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Development of Smart Data Acquisition and Monitoring System for Maternal Health care

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Abstract
Health care monitoring is very important for pregnant women. Continuous monitoring of vital parameters is very essential in case of pregnancy associated with risk factors such as high blood pressure, diabetes, pregnancy after repeated abortions. In this paper a smart data acquisition and monitoring system is proposed that can be used in public health care centre especially in rural areas. The vital parameters of pregnant women such as blood pressure, Pulse rate, temperature, blood glucose and hemoglobin content in the blood are measured using suitable sensors and measurement techniques. The health status of maternal women is measured by the nurse present in the primary health center. The health sensors such as hemoglobin measuring unit, Pulse rate sensor (SEN1154), Temperature sensor (LM35), Blood pressure measurement unit and blood sugar device senses all the parameters and it is being measured and recorded periodically. The health parameters being measured are continuously recorded in the local storage device. The recorded data is given to the doctor by the nurse and the data stored is analyzed by the doctor using the graphical user interface (GUI), which is recorded and analyzed for all the three trimesters.

Keywords: *Haemoglobin measuring unit, Pulse rate sensor, Blood pressure measuring unit, Blood Glucose level, vital parameters.*

I. INTRODUCTION

Survey done by World Health Organization in 2005, reveals 800 women die from unknown causes associated to pregnancy and childbirth which are mostly preventable and 99% of all these maternal deaths are in developing countries. In rural areas the maternal mortality is higher among underprivileged community. At home 75.3% of birth happens in rural areas. Therefore, efforts are to be taken to provide suitable and life worth health support to pregnant ladies who give birth of health children. Health care centre awareness and access, are to be increased and equipped with up to date maternity services. Various physical problems such as anemia, lack of nutritious food, weakness, below the threshold weight are to be monitored all through the duration of pregnancy period which will increase the positive impacts on pregnancy and its outcome of all women.

In developing countries like India maternal mortality is very high. Socio Democratic factors are responsible for this high ratio. Early age of marriage among women, early age of pregnancies less spacing between two deliveries and high birth rate are some social factors for the increase in Maternal Mortality Rate. Government of India has taken many steps for the improvement of health for pregnant and nursing women and the women in reproductive age group. But the result is not satisfactory enough as far as the ratio is considered. The condition is not satisfactory in rural areas.

The Proposed monitoring system shall be made available at Public Health Centre in all villages. The health status of maternal women is measured by the nurse present in the primary health center. Maternal women residing in deep rural areas mostly do not comprise of network facilities. So in the absence of network all the parameters are being measured and stored in the local storage device. The parameters of the maternal women are detected and stored by the nurse for all the three trimesters at periodic intervals. The doctor present at the primary health center analyses the data stored in the local storage device using graphical user interface (GUI). At periodic trimesters the analysis of data done using GUI is classified based on the parametric values. The data are

classified into normal, abnormal and critical conditions. In case of any emergency, the affected patient will be admitted in nearby Government Hospitals. The kit will be highly helpful to provide timely treatment and also results in the gradual decrease of Maternal Mortality Rate (MMR). At any cause the Periodic records of maternal is being maintained and sent to PHC & GH. According to the data it can be accessed and monitored in real time for all the three trimesters. Therefore the compact kit is designed for the close monitoring of data and periodic analysis.

II. LITERATURE REVIEW

An article in Times of India a leading daily in December 2017 reveals the fact that the Maternal mortality ratio (MMR) or the number of mothers dying per 100,000 live births, has increased by nearly 80% in the past five years. Sources indicate that heart diseases, disorders associated with high blood pressure and sepsis have been the top three contributors to these maternal deaths.

Implementation of IoT based rural health care monitoring system, wearable health care monitoring devices, microcontroller based sensor units and data loggers were developed to address the issues related to continuous health care monitoring for rural pregnant women. Remote health care monitoring systems and pregnancy risk assessment system were developed as found in literature. Still there is a very big lag when it comes to medical equipment and medical care for the people living in villages and rural areas. The patients who needs medical help, especially the maternal women who are in need of timely and periodic check-ups are deprived of medical facilities in their vicinity. Insufficient hospitals and Doctors are also a major concern. Currently in our country the card system is in practice, where the nurse in Primary Health Care centers, check the maternal women's health status and enter them in a card for all the three trimesters, which in turn results in manual error while entering the data. This practice may lead to various misconceptions in giving treatments to the patients. If the cards are mislaid it leads to chaotic situations, as there is no back up facilities when it comes to card system. Lack of periodic check-ups, timely health assistance and loss of data are the main disadvantages found in exciting methodology which is currently in practice in rural remote areas of India. Therefore the above factors lead to the major requirement of development of the proposed compact health care kit for acquiring vital parameters connected with the health issues of pregnant women, analyze the parameters throughout the period of pregnancy and assist the doctors to provide continuous monitoring in remote rural areas.

II. PROPOSED SYSTEM

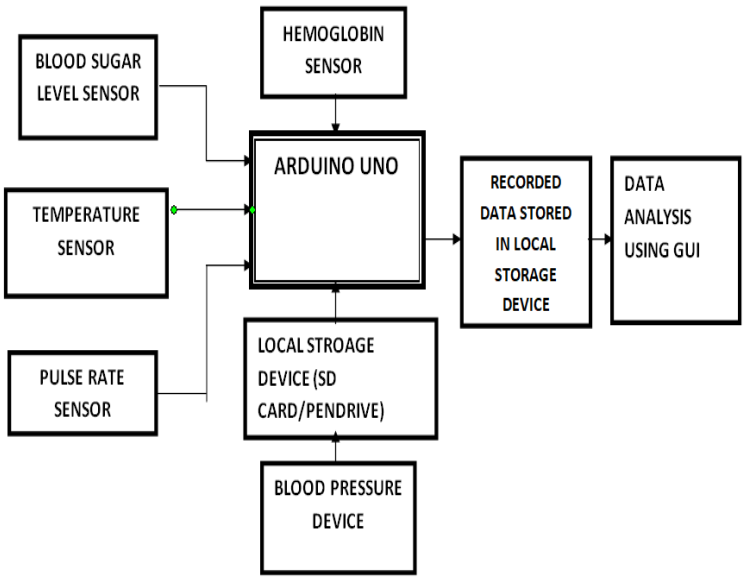

Fig. 1. General Block Diagram

The vital parameters of pregnant women such as Hypertension, Diabetes, Pulse rate and Oxy-haemoglobin content in the blood are measured using suitable sensors and measurement techniques. The power supply is given to the Arduino. The local storage device such as a SD card or a pen drive is connected to the Arduino through serial communication device. The local storage device is used to notify the user about the patient health records periodically for all the three trimesters even in the absence of network. The health sensors are connected to the Arduino through the ADC. The ADC converts all the sensor analog outputs to the digital outputs. Pulse rate, Glucose level, Temperature, Haemoglobin content and blood pressure is detected using sensors. The output is given to the Signal Conditioning System. The different type of output signal is converted into a standard 0 to 5v

DC voltage signal. The conditioned signal is transferred to the microcontroller. Arduinomicrocontroller collects all the signals and compares it with the applied threshold value. The output of the microcontroller is transferred to the display device which is categorized into Normal, Abnormal and Critical condition according to the range. The readings recorded by the system are stored in a local memory storage device. The data stored are connected to a PC and is monitored by the doctor. Health status can be checked from home by a nurse and data are stored in local storage device. Periodic records of maternal is maintained and sent to PHC & GH. The doctors analyze the recorded values using the GUI developed and the outcomes are classified into three categories. It enhances continuous data analysis of the pregnant women by the Doctor. The embedded system-hardware Kit with the GUI platform will be greatly helpful in continuous monitoring of maternal health.

A. TEMPERATURE SENSOR

The LM35 series are low cost IC temperature sensor with built in signal conditioning circuits. It gives an analog output voltage proportional to Centigrade temperature. The sensor characteristics are linear. Convenient scaling is provided, requires hardly any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°C over a full −55°C to 150°C temperature range. The advantages offered by LM35 is as follows, low-output impedance, linear output, precise inherent calibration, easy interface with readout circuitry, draws only 60 µA from the supply, it has very low self-heating of less than 0.1°C in still air. Operating range is over −55°C to 150°C temperature range. The IC sensor has three Pins only. The operating input voltage of 5V is applied to the Pin1.Analog output is taken from Pin2 wherein 10mv rise will be recorded for every 1 deg.celcius.Pin3 is used as ground Pin.

B. Pulse Rate Sensor (SEN 11514)

It is a low cost optical type of sensor that can be easily interfaced with Arduino board. Pulse rate sensor works on the principle of PhotoPhlethysmography.Change in blood volume causes change in the light intensity through any organ of the body. For the measurement of pulse rate, the flow of blood volume is given by the rate of heart pulses, light is absorbed by blood, the signal pulse rate is equivalent to the heart beat pulses. Beats per minute is 60*f- where f is the signal frequency. The SEN 11514 has two sides, LED is placed with ambient light source on one side, on the other side amplification and noise cancellation circuitry is placed. The sensor can be easily placed over a vein in our human body either in finger tip or ear lobe. The output of the sensor is pulsating. Operating voltage is +5v /+3.3v.The only disadvantage of the sensor is its placement or positioning.

C. Automatic Blood Pressure Measuring Unit

The project developed is a smaller unit that can be fixed in the wrist of pregnant women which is a compact and low cost device. The cuff which is surrounding the arm is inflated automatically to prevent main artery blood flow and it is automatically lowered to a pressure where the artery blood flow begins which measures the systolic pressure. The measurement of diastolic pressure is taken when the blood flow is no longer restricted. The pulse rate of pregnant women is also measured using sensors. A pump, cuff, valve, and pressure sensor are the main components which are fixed in the device. A signal-conditioning circuit with op-amps or an instrumentation amplifier is used for pressure sensor circuitry before the data is converted to analog value using a analog to digital code convertor. The pulse rate pressures of systolic and diastolic are calculated and the digital information is given to a monitor which indicates the pulse rate of a women and also the systolic and diastolic pressures of the women in the LCD display provided with proper time stamps and a volatile memory is used to store the measured data which can be used for further analysis

D. Data Acquisition and GUI

The vital parameters from the sensors and measuring unit are interfaced with the Arduino board. It has both analog and digital inputs. The temperature data and pulse rate is acquired as analog values. The built in Analog to digital converter provides the equivalent digital values. The use of Arduino enables the system to be very compact as there is no need for the use of separate signal conditioning circuit or converters. Haemoglobin, Blood Pressure along with the blood glucose is directly interfaced from the measurement system as digital values. The readout values are stored in SD card as well as through the interface acquired in a PC.

Threshold values are fixed based on the normal healthy conditions during pregnancy for women.

Table 1: Normal vales –used as reference for creating Threshold

Parameter	First TRISEMESTER	SECOND TRISEMESTER	THIRD TRISEMESTER
Oxy-Haemoglobin(g/L)	116-139	97-148	95-150
Blood Pressure	Low BP 70-80 mmHg and High BP 110-120 mmHg		
Glucose Level	Diabetes	Before meals and fasting	After meals
	Pre-existing Gestational	130-140mg/dL 140mg/dL	95mm/dL 120mm/dL
Pluse Rate	60-100 beats per minute	Increases by 30-50% during Pregnancy	
Temperature	Normal 37 deg. Cel	Above the value Abnormal	

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The input values to the controller are normalized in line with the operating voltage of 0-5v and its digital equivalents. A GUI is developed which consists of the following information. Patient name, Age, Address, Pregnancy week, Height, weight, vaccination details, details of first pregnancy, medical history, Husband name and Age, Contact number, Details of PHC/ Near by Govt. Hospital .

Three output conditions are displayed in the user interface window, normal, Abnormal and critical. Also a trend plot is generated so as to give a clear status of the health condition of the pregnant women. The system is programmed to send alert messages to the contact number stored in case of critical values.

IV. RESULTS

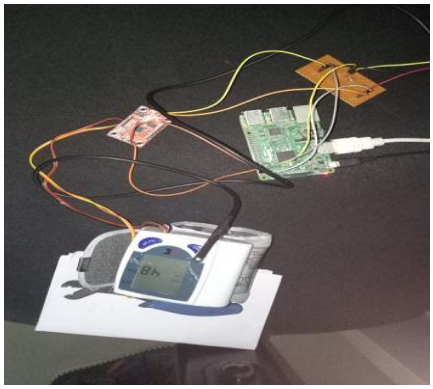

Fig. 2. Hardware in Development Phase1

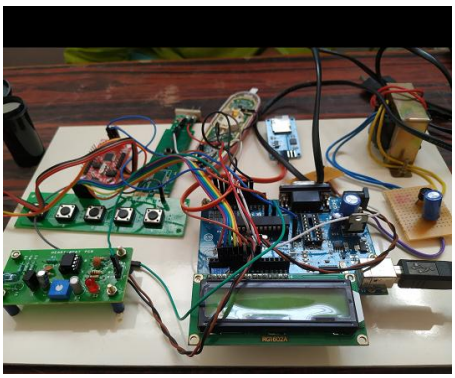

Fig. 3. Hardware in Development Phase 2

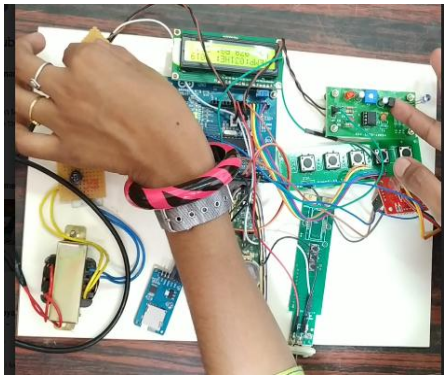

Fig. 4. Hardware in Testing Phase

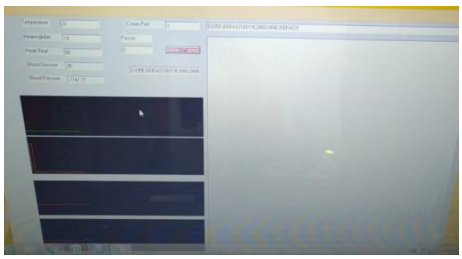

Fig. 5. GUI in development Phase

V. CONCLUSION

The proposed system is in the development stage. It has to be tested in rural areas. If tested successfully the system will largely contribute in the directions of reducing MMR prevailing in our country. The advantage of using this system is that timely health care monitoring is assured by every PHC to all pregnant women in nearby villages at free of cost. This will increase the confidence of village women towards treatment rendered by Govt. hospitals. The fully developed compact kit for maternal care shall be made readily available in public health care centers. There will be no major limitations when it comes to the technical feasibility of the kit , as this kit is especially designed to work efficiently even in the absence of network , which is a significant feature to deploy this technology in rural areas.

Enhancement is being made in the system to include sensors that will also monitor the movement of the foetus in the last trisemester of the pregnancy so that any movement abnormality or absence of movement over a period shall be monitored. This research work is carried out towards achieving the goal 3 of sustainable development goals put forth by UNO in terms of ensuring good healthy lives and reducing the child and maternal mortality by improving skilled delivery care.

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