IoT Based Health Care Monitoring System for Rural Pregnant Women

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ABSTRACT

Human resources is the foundation of developing and under developed nations. Almost all maternal deaths (99%) occur in developing countries. Everyday 830 women die due to pregnancy. In the majority of the developing countries and in the smart cities medical systems is not centralized for sharing of information. Most part of the pregnant ladies may not be able to do their customary checkups at the beginning time of pregnancy and this prompts higher death rate in case of infant and maternal in the rural areas. Due to these issues, the society is facing an immense medical issues. In the existing strategy ultrasound sweep of the pregnant ladies is performed and along with that some fundamental signs are estimated and it is handled by Bluetooth innovation. The disadvantage of the existing framework is that the ultrasound scan is costly and the Bluetooth innovation. In order to overcome this, in the proposed work Accelerometer sensor is made wireless and it is mainly used to measure the movement of the fetus and some vital parameters such as the temperature, heart rate and blood pressure for the women are measured by using different sensors. The measured parameters are transferred through IoT and it is viewed in the mobile phone. The proposed work concerns in developing a compact assist device for rural pregnant women in order to access the vital signs of maternal and fetus with low cost using recent sensors and internet of things for personalized care.

Keywords: Temperature sensor, Heart rate sensor, Accelerometer sensor, blood pressure sensor, Arduino board, Internet of things.

1. INTRODUCTION

Every day approximately 830 women die from pregnancy and childbirth. It was estimated...
roughly that 303,000 women died during pregnancy and childbirth. Almost all of these deaths occurred in low-resource settings, and most could have been prevented. Almost all maternal deaths (99%) occur in developing countries. Women die as a result of complications throughout pregnancy and childbirth. Most of those complications develop throughout pregnancy and it is treatable. Different complications could exist before pregnancy but they are worsened throughout pregnancy, particularly if not managed as part of the woman’s care. The major complications that account for nearly 75% of all maternal deaths are due to severe bleeding, infections, complications from delivery etc. Other factors that prevent women from receiving or seeking care during pregnancy and childbirth are Poverty, distance, lack of information, inadequate services, cultural practices. Therefore necessary efforts should start right from providing timely and quality health assistance to pregnant ladies which will lead to the birth of healthy children.

For instances, pregnant women should perform ultrasound scan at least two times during pregnancy period to know about the fetal growth. Moreover, proper and timely checkups will ensure safe delivery. Women in the rural areas lack knowledge about importance of proper medication. Though India has made an appreciable progress in improving the overall health status of its population but it is far from satisfaction. Awareness and access to a health care center, equipped with modern maternity facilities has a significant positive impact on the health seeking behavior and pregnancy outcome of rural women. Lack of knowledge leads to high mortality among the women living in the rural areas. Also they suffer from various health issues such as anemia, weakness and vomiting. Ultrasound scanning method is mainly to check the growth of the baby in mother’s womb. By using this ultrasound scanning method we can detect many problems such as development anomalies, chances for miscarriage, confirming a pregnancy, multiple pregnancies etc. Since the Ultrasound scanning method very expensive and there are objections for its long-term usage. The side effects of long-term ultrasonic exposure on the fetal are not completely clear and it is the reason that this method is not recommended for long hours monitoring. Hence, we use latest sensors which will not harm both the fetus and the maternal.

2. METHODS

2.1. HARDWARE SETUP

In the hardware setup different types of sensors have been used to measure the vital parameters such as temperature, heart rate, blood pressure for the maternal and the movement of the fetus. Sensors are attached in the system thus it helps to take reading and it is displayed. IoT is increasingly allowing to integrate devices capable of connecting to the Internet and provide information on the state of health of patients and provide information in real time to doctors who assist it. The following sensors are used they are

2.1.1 ACCELEROMETER SENSOR

One of the foremost common mechanical phenomenon detectors is that the measuring instrument sensor. Accelerometers are available that can measure acceleration in one, two or three orthogonal axis. The movements of the fetus is mainly due to the vascular state of the placental insufficiency in the uterus. These movements is known as “kicking”. From the fourth month onwards the baby will start kicking but it will not observed by the mother. By measuring the fetal movement, the clinicians will be able to predict the condition and development of the fetal.

Fetal movement is monitored by ultrasound scan but this is expensive, so accelerometer sensor is used. The ADXL335 is a small, thin and low power sensor, it have 3-axis with signal conditioned voltage outputs. It will measure the acceleration with a minimum full-scale range of ±3 g. Accelerometer sensor have three voltage output pins namely XOUT, YOUT, and ZOUT. Bandwidths can be selected to suit the application, with a range of 0.5 Hz to 1600 Hz for the X and Y axes, and a range of 0.5 Hz to 550 Hz for the Z axis. The ADXL335 is available in a small, low profile, 16-lead, plastic lead frame chip scale package.

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Fig.1. Sensor placed on the mother abdominal wall

Accelerometer sensor is designed wireless and the fetal movement is measured. By using RF modules transmitter and receiver the output from the accelerometer sensor is transmitted to the arduino controller.

The table represents the kick count of the fetus as normal or abnormal. The fetal count starts from the fourth month, but it is not observed by the mother. The movement of the fetus will be observed by mother only in the fifth month. If the reduced fetal movement is less than ten times in 12 hours it is considered as an important manifestation of fetal hypoxia. So immediate measures should be taken in order to avoid these issues.

