Real-time telemonitoring system for Pregnant Women using IoT

Dr.K.G.Revathi [1], Evangeline Jothi.W[2], Sonali.T[3], Thanusavarthini.A[4],
[1] *Professor, Department of ECE, DMI College of Engineering, Tamilnadu 600123*
[2,3,4] *UG Students, Department of ECE, DMI College of Engineering, Tamilnadu 600123*

Abstract **- Human resources is the backbone of developing and underdeveloped nations. In most of the developing countries and in the smart cities medical systems is not centralized for sharing of information. Mostly pregnant women are not able to do their regular checkups at the early stage of pregnancy and this leads to higher mortality rate in case of infant and maternal in the rural areas. Due to these issues, the society is facing an immense health problem. In the existing method ultrasound scan of the pregnant women is performed and along with that some vital signs are measured, and it is processed by Bluetooth technology. The main drawback of the existing system is that the ultrasound scanning is expensive and the Bluetooth technology. In order to overcome this an accelerometer sensor is used to measure the kick count of the fetus and the vital parameters such as temperature and heartbeat is measured and the aim is to develop 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.**

Index Terms **- Accelerometer sensor, Force sensor, IOT Microcontroller, Pulse rate sensor, Temperature sensor.**

INTRODUCTION

Maternal mortality rate is high because of no proper routine check-ups. Pregnancy is the time duration where one or more offspring develops inside a woman. A pregnancy may end in a live 2birth, abortion or miscarriage, though access to safe abortion cares varies globally. Childbirth typically occurs around 40 weeks from the start of the last menstrual period (LMP). This is just over nine months, where each month averages 31 days. When measured from fertilization it is about 38 weeks. An embryo is the developing offspring during the first eight weeks following fertilization after which the term foetus is used until birth. During the first trimester, the possibility of miscarriage is at its highest around the middle of the second trimester, movement of the foetus may be felt. Prenatal care improves pregnancy outcomes. Prenatal care may include taking extra folic acid, avoiding drugs and alcohol.

Regular exercise, blood tests and regular physical examinations, Complication of gestational diabetes, iron deficiency anaemia, and severe nausea and vomiting among others. In the ideal childbirth labor begins on its own when a woman is "at term". Prenatal care may also include the knowledge about the foetus growth and development. Poor prenatal care results in foetal death which lead to maternal mortality for women aged 15-49 years accounted for 36.4%of total female mortality; 28.2% inurban areas and 38.4% in rural areas. About 50% of the maternal deaths for women aged 15-29 years in rural areas were due to pregnancy complications and childbirth. Prolonged and obstructed labor ranks high among the most common causes of maternal deaths. About 99% of these deaths occur in low- and middle-income countries like India where 44,000 women die due to preventable pregnancy-related causes. In order to overcome these issues real time monitoring of the foetus is necessary, it can be obtained with the help of this device which consist of sensors like temperature sensor, pulse rate sensor, accelerometer sensor, sweat sensor and force sensor. These sensors are used to measure the vital parameters like temperature, heart rate and movement of the foetus along with the symptoms of labor pain. The measured parameters are stored in cloud using IoT (Internet of Things), the stored data is easily accessible by the patient as well as the doctor from any part of the world using the cloud address this will also be useful to check the previous data. GSM (Global System for Mobile communication) module is used to send alert indication in case of any emergency.

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.

related work

Health Monitoring Laboratories by Interfacing Physiological Sensors to Mobile Android Devices: SuhasRanganath-Mahesh.K,

This paper describes, Android Java-DSP (AJDSP) as a mobile application that interfaces with sensors and enables simulation. This also helped in visualization of signal processing. In this system firstly there is creation of interface between both external sensors and on-board device sensors for monitoring the physiological parameter of human being. This paper also explored the trend of mobile sensing and adapted it towards improving digital signal processing (DSP), by building interfaces to medical sensor and external sensors. In this paper there is use of SHIMMER. It is a small wireless low-power sensor International Journal of Advance Foundation and Research in Computer platform that can record and transmit physiological (Health related like ECG) and kinematic data in realtime. The drawback of this system is that it only monitors the patient which is admitted in the hospital. In this low power sensor are used.

