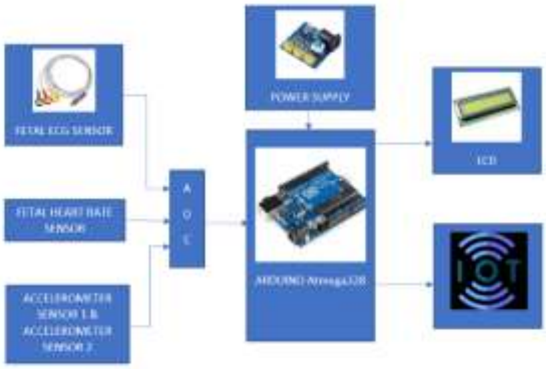

Fig 1. Block diagram

ArduinoATMEGA328

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (6 of which can be used as PWM outputs), 6 analog inputs, 16 MHz ceramic resonator, USB connection, power jack, ICSP header and reset button. Contains everything needed to support the microcontroller; simply connect it to your computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.

The Uno differs from all previous boards in that it does not use an FTDI USB-to-serial driver. Instead, it contains an Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB to serial port converter.

"Uno" means number one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of the Arduino moving forward. The Uno is the latest in the line of USB Arduino boards.

Fig 2: Description of Board Arduino Uno

ADC 0808/0809

TheADC0809 data acquisition component is a monolithic CMOS device with an 8-bit analog-to-digital converter, an 8-channel multiplexer, and microprocessor-compatible control logic. The 8-bit A/D converter uses successive approximation as the conversion technique.

The converter is equipped with a high-impedance chopper stabilized by a comparator, a 256R voltage divider with an analog tree of switches and a step-by-step approximation register. An 8-channel multiplexer can directly access any of the 8 single-ended analog signals.

Accelerometer Sensor

Accelerometer-based systems are developed to solve common problems in ultrasound measurement and enable remote, self-service monitoring of fetal movement. A single wearable device is placed on the abdomen that uses an accelerometer-based system to accurately detect fetal kicks. Here, two methods are used to accurately detect fetal kicks, a single wearable device that aims to reduce false positives and increase positive predictive values (PPVs) when a reference accelerometer is not present outside the abdominal region.

Fetal Electrocardiography

It is a method that effectively ensures the well-being of the fetus. It is a non-invasive technique that ensures minimal patient discomfort and makes the product suitable for wearable applications. An analog front-end module with optimized noise is used for non-invasive fECG monitoring. It requires a mobile, low-power, low-cost device, connected to a smartphone and capable of running computationally intensive signal processing algorithms.

Liquid Crystal Display (LCD)

An LCD (Liquid Crystal Display) screen is an electronic display module and finds a wide range of applications. The 16x2 LCD display is a very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven-segment and other multi-segment LEDs. The reasons are: LCDs are economical; easily programmable; they have no restrictions on showing special and even custom characters (as opposed to seven segments), animations and so on.

A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. On this LCD, each character is displayed in a 5x7 pixel matrix. This LCD has two registers namely Command and Data.

ADVANTAGES

ArduinoATMEGA328: Processors are easier to use, using 8-bit and 16-bit instead of 32/64-bit, which are more complex. Easy to use without additional computing components with 32k bytes of built-in self-programmable flash program memory and 23 programmable I/O lines. Efficient code, all 31 registers are directly connected to the Arithmetic Logic Unit (ALU), making it 10 times faster than conventional CISC microcontrollers. Optimized for the AVR-enhanced RISC instruction set.

ADC 0808/0809: There Conversion speed is much higher. Accuracy is also high. It has minimal temperature dependence. Excellent long-term accuracy and repeatability. Less power consumption

WORKING

ARDUINO ATMEGA328: Arduino is an open-source electronics platform based on easy-to-use hardware and software. The circuit design of Arduino based Heart rate monitor system using Heart beat Sensor is very simple. First, in order to display the heartbeat readings in bpm, we have to connect a 16×2 LCD Display to the Arduino UNO.

The 4 data pins of the LCD Module (D4, D5, D6 and D7) are connected to Pins 1, 1, 1 and 1 of the Arduino UNO. Also, a 10KΩ Potentiometer is connected to Pin 3 of LCD (contrast adjust pin). The RS and E (Pins 3 and 5) of the LCD are connected to Pins 1 and 1 of the Arduino UNO.

Next, connect the output of the Heartbeat Sensor Module to the Analog Input Pin (Pin 1) of ArduinoUpload the code to Arduino UNO and Power on the system. The Arduino asks us to place our finger in the sensor and press the switch.

Place any finger (except the Thumb) in the sensor clip and push the switch (button). Based on the data from the sensor, Arduino calculates the heart rate and displays the heartbeat in bpm.

