Sensorized System for Assistance during Childbirth

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Abstract: The fact that every 90 seconds, somewhere in the world, a woman dies during pregnancy or childbirth is simply unacceptable. What is even more shocking is that most of these deaths are preventable if appropriate care is available. The death of a mother is not only the end of a life; instead, it is most often the beginning of a dark and difficult future for the whole family and the aftershocks affect the community at large. Children, particularly in developing countries, who lose their mothers early on are less likely to be productive members of society, are likely to be malnourished, and face lifelong social and economic challenges. India loses 2.5 times more women in rural areas or from lowest economic bracket, in the name of maternal mortality. Most childbirth complications require appropriate devices and a high degree of medical expertise by the overlooking specialist, midwife etc. For the purpose of detecting the birthing child, the most significant statistics are the fetal heart rate and intra-uterine pressure during the delivery. The acceptable fetal heart rate (FHR) ranges from 120 – 160 beats per minute (bpm)[4] and the normal intra-uterine pressure (IUP) during contractions is around 40 mmHg. The system measures these parameter and if it is not in range an alert is set off. The proposed system has been designed keeping in mind the high fetal mortality rates in rural, underdeveloped or remote areas.

IndexTerms **- Fetal heart rate, uterine contraction, Intra-Uterine pressure, maternal mortality, Childbirth**

I.INTRODUCTION

During the pregnancy antenatal care helps mother for a smooth delivery. In this the fetal heart rate monitoring has been a primary method to assess the health status of the fetus. Abnormal FHR may lead to dangerous situation. It is very important to monitor for such abnormalities in pregnant women at high risk for prematurity and miscarriage. Another parameter, Intrauterine Pressure is very essential to measure during labor to monitor uterine contractions.

Various technologies are used for the monitoring and position detection of the fetus such as Doppler ultrasonic monitoring, phonocardiography, sonography. These methods are passive and non-invasive in nature. An important factor under consideration while monitoring is to ensure that the detection and monitoring technology does not cause any harm either to the mother or fetus.

The proposed system consists of pressure and sound sensors for the purpose of gauging the movements of the enclosed fetus. The sensed input shall convert the received analog impulses into a set of digital values for better computation. The digital values so obtained can be given to the LCD, and further used to plot a graphical representation of the observed inputs. By using the appropriate plotting technique and correct software, the proposed detection can be achieved with a great deal of accuracy. The most crucial part of the proposed setup lies in the detection of the heartbeat of the fetus in the form of a low-frequency signal. In this sense, treating the signal as infrasound to detect it seems both simple and effective. The idea shall be aimed at reducing the complexity of the system while maintaining an affordable price.

II. EASE OF USE

Convenience for layman users

The proposed system is designed to be a handheld device. Mobility and portability of the device shall be maintained. The proposed device has been designed, keeping in mind its use in rural, remote and underdeveloped areas. As the device shall be used by paramedic personnel and midwives, convenience and user-friendly attribute of the device is maintained throughout

III. TOOLS AND EXTENSION

Pinard horn or stethoscope is a simple, trumpet shaped device that can be considered as the first fetal heartrate sensing tool. The horn, now also called as the fetoscope, was developed in 1895, by the French obstetrician, to elegantly and effectively detect the heartrate of in utero babies. The effectiveness of the device lies in its simplicity of design and make. The horn is most commonly made of material like aluminum, wood and plastic. In the system being developed, the use of the Pinard horn s proposed for the purpose of improved heartrate detection and better avoidance of external interference. The Doppler fetal heartrate monitor utilizes the Doppler technology and is widely popular among medical circles in developed nations. The device is comprehensive with its main components being a simple probe and a handy processing unit.