Smart Elderly Home Monitoring System with an Android Phone: Kenny T.H. Chieng Dr. Lee JerVui, Chuah Yea-Dat el al

This paper considers or takes into account certain facts, which are heart attack and stroke as they are the major cause of hospitalization of the elder people. There is more chances of survival if the older people gets the treatment within an hour. it had also been developed. An android smart phone with accelerometer is used to detect a fall of the carrier, and this android device is known as healthcare device. The android phone is then connected to the monitoring system by using the TCP/IP protocol through Wi-Fi. Because of this system, elderly and chronically ill patients can stay independently in their own home and secure in the knowledge that they are being monitored. The drawback of this system is that it only considers elder people as there is more chances of sudden (emergency situation) outbreak in them like heart attack and stroke.

Design and Implementation of Wearable ECG System: ByungkookJeon, Jundong Lee, JaehongChoielal,

This system describes the design and implementation part of wearable ECG with the smart phone for the real time monitoring of health. In this system smart shirt

are developed with ECG sensors can be worn by any type of patient for monitoring his or her health in real time and get required treatment or prescription. These systems are mainly developed considering elder people in mind as they live alone in their homes. Therefore, this system basically monitors the elderly people for self-diagnosis purpose. The result of this system was the system could monitor and diagnose patients' heart conditions in real time, when they wear a sports-shirt with a ECG sensor in it. In addition to this, the system also provides graphical information with history management tools and an automatic emergency call system to the patient to get the required treatment in time. The drawback of the system is that it only concentrates on elder people and it includes shirt (ECG sensor) for wearing which cost a lot.

Remote patient Monitoring System: YeduManmadhanAn and V.R.M.J. JayashreeSherin Sebastian, Neethu Rachel Jacob

This paper provides the image-based system which acquires the ECG signal via digital camera; this information is performed on the tool like MATLAB and data sending through the internet network and stored in database. Then the original image is then availed to the doctor via Android mobiles. The purpose of this system is the vital signs and parameters from the ICU monitoring system and makes this data to be available to the doctor who may not be in the hospital and in the country. In case of any abnormality, the doctor is alerted by sending a notification from C2DM server to his mobile. The drawback of this paper is that due to the slow internet connection the data will not be send to the doctor which is located remotely. The image is captured through the camera, which must be HD which cost a lot.

Hospital Health Care Monitoring System using Wireless Sensors Network: Naji HR Aminian M. Ael al, International Journal of Advance Foundation and Research in Computer.

In this paper there is continuous observation of the patient's physiological parameters such as blood pressure of patient as well as heart rate. This system is mainly useful for pregnant women to measure the various parameters like blood pressure, heartbeat and fatal movement to control the health issue. This system has to monitoring more than one patient at a time and easily able to sense the blood pressure (BP) and heart rate of the patients. In this system, there is a sensor node attached to body of patient to measure signals from the wireless sensors and sends these signals to the database. This system can detect the abnormal conditions of the patient, raise an alarm to the patient and sends a SMS/Email to the doctor for treatment. The main advantage of this system is to increase the freedom for enhancing patient's quality of life. The demerit of this system is that in this the patients need to get admitted in the hospital for continuous monitoring of the patient physiological parameters. This WSN gets complicated if number of patients is admitted in the hospital beyond the specified limit.

Android ECG Application Development: BehutiyeWoubshet,

The paper describes the design and implementation part of ECG application. The main purpose or objective of this paper was to use the power of android platform and produce a prototype model of ECG application. It performs its works with VS100, Bluetooth ECG monitoring device. This paper also describes the architecture, development environment and tools that are used in android mobile application development. The tools used in development process or phase are Eclipse, Android SDK, ADT plugging for Eclipse. This device monitors Heart Rate via Bluetooth communication. The result of this paper was communicating with vital sense device via Bluetooth communication. The demerit of this system is that it monitors only ECG and no other parameters like temperature.

METHODOLOGY

Women in rural areas lack knowledge about importance of proper medication. Medical Expenses are also unaffordable to them. Therefore, in this system, some vital parameters like heartbeat, temperature and Kicking is measured. 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 assists it.

