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Wireless Fetal Heartrate Monitoring System

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ABSTRACT: In the developing country like India there has been a great deal of interest to provide greater freedom of movement to patients during labor while a patient is continuously monitored through a wireless link. This advancement in the field of biomedical engineering has given a rest to the pregnant ladies from the discomfort of visiting a hospital and waiting in long queue.

A Wireless fetal monitoring system includes a fetal sensor unit adapted to receive signals indicative of a fetal heartbeat, the sensor optionally utilizing a Doppler ultra sound sensor. The signal received from the sensor is processed and after proper filtration and amplification through instrumentation amplifier is send to a micro-controller. Now the output from the micro-controller is displayed on screen, transmitted through a wireless network or heard from a speaker. With the success of this project patient can record the fetal heart rate back in their own home and transfer the important data to the doctors through a telemetry system .

KEYWORDS: Fetal heartrate monitoring; doppler ultrasound; wirelesslink;

I. INTRODUCTION

To diagnose pre-term labor, ambulatory monitoring for abnormal FHR has proven to be an effective method. Abnormality in fetal heart rate (FHR) is an indicator of pre-maturity and miscarriage. It is very important to monitor, such abnormalities in pregnant women, which are at high risk, with history of miscarriage. These abnormalities are unpredictable and may occur at any time, especially in the case of pre-term labor. The pathogenic-sis of pre-term labor is still poorly understood, however, the unusual occurrence of pre maturity and miscarriage can be largely prevented by the timely diagnosis of pre-term labor and its arrest with tocolytic medication. If the unborn heart rate increases very high or drops to a very low, it calls for urgent attention. In both the cases, it is obvious that the baby is in stress and special urgent medical attention is needed. For this reason, the electronic monitoring of the FHR has become one of the most familiar methods used in the antenatal period. The ultrasound based Doppler instruments are widely used for this purpose in hospitals, but for varied reasons, they are not suitable for home monitoring application and long-term surveillance of unborn. It is imperative to note that these instruments are also invasive in nature. There is still a gap between existing technologies and the user requirement for safe, convenient, and reliable fetal monitoring. In view of these considerations, a strong need is felt for the development of a FHR monitoring machine which will be non invasive, cost effective, simple to operate and which can be used by a pregnant woman for prolonged home monitoring application.

Fetal heart rate monitoring is a procedure used to evaluate the well-being of the fetus by assessing the rate and rhythm of the fetal heartbeat.

During late pregnancy and labor, your health care provider may recommend monitoring the fetal heart rate and other functions. The average fetal heart rate is between 110 and 160 beats per minute, and can vary five to 25 beats per minute. The fetal heart rate may change as the fetus responds to conditions in the uterus. An abnormal fetal heart rate or pattern may indicate that the fetus is not getting enough oxygen or that there are other problems.

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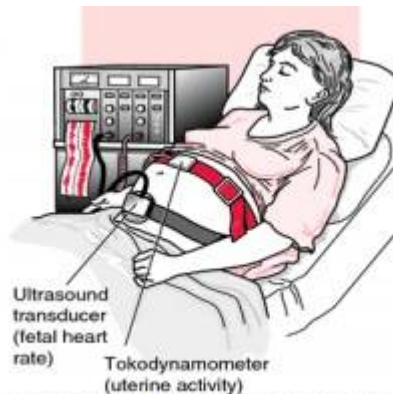


Figure 1: External Fetal Monitoring Technology

II. LITERATURE WORK & APPLICATIONS

There are two methods for fetal heart rate monitoring, external and internal.

Internal fetal heart rate monitoring uses an electronic transducer connected directly to the fetal scalp. A wire electrode is attached to the fetal scalp through the cervical opening and is connected to the monitor. This type of electrode is sometimes called a spiral or scalp electrode. Internal monitoring provides a more accurate and consistent transmission of the fetal heart rate than external monitoring because factors such as movement do not affect it. Internal monitoring may be used when external monitoring of the fetal heart rate is inadequate, or closer surveillance is needed.