However, the main disadvantage of the Doppler monitor lies in its high device cost, especially for more accurate versions. As an extension to the current system, the Doppler monitor can be used for detection and further processing can be continued with the existing hardware of the system

IV. EQUATIONS

The conversion of beats per minute (BPM) to hertz (Hz) is performed as follows:

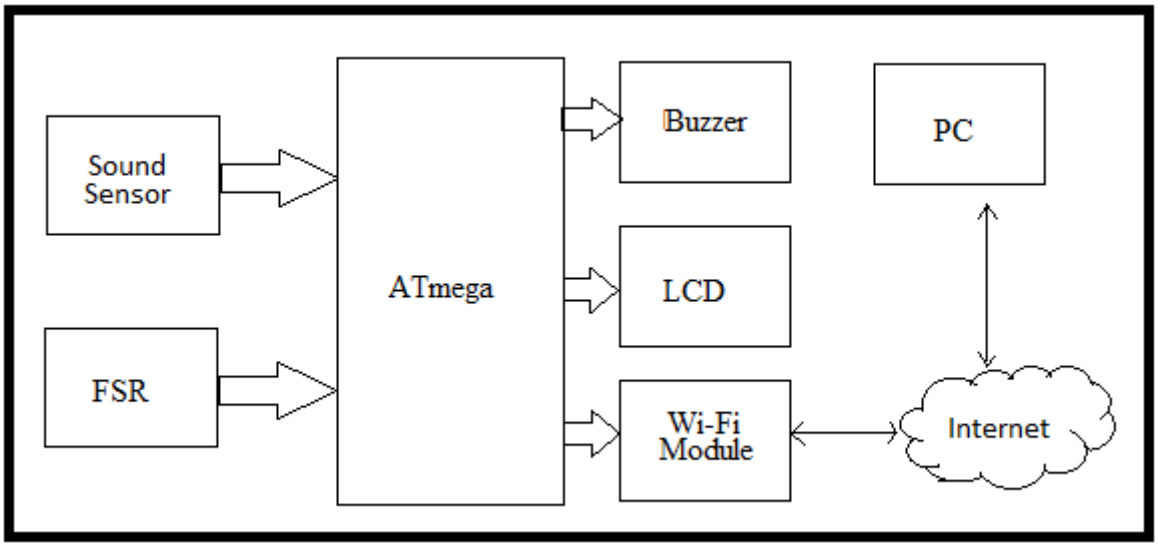
Value in Hz = Value in BPM/60

Fetal Heart Rate (in beats/minute)	Miscarriage Rate (percentage)
<70	100
70-79	91
80-90	79
Under 90 BPM	86

Table-1 Percentagewise likelihood of miscarriage with respect to Fetal heart rate

V. SYSTEM DESCRIPTION

The main components of the proposed system include a sensor panel, attached to a controller, an alarm alerting system and a display unit. A Wi-Fi module can be attached to the controller for transmitting the received data to a distant device for remote monitoring.



`Fig1. Block diagram of system

The sensor panel is essentially composed of sensors for FHR and IUP detection. For the purpose of FHR detection, a sound sensing module is used. The module is capable of detecting the presence of sound along with the ability to measure the intensity of the sounds detected. The module works on the range of 3.3 – 5 V and converts this into a compatible signal for the microcontroller. The single chip module detects sound intensity present in the environment, in high and low level. For the purpose of intra uterine pressure (IUP) detection, the force sensing resistor (FSR) shall be deployed. The FSR is a special type of resistor that gives a variable resistance when force or pressure is applied. The FSR is a combination of a resistor and sensing technology. The FSR outputs are more stable than the commonly used piezoelectric sensor and hence proposed to be used in the current system.

The controller deployed here is the ATmega328. This is an Alf and Vagard's RISC (AVR) f8-bit microcontroller, which has 28 pin-outs. The ATmega328 also supports serial communication and uses SPI Protocol for communication. In the proposed system, the controller shall be converting the measured fetal heart rate (FHR) from hertz (Hz) to beats per minutes (BPM). The controller shall be collecting the sensed data, processing the same and setting-off the alarm, for the purpose of alerting the available personnel in case the detected parameters are outside permissible range. A 16X2 LCD is used to display the measured value of FHR and IUP to the personnel present with the patient. The permissible range for parameters, as directed by consulted doctors is FHR: 120-140 BPM and IUP: 30-50 mm of Hg (millimeter of mercury). A buzzer alarm has been provided to inform a breach in the permissible parameter ranges.

A Wi-Fi module shall be added to the above assembly for distant transmission of the collected patient stats. This will fulfill the proposed purpose of remote monitoring and guidance, especially in challenging cases.