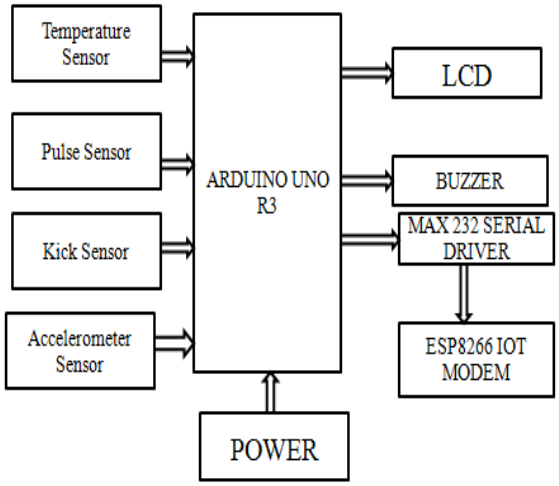

Fig 1:Block Diagram

Hardware Requirements

Arduino Uno R3

- Temperature Sensor
- Pulse Sensor
- Piezo Electric Kick Sensor
- Adxl 345 Accelerometer
- Sim 800c Gsm Modem
- Esp8266 Iot Modem
- Power Supply Unit
- 16*2 Lcd
- Buzzer

Software Requirement

- ARDUINO IDE
- Embedded C

HARDWARE IMPLEMENTATION

Arduino UNO

The Arduino UNO is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by arduino. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 Digital pins, 6 Analog pins, and programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable. It can be powered by a USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under Common Creative Attribution Share-Alike 2.5 license and is available on the arduino website. Layout and production files for some versions of the hardware are also available. "UNO" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The UNO board and version 1.0 of arduino Software (IDE) were the reference versions of arduino, now evolved to newer releases. The UNO board is the first in a series of USB arduino boards, and the reference model for the arduino platform. The ATmega328P on the arduino UNO comes preprogrammed with a boot loader that allows uploading new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol. The UNO also differs from all preceding boards in that it does not use the FTDI USB-to serial driver chip. Instead, it uses the Atmega16U (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

Fig -2: Arduino Board

LCD

Liquid Crystal Display (LCD) is used to display the output to the user in the form of GUI (Graphic User Interface) and a mono chromatic display. LCD used in this project is JHD162A series. There are 16 pins in all. They are numbered from left to right 1 to 16 (if you are reading from the backside). Generating custom charcters on LCD is not very hard. It requires the knowledge about custom generated random-access memory (CG-RAM) of LCD and the LCD chip controller. Most LCDs contain Hitachi HD4478 controller. CG-RAM is the main component in making custom characters. It stores the custom characters once declared in the code. CG-RAM size is 64 byte providing the option of creating eight characters at a time. Each character is eight byte in size.

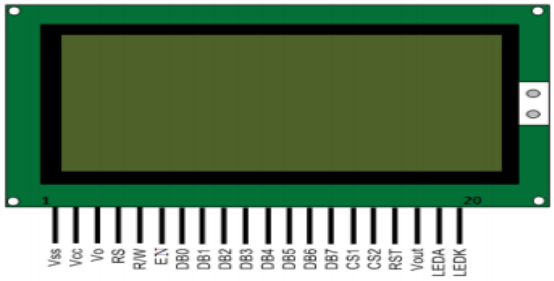

Fig 3: LCD

Accelerometer Sensors

Accelerometer within the Gesture Vocalized system is employed as a tilt sensing element, which checks the tilting of the hand. ADXL103 measuring system as shown in Figure three. The tip product of the measuring system is provided to 3rd module, which incorporates pipeline structure of 2 ADC. There is a technical issue at this stage of the project, that the analog output of the measuring system.

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 -55ºC to +150ºC.

Fig 4: Temperature sensor

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 heartbeat 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.

Fig 5: Heartrate Sensor

Kicking

When the baby's first movements, called "quickening," between weeks 16 and 25 of your pregnancy. During pregnancy, some women start to feel movements as early as 13 weeks. You are more likely to feel baby move when you are in a quiet position, either sitting or lying down. Pregnant women describe their baby's movements as butterflies, nervous or a tumbling motion. At first, it may be hard to tell whether your baby has moved. Second- and third-time moms are more adept at distinguishing those first baby movements from gas, hunger pangs, and other internal motions. Babies tend to move more at certain times of the day as they alternate between alertness and sleep. They are usually most active between 9 p.m. and 1 a.m. as trying to get to sleep. This surge in activity is due to changing blood sugar levels. Babies also can respond to sounds or touch and may even kick your partner in the back if you snuggle too close in bed.

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.

RESULTS AND DISCUSSION

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 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.

