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Smart Fetal Health Monitoring System

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***Abstract*—Human resource 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 most of the developing countries and in the smart cities medical systems are 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 prompt higher death rate in case of infant and maternal in the rural areas. Due to these issues, the society is facing 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. 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 to access the vital signs of maternal and fetus with low cost using recent sensors and internet of things for personalized care.**

***Index Terms*— Accelerometer sensor, Heart beat sensor, Blood pressure sensor, Bluetooth, IoT.**

I. 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 these deaths occurred in low-resource settings, and most could have been prevented. Almost all maternal deaths (99%) occur in developing countries. Women die because 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

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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.

II. System Deign

A. Existing System

A normal pregnancy lasts nine months. Each three-month period of pregnancy is called a trimester. During each trimester, the fetus grows and develops. There are specific prenatal tests to monitor both the mother's health and fetal health during each trimester. With modern technology, health professionals can detect birth defects, identify problems that may affect childbirth and correct some kinds of fetal problems before the baby is born. Biophysical tests are conducted using ultrasound. Ultrasound is done every trimester, so it is enough if the patient visits the hospital every trimester that is once in three months. Other than that, it is mandatory for the patient to go for a monthly health checkup which includes checking up of respiration rate, heart rate and ECG of both mother and fetus.Although ultrasound imaging is generally considered safe when used prudently by appropriately trained health care providers, ultrasound energy has the potential to produce biological effects on the body. Ultrasound waves can heat the tissues slightly. In some cases, it can also produce small pockets of gas in body fluids or tissues (cavitation). The long-term consequences of these effects are still unknown.

B. Proposed System

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 displayed on the LCD display and 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 to access the vital signs of maternal and fetus with low cost using recent sensors and internet of things for personalized care.

C. Block Diagram

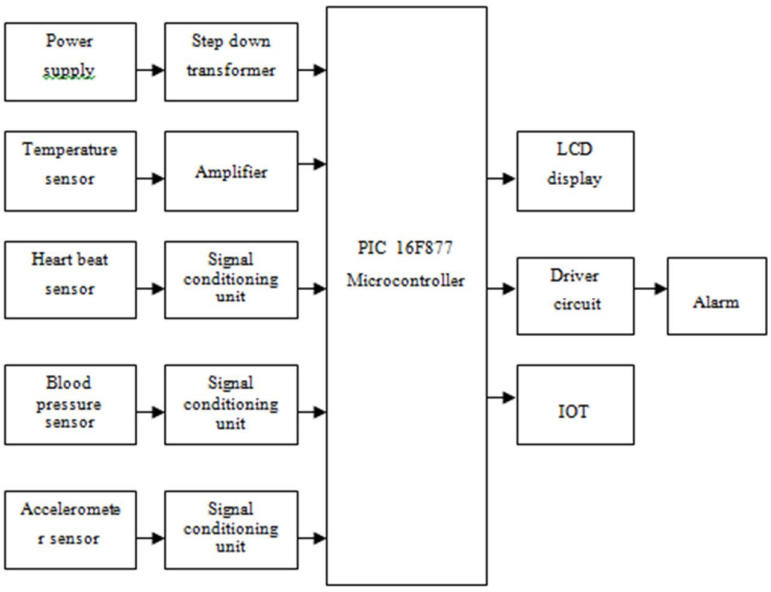


Figure. 1. Block Diagram

D. Microcontrollers

A microcontroller is a complete microprocessor system built on a single IC. Microcontrollers were developed to meet a need for microprocessors to be put into low cost products. Building a complete microprocessor system on a single chip substantially reduces the cost of building simple products, which use the microprocessor's power to implement their function, because the microprocessor is a natural way to implement many products. This means the idea of using a microprocessor for low cost products comes up often. But the typical 8-bit microprocessor-based system, such as one using a Z80 and 8085 is expensive. Both 8085 and Z80 system need some additional circuits to make a microprocessor system. Each part carries costs of money. Even though a product design may require only very simple system, the parts needed to make this system as a low-cost product.To solve this problem microprocessor system is implemented with a single chip microcontroller. This could be called microcomputer, as all the major parts are in the IC. Most frequently they are called microcontroller because they are used, they are used to perform control functions. The microcontroller contains full implementation of a standard MICROPROCESSOR, ROM, RAM, I/0, CLOCK, TIMERS, and SERIAL PORTS. Microcontroller also called "system on a chip" or "single chip microprocessor system" or "computer on a chip".