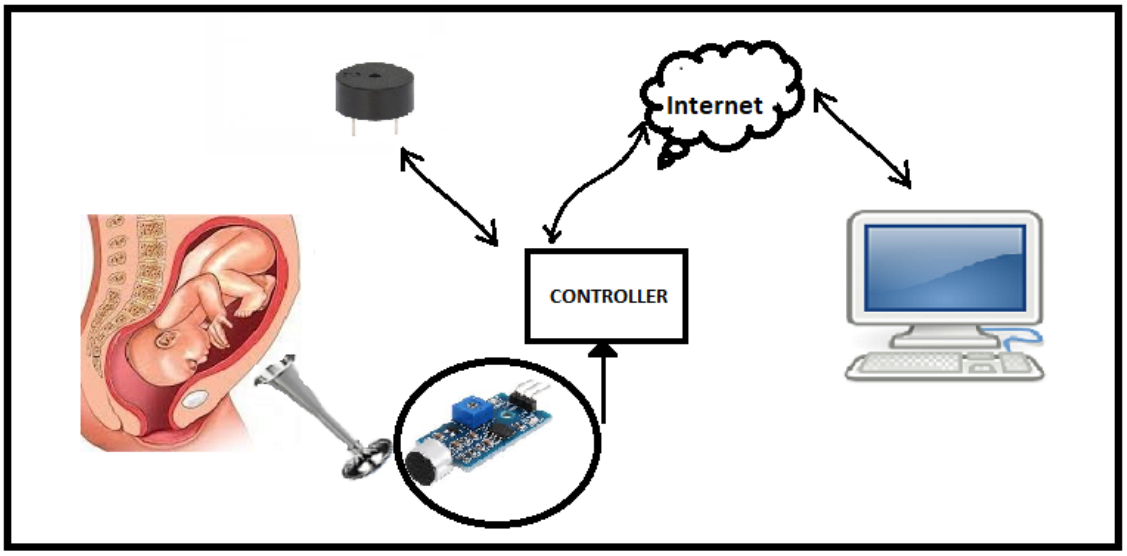


Fig2. System architecture

VI. EXPECTED RESULTS

Through the proposed system, it is aimed to accurately sense and detect the FHR and IUP. The system at its full scope is expected to transmit the detected data to a distant location for analysis by a medical expert.

The system is also expected to set-off an alarm as an alert to the personnel or relative present with the patient or the sensing location.

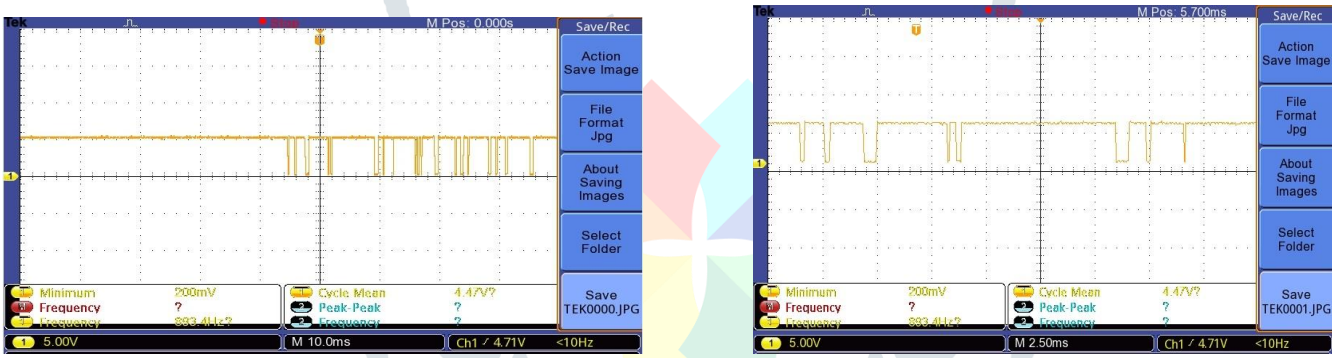


Fig3. Pulsed output received on sensing FHR on DSO

VII. CONCLUSION

Through the proposed system, an effort towards better monitoring and guidance during childbirth is expected to be achieved. It is hopeful that the system shall bring a real; change in the daunting maternal mortality rates currently rampant. The proposed system is expected to assist in improving the quality of mother and child healthcare, and life at large.

VIII. ACKNOWLEDGEMENT

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