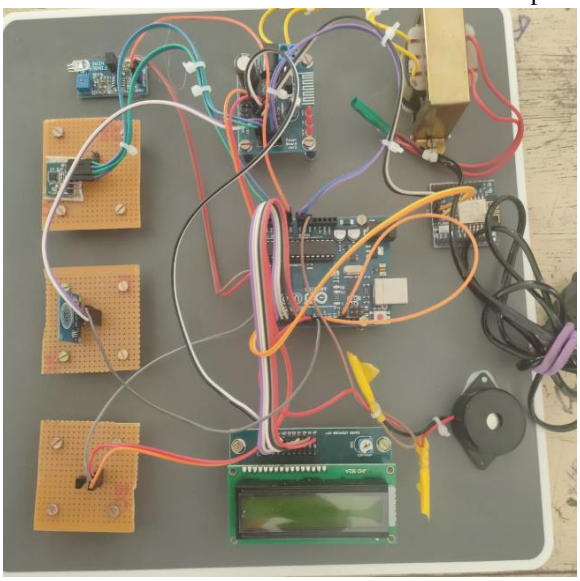

Fig 6: Experimental Setup

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 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 through the IoT.

REFERENCES

[1] Jianqiang Li, Luxiang Huang, Zhixia Shen, Yifan Zhang, Min Fang, Bing Li, Xianghua Fu, Qingguo Zhao, Huihui Wang, “Automatic Classification of Fetal Heart Rate Based on Convolutional Neural Network”, IEEE Internet of Things Journal, Volume: 6, Issue: 2, April 2019.

[2] HUGH 0. NASH, JR,” Fire Alarm Systems for Health Care Facilities”, IEEE transactions on industry applications, vol. 19, no. 5, September/October 1983.

[3] Rob Buckingham 0, University of Bristol, “Robotics in surgery”, IEEE review September 1994.

[4] Ramalatha Marimuthu, Alagu Meenal S, Preethi R, Harshini Infanta A, "Design of Robotic Hand Glove for Assisting Mobility Impaired", Volume 2, Smart Innovation, Systems and Technologies 51, DoI 10.1007/978-3-319- 30927-9_59, Springer International Publishing Switzerland 2016.

[5] Thomas F. Deutsch,” Lasers and Optics in Health Care”, proceedings of the IEEE, Vol. 85, no. 11, November 1997.

[6] Rolf Holle and Gudrun Zahlmann,” Evaluation of Telemedical Services”, IEEE transactions on information technology in biomedicine, vol. 3, no. 2, June 1999.

[7] Luisa Portoni, Carlo Combi,” User-Oriented Views in Health Care Information Systems”, IEEE transactions on biomedical engineering, vol. 49, no. 12, december 2002.

[8] Hairong Yan, Hongwei Huo, Youzhi Xu, and Mikael Gidlund,” Wireless Sensor Network

Based E-Health System – Implementation and Experimental Results", IEEE transactions on consumer electronics, vol. 56, no. 4, november 2010.

[9] Shih-Lun Chen, Ho-Yin Lee, Chiung-An Chen, Hong-Yi Huang and Ching-Hsing Luo," Wireless Body Sensor Network With Adaptive LowPower Design for Biometrics and Healthcare Applications", IEEE systems journal, vol. 3, no. 4, december 2009.

[10] Yena Kim, SeungSeob Lee and SuKyoung Lee," Coexistence of ZigBeebased WBAN and WiFi for Health Telemonitoring Systems",IEEE Journal of Biomedical and Health Informatics, 2013.

[11] Amir Ehsani Zonouz, Liudong Xing, Vinod M. Vokkarane and Yan (Lindsay) Sun, "Reliability-Oriented Single-Path Routing Protocols in Wireless Sensor Networks", IEEE Sensors Journal, Volume: 14, Issue: 11, Nov. 2014.

[12] Ting Liang and Yong J Yuan," Wearable medical monitoring systems based on wireless networks: A Review", IEEE Sensors Journal Volume: 16 Issue: 23, Dec.1, 2016.

[13] Anpeng Huang, Wenyao Xu Zhinan Li, Linzhen Xie, Majid Sarrafzadeh, Xiaoming Li, and Jason Cong," System Light-Loading Technology for mHealth Manifold-Learning-Based Medical Data Cleansing and Clinical Trials in WE-CARE Project", IEEE journal of biomedical and health informatics, vol. 18, no. 5, september 2014.

[14] N. Saleh, A. Kassem and A. M. Haidar," Energy-Efficient Architecture for WirelessSensor Networks in Healthcare Applications".IEEE sensors.

[15] Yoney Kirsal Ever," Secure-Anonymous User Authentication Scheme for e-Healthcare Application Using Wireless Medical Sensor Networks", IEEE systems journal., Volume: 13, Issue: 1, March 2019.