A microcontroller is a Computer-On-A-Chip, or, if you prefer, a single-chip computer. Micro suggests that the device is small, and controller tells you that the device' might be used to control objects, processes, or events. Another term to describe a microcontroller is embedded controller, because the microcontroller and its support circuits are often built into, or embedded in, the devices they control.Today microcontrollers are very commonly used in wide variety of intelligent products. For example, most personal computers keyboards and implemented with a microcontroller. It replaces Scanning, Debounce, Matrix Decoding, and Serial transmission circuits. Many low-cost products, such as Toys, Electric Drills, Microwave Ovens, VCR and a host of other consumer and industrial products are based on microcontrollers.

The microcontroller that has been used for this project is from PIC series. PIC microcontroller is the first RISC based microcontroller fabricated in CMOS (complementary metal oxide semiconductor) that uses separate bus for instruction and data allowing simultaneous access of program and data memory.The main advantage of CMOS and RISC combination is low power consumption resulting in a very small chip size with a small pin count. The main advantage of CMOS is that it has immunity to noise than other fabrication techniques.Various microcontrollers offer different kinds of memories. EEPROM, EPROM, FLASH etc. are some of the memories of which FLASH is the most recently developed. Technology that is used in pic16F877 is flash technology, so that data is retained even when the power is switched off. Easy Programming and Erasing are other features of PIC 16F877.

E. Hear Rate Sensors

Heart rate is a term used to describe the frequency of the cardiac cycle. It is considered one of the four vital signs. Usually it is calculated as the number of contractions (heart beats) of the heart in one minute and expressed as “beats per minute” (bpm). See “Heart” for information on embryofetal heart rates. The heart beats up to 120 times per minute in childhood. When resting, the adult human heart beats at about 70 bpm (males) and 75 bpm (females), but this rate varies among people. However, the reference range is normally between 60 bpm (if less termed bradycardia) and 100 bpm (if greater, termed tachycardia). Resting heart rates can be significantly lower in athletes. The infant/neonatal rate of heartbeat is around 130-150 bpm, the toddlers about 100–130 bpm, the older child’s about 90–110 bpm, and the adolescents about 80–100 bpm.

The pulse is the most straightforward way of measuring the heart rate, but it can be deceptive when some heart beats do not have much cardiac output. In these cases (as happens in some arrhythmias), the heart rate may be considerably higher than the pulse rate.The main purpose of heart beat sensor is to measure the range of heartbeat level from human being. The heart beat sensor provides a simple way to study the heart’s function. This sensor monitors the flow of blood through ear lobe. As the heart forces blood through the blood vessels in the earlobe, the amount of blood in the ear changes with time. The clip can be used on a fingertip or on the web of skin between the thumb and index finger. The signal is amplified, inverted and filtered in the box. By graphing this signal, the heart rate can be determined, and ranges can be viewed on LCD.

F. Blood Pressure Sensors

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.Pressure sensor is the basis of electronic pressure measurement systems. This is used to measure the pressure level of human.Most methods are based on the measurement of a force. In other words, the physical variable pressure must be converted into an electrically quantifiable variable. Unlike mechanical pressure measuring methods, this conversion requires an external power source for the pressure sensor.

G. Accelerometer Sensors

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 axes. The movements of the fetus are mainly due to the vascular state of the placental insufficiency in the uterus. These movements are known as “kicking”. From the fourth month onwards, the baby will start kicking but it will not be 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 has 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.

H. Temperature Sensors

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.A thermistor is a type of resistor used to measure temperature changes, relying on the change in its resistance with changing temperature. Thermistor is a combination of the words thermal and resistor. LM35 sensor operates from 4 to 30 volts. It covers the range from -55ºC to +150ºC. If we assume that the relationship between resistance and temperature is linear (i.e. we make a first-order approximation), then we can say that:

$$\Delta R = k\Delta T$$

Where

ΔR = change in resistance

ΔT = change in temperature

k = first-order temperature coefficient of resistance

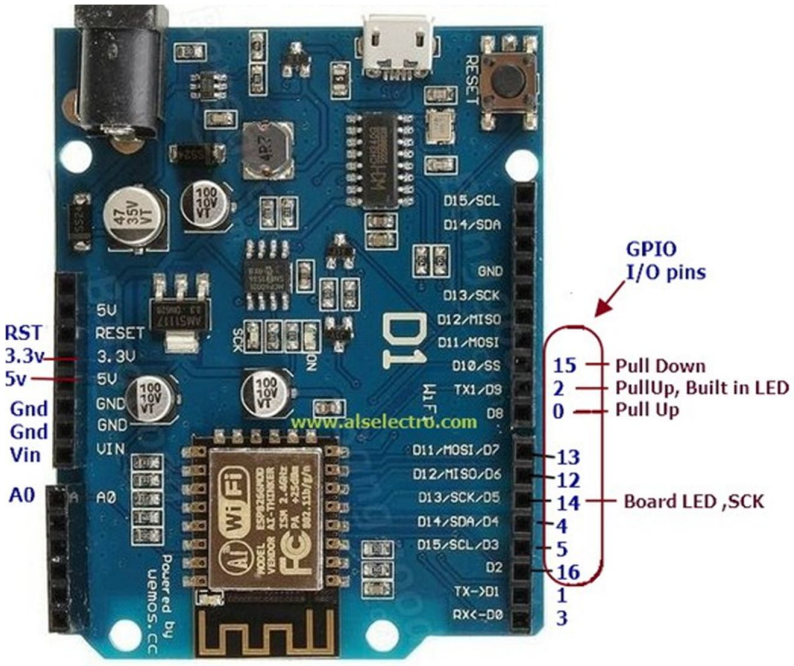
Thermistors can be classified into two types depending on the sign of k. If k is positive, the resistance increases with increasing temperature, and the device is called a positive temperature coefficient (PTC) thermistor, Posistor.

I. IoT Board

WEMOS D1 is a WIFI development board based on ESP8266 12E. The functioning is like that of NODEMCU, except that the hardware is built resembling Arduino UNO. The D1 board can be configured to work on Arduino environment using BOARDS MANAGER.So, it is not necessary to use a separate Arduino board, the D1 itself can be programmed on Arduino IDE. This is handy in using with IOT projects. Further many Arduino SHIELDs are compatible with the D1 board. Different versions of D1 boards are available in the market R1, R2, MINI. As the name implies D1 Mini is a smaller version.R1, R2 boards look like Arduino UNO board, but version is not printed on board. On some boards WEMOS D1 is printed, as the ESP12 chip is manufactured by WEMOS. In some other boards it is printed just D1, where the ESP12 chip is that of AI Thinker. As the ESP12 chip has only one ANALOG pin, on board there is only A0 & other analog pins are dummy.

III. Result and Implementation

The hardware setup is designed and the parameters such as the temperature, pressure and heartbeat are measured using different sensors. In addition to this accelerometer sensor is placed along with the three axes 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. If the temperature value increases from the normal value there will be an indication of “HIGH TEMPERATURE”. If the pressure value decreases or increase s from normal value there will be an indication of “LOW PRESSURE” and “HIGH PRESSURE” respectively. If the heart beat value increases from normal value there will be an indication of “ABNORMAL HEART BEAT”. If there is abnormal condition in accelerometer it will indicate “ABNORMAL POSITION”. Furthermore, all the abnormal conditions will be shown in mobile through IoT.

Figure 3. Output on LCD Display

IV. Conclusion And Future Enhancement

Most studies of maternal mortality are hospital based. However, in developing and under developed countries, most of the maternal deaths take place at home. 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 the rural areas, reduces the 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

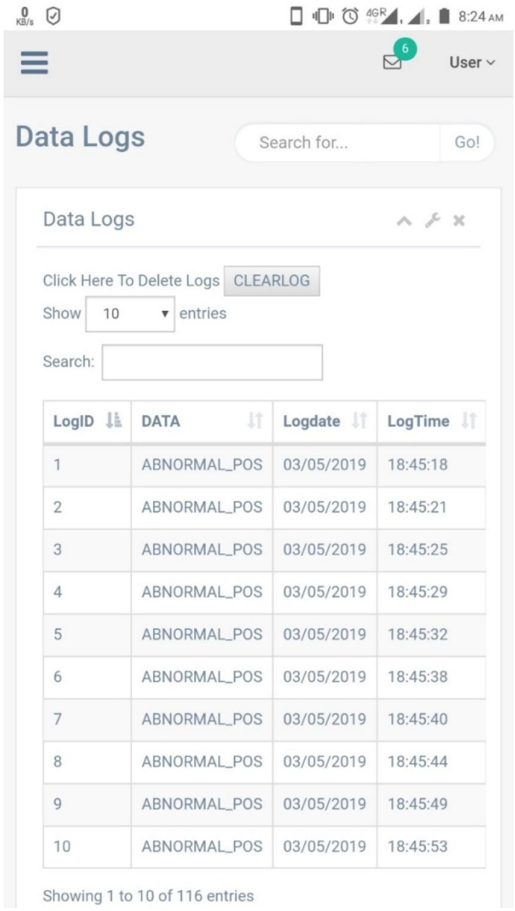


Figure 4. Output Displayed in Mobile phone

through the IoT. In future enhancement this project can be implemented in more places because, it requires low power, low cost and reduces the personal effort.

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