**Table 1. Measurement of Fetal Movement**

<table>
<thead>
<tr>
<th>Duration Hours</th>
<th>No of fetal movement Normal</th>
<th>No of fetal movement Abnormal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 hours</td>
<td>3 or more</td>
<td>2 or fewer</td>
</tr>
<tr>
<td>2 hours</td>
<td>6 or more</td>
<td>Less than 6</td>
</tr>
<tr>
<td>12 hours</td>
<td>Greater than 10</td>
<td>Less than 10</td>
</tr>
</tbody>
</table>

**2.1.2. Temperature Sensor:**

Temperature sensor are mainly used to measure the body temperature of the maternal. It can measure temperature more accurately than a using a thermistor. It is common for a woman’s body temperature to change during pregnancy. During pregnancy the woman's body generates additional heat due to increased metabolism. Elevated levels of hormones such as progesterone, increased workload on the woman’s body, a result of extra weight as the pregnancy progresses as well as the processing and fetal nutrients and waste products. Simultaneously the woman has increased peripheral circulation which leads to dissipation of heat from the body. LM35 sensor operates from 4 to 30 volts. It covers the range from -55°C to +150°C.

**2.1.3. Heart Rate Sensor**

The heart rate measure kit can be used to monitor heart rate of maternal. The result can be displayed on a screen via the serial port. It is designed to give digital output of heart beat when a finger is placed on it. Operating voltage is +5V regulated and the operating current 100mA. The entire system is a high sensitivity, low power consumption and portable.

**2.1.4. Blood Pressure Sensor**

Blood pressure is a major concern for any human being. For a pregnant woman the blood pressure will keep varying slightly throughout the 10 months. This is what makes them feel dizzy during the pregnancy period. Monitoring Blood pressure is very important as the variation in blood pressure can affect the baby’s supply of oxygen and nutrients. High blood pressure during pregnancy doesn’t usually lead to serious problems. However, if it goes untreated, hypertension can become life-threatening for both mother and baby.

If high blood pressure continues after 20 weeks of pregnancy, there can be complications. Preeclampsia can develop. This condition can cause...
serious damage to your organs, including your brain and kidneys. Preeclampsia is also known as toxemia or pregnancy-induced hypertension. So it is very much important to detect the blood pressure for the maternal.

2.2. INTERNET OF THINGS

The Internet of Things (IoT) is an ecosystem connected of physical devices that are accessible through the internet. The IoT allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit. The concept Internet of Things (IoT), each device can be connected to the internet or intranet, or to other devices on the network. This enables the collection of a variety of information from the devices, including data on operations, configuration, energy consumption, and the power factor. The IoT enables devices to make smart decisions based upon analytical rules that serve the purpose of the devices best. The devices can send, receive, store, and control information, sending the information individually to another device or broadcasting it to all devices.

2.3. SYSTEM DESCRIPTION

In this methodology the temperature sensor, heart rate sensor, accelerometer sensor and blood pressure sensor are controlled by using an Arduino controller. The data from the sensors are being analyzed by this controller and the results are being simulated. IoT refers to the inter networking of physical devices. IoT will transfer data over a network without requiring human-to-human or human-to-computer interaction. IoT used in this technology will be able to transfer the data for long distance.

The Arduino UNO is a microcontroller board based on the ATmega328. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz crystal oscillator, a USB, a power jack, an ICSP header, and a reset button. Since the value sensed from the sensor is in analog form, it can be directly connected to the analog input pin. ADC in this Arduino microcontroller will convert to digital signal before any further process can be done. The Arduino will process the signal and the output will be in digital signal voltage form.

3. RESULTS

The hardware setup is designed and the parameters such as the temperature, pressure and heartbeat is measured using different sensors. In addition to this accelerometer sensor is placed along with the three axis for the measurement of the kick count of the fetus. The parameters are measured and transferred to the mobile phone through IoT and the results obtained from the different sensors are discussed in this chapter.
Fig 3: Hardware Setup of Accelerometer Sensor

The above Fig 3: shows the hardware setup of Accelerometer sensor. The three axis X,Y,Z in the accelerometer sensor shows the tilt of the fetus when the sensor is placed in the mother abdominal wall.

Fig 4: Hardware Setup of IoT Based Health Care Monitoring System

The above Fig 4: shows the hardware setup of IoT based Health Care Monitoring System for Rural Pregnant Women. It is designed to give digital output of heart beat of the maternal when a finger is placed on it. The temperature of the maternal can also be measured by placing a finger on it. The blood pressure of the maternal is measured by placing the cuff over the arm.

Fig 5: Displayed Output of Accelerometer Sensor

Fig 5: shows the displayed output of accelerometer sensor with the measured values of the three axis. The values in the accelerometer sensor vary according to the movement of the fetus. Accelerometer sensor is designed wireless and the fetal movement is measured. By using RF modules transmitter and receiver the output from the accelerometer sensor is transmitted to the arduino controller.

Fig 6: Displayed Output for the Parameters Measured

Fig 6 shows the Displayed Output for the measured parameters obtained from different sensors. This hardware setup displays the output for the parameters measured such as the temperature,
pressure heart beat and along with the three axis in the accelerometer sensor using IoT based healthcare monitoring system.

![IoT based Remote Health Care System](image-url)

**Fig 7: Displayed output of IoT**

Fig 7: shows the displayed output i.e. viewed through the mobile application through IoT by transferring the measured parameters. By using this approach the pregnant women and disabled patients in rural areas will be able to do their regular check-ups on the daily basis.

4. CONCLUSION

Most studies of maternal mortality are hospital based. However, in developing and underdeveloped countries, most of the maternal deaths take place at home. In order to reduce these complications, a compact assistive device is designed and the vital parameters such as the temperature, pressure for women and heart rate of the fetus is measured by using different sensors. The device is lightweight and highly sensitive even for small movements, thus preferred as a home monitoring device. Regular monitoring of the vital parameters of fetus and women in rural areas reduces infant mortality. The measured parameters are transferred through the IoT. It provides quality and timely health assistance for both fetus and women. The results are viewed in the mobile phone through the IoT.

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