While the sensor is collecting the data, sit down and relax and do not shake the wire as it might result in a faulty values.After the result is displayed on the LCD, if you want to perform another test, just push the rest button on the Arduino and start the procedure once again.

Liquid crystal display (LCD)

A liquid crystal display (LCD) is an electro-optical amplitude modulator implemented as a thin, flat display device composed of any number of color or monochrome pixels arranged in front of a light source or reflector. It is often used in battery-powered electronic devices because it consumes very little electrical power.

Each LCD pixel typically consists of a layer of molecules aligned between two transparent electrodes and two polarizing filters whose transmission axes are (in most cases) mutually perpendicular. Without the liquid crystals between the polarizing filters, light passing through the first filter would be blocked by the second (crossed) polarizer.

IV. IMPLEMENTATION AND RESULT

The proposed system introduces a new approach to monitor fetal heart rate with maternal parameters such as movement and heart rate. It is a comprehensive and inexpensive device for monitoring a healthy fetus. This system must be placed on the mother's abdominal wall to monitor and obtain a graphic representation**.**

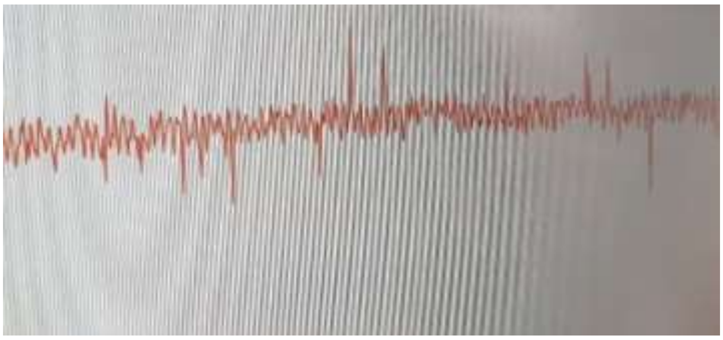

Fig 3. ECG Waveform

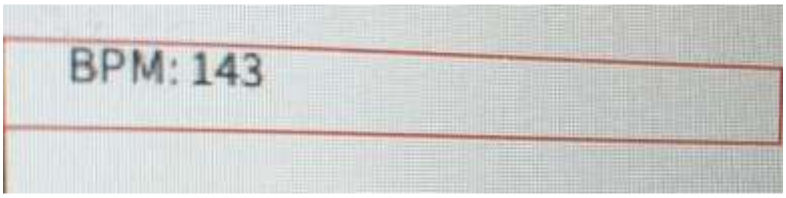

Fig 4. Heart Rate Monitoring

Depending on the analog signals sensed by the sensors, it calculates the sensed value and then interprets the result.

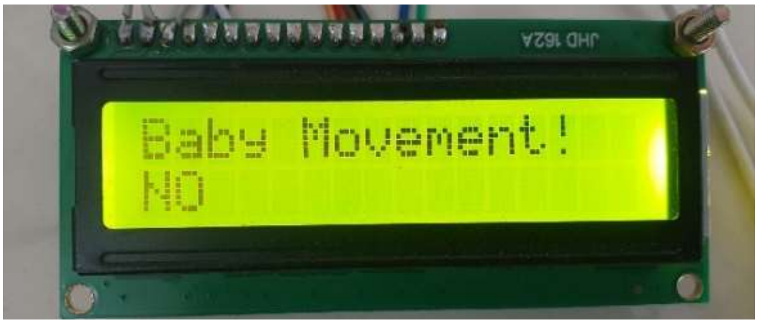

Fig 5. Movement Detection

If the fetal heart rate exceeds the normal baseline (increases or decreases) or when normally pregnant women move on the accelerometer1 sensing fetal movement capturing on the accelerometer 2 no motion detecting the accelerometer sensors 2, a yellow signal will be displayed to immediately indicate momentum via UART-based IoT and PC. The sensed information of the user is collected, processed by the arduino microcontroller and the information is stored in the cloud.

Fig 6. Fetal Monitoring System

V. CONCLUSION AND FUTURE SCOPE OF STUDY

Future work will focus on monitoring changes in the normal fetal heart rate and controlling fetal movement accordingly. Although captured by very different methods, FHR outputs were obtained wirelessly by this system through passive methods that were very similar to those obtained by the current standard of care. The limits of agreement for FHR measured by this system were within a clinically acceptable ± 8 bpm cardiotocographic FHR. This device uses passive technology that enables safe, non-invasive and convenient monitoring of patients in the clinic and remotely. Further work should explore how remote prenatal monitoring might best address some of the recent issues that have emerged in prenatal care and fetal outcomes.

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