External fetal heart rate monitoring uses a device to listen to or record the fetal heartbeat through the mother's abdomen. One type of monitor is a hand-held electronic Doppler ultrasound device. This method is often used during prenatal visits to count the fetal heart rate. A Doppler device may also be used to check the fetal heart rate at regular intervals during labor. Various external fetal heart rate monitoring techniques are –

- Pinard Stethoscope (Fetoscope)
- Doppler Fetal Monitor
- Microphone Fetal
- Monitor Cardiotocography (CTG)

APPLICATIONS

- It can detect early fetal distress resulting from fetal hypoxia and metabolic acidosis.
- Closer assessment of high-risk mothers.
- Detects FHR baseline
- Detects FHR rhythm
- Previous history of stillbirth

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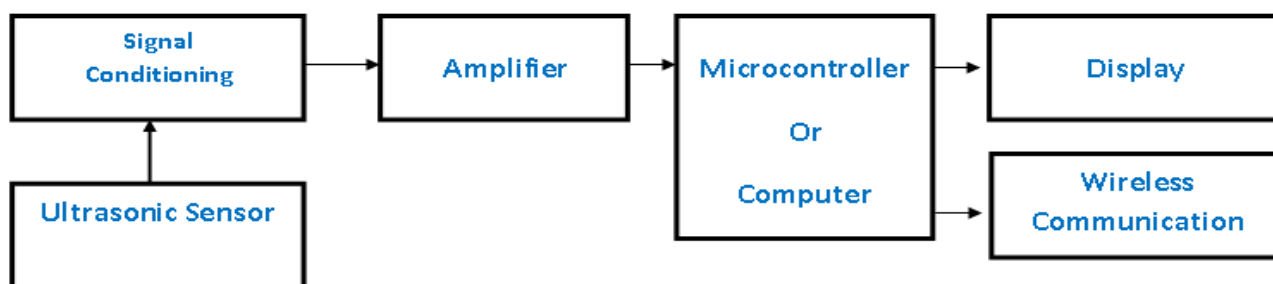
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- Complications of pregnancy
- Induction of Labor
- Preterm labor

III. BLOCK DIAGRAM & EXPLANATION



Fetal heart sound recording system is considerably susceptible to the ambient noise. The abdominal sensor records principally the sound originating from the fetal heartbeats, but this sound gets mixed with damped version of following unwanted sounds.

- Movement of measurement head during recording (shear noise).
- External noise originating from the environment (ambient noise).
- Acoustic noise produced by the fetal breathing movements.
- Maternal digestive sound (gut sound).
- Sound of maternal heart and breathing activity.

In fetal measurement, these unwanted sounds create major problem at signal processing stage. Hence advanced digital signal processing technique is required for the extraction of fetal heart sound from the acquired signals. To overcome the problems associated with the existing fetal monitoring system and their signal acquisition procedures, data acquisition system is developed specially for this purpose. This system is portable, comfortable for longer periods and having sustainable battery backup. It consists of wireless data acquisition, processing and transmission hardware along with a remote monitoring station for fetal monitoring applications. The implementation of Wireless Technology in continuous fetal monitoring provides not only the reduction of supply voltage, power consumption and memory capacity, but also increasing applications of the system, like battery backup and mobility.

The acquired fPCG signals are then transmitted to the personal computer (PC) or microcontroller. The signals are then saved in Wave format for its graphical display and subsequent processing. A monitoring obstetrician/gynecologist can also replay the recorded fPCG signal by connecting a headset to Line-out port of the PC.

IV. CONCLUSION

Fetal heart rate monitoring devices are becoming more popular day by day and they are taking place in almost every pregnancy and/or laboring procedure, especially in high risk pregnancies. A number of devices have been proposed since the beginning of the 20th century; such as the fetoscope, the fetal scalp electrode, Doppler ultrasound in addition to a few others. FHR monitoring via abdominal ECG electrodes has widespread clinical acceptance as it has the advantages of being relatively cheap, easy to handle and suitable for long term recordings with the ability for beat-to-beat variability monitoring but has complex design requirements. The use of Doppler ultrasound to monitor the FHR



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was soon proposed in the 1960's and is still being used on a daily basis till present for its low cost and simplicity although it is not suitable for continuous monitoring. Later in the same decade the first commercial CTG monitor was introduced by Hewlett Packard which has the ability to continuously monitor FHR tracings and maternal contractions simultaneously but has the disadvantages of having low accuracy and being difficult to interpret. The fetal magnetocardiography has solved the accuracy problem seen in the previous devices but is relatively expensive, has large size, complex design requirements and requires the mother to have minimal movement. Almost all of the previously mentioned drawbacks have been solved with the most recent FHR monitoring device, taking advantage of light properties, which is the photo plethysmography. This device meets all of the important criteria which are being easy to use, not overly large, having low power consumption, not using ultrasonic waves, being completely non-invasive, being safe for both the mother and the fetus and last but not least being suitable for long-term monitoring.

V. RESULTS

Normal Results: Normal values show a foetal heart rate between 120 and 160 beats per minute and are a sign that the developing baby is not in distress. The heart beat may vary 5 - 25 beats per minute from the baseline (normal) foetal heart rate.

A rise above baseline with foetal movement is a reassuring sign. The foetal heart rate may drop slightly during a contraction. This is normal as long as the foetal heart rate recovers quickly once the contraction has stopped.

Abnormal Results: Foetal heart monitoring tests can detect the following abnormal situations or conditions during pregnancy:

- Reduced blood flow to the developing baby (cord compression).
- Block of electrical signals within the heart muscle, causing an altered heart beat (foetal heart block).
- Incorrect positioning of the baby (foetal malposition).
- Too little oxygen supply to the developing baby (potential foetal hypoxia).
- Infection (monitoring cannot diagnose an infection, but can suggest the presence of an infection).
- Too little oxygen exchange between the uterus and the placenta (uterus placental insufficiency).
- Foetal distress.
- Abruption placenta

Sr. No	Patients (Weeks)	Electronic Stethoscope (BPM)	Prototype of Wireless Fetal Heart Rate Monitor (BPM)
1	33	150	150
2	22	0	0
3	27	0	0
4	32	150	144
5	34	157	162
6	34	142	162
7	20	0	0
8	32	142	144
9	13	0	0
10	38	150	0



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Fig: Comparison between Electronic Stethoscope and Prototype of Wireless Fetal HeartRate Monitor

Fetal Age/Size of the Fetus	Normal Fetal Heart Rate (BPM)
2mm embryo and gestational sac diameter of 20mm	75
5mm embryo and gestational sac diameter of 30mm	100
10mm embryo	120
15mm embryo	130
5weeks(beginning)	80-85
5weeks	Starts at 80 and ends at 103
6weeks	Starts at 103 and ends at 126
7weeks	Starts at 126 and ends at 149
8weeks	Starts at 149 and ends at 172
9weeks	155-195(average 175)
12weeks	120-180(average 150)
After 12weeks	120-160(average 140)

Fig: Normal Fetal Heartrate Chart

VI. FUTURE WORK

As future scope, it can be extended in the following directions

- By early measurement of autonomic nervous system activity during gestation period and fetal heart rate variability diagnostics indices relative features, it may be possible to make advanced preventive treatments to overcome the future health problem of child after birth
- The effects of mother health problems, their related food and cultural habits on child's growth can be considered for further statistical findings.
- The effect of mother nervous system parameters can be related to development of fetus. Further we can study magnetic resonance image (MRI) of mother's brain. If pressure changes in brain are not proper it can affect fetal nervous system development. Fetal development can be further studied and related with mother's brain defects by using MRI techniques.
- In Indian culture, pregnant women have been restricted to go out during certain days in the month, especially during solar eclipse and no moon day. Reason behind this is that electromagnetic forces have been found to change their strength in these days. The effect of these forces on child growth, fetal nervous system and fetal HRV on these days can be studied in the future.



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