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IOT-BASED MONITORING SYSTEM FOREXPECTANT WOMEN

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Abstract **—** Maternal and child deaths due to pregnancy related complications are still a huge concern and more prevalent in developing countries. Early detection of complications can help avoid many of the reported cases. Due to factors like long distances to nearby health facilities, lack of knowledge and poverty, majority of expectant mothers in rural developing nations are still adamant in prioritizing their health during this very sensitive period. This thesis research project was aimed at designing and prototyping a system intended to help reduce and improve maternal health in rural areas of developing nations by providing a rather easy way to monitor the health of expectant mothers remotely and to also provides vital information in form of periodic tips with automatic alerts . A survey was conducted so as to investigate the capabilities of the existing systems, identify the challenges with the systems and find out the awareness and readiness integration of internet of things in pregnancy monitoring. For data collection questionnaires were selectively distributed to expectant mothers and health facility officers. Selected health system managers were interviewed and existing documentation analyzed. From the analysis of collected data, the results show that current systems are ineffective and there is a need for Internet of things-based solutions. An architecture for context awareness and an IoT based system are therefore proposed so as to improve pregnancy monitoring and thus a reduction in fatalities and complications. The system uses a pulse sensor, temperature sensor and sweat sensor to collect data with an NodeMCU as the microcontroller. The collected data is then sent to the cloud. From the cloud data is stored, processed and analyzed then sent to the health worker. In case of any health complication or an appointment is missed the health officials are alerted on real-time. The use of this system will ensure a timely response in case of an emergency thus lead to better health and a contribution towards the sustainable development goals.

Keywords — IoT, Health monitoring system, Health information system, Pregnancy monitoring, IoT in health care.

1. INTRODUCTION

Pregnant women may face several challenges when visiting the hospital when they feel ill. Some of the common issues are: Accessibility: Some women, especially those living in rural or remote areas, may face difficulty in reaching the hospital due to lack of transportation or limited healthcare facilities.

Financial constraints: Pregnancy and delivery can be expensive, and many women may not have adequate health insurance coverage to pay for hospital visits and treatments. Stigma and discrimination: Pregnant women, especially

those from marginalized communities, may face discrimination and stigma, which can discourage them from seeking medical help.

Fear of negative outcomes: Women may avoid seeking medical attention due to fear of losing their pregnancy or other negative outcomes.

Lack of awareness: Some women may not be aware of the symptoms that require medical attention, or may delay seeking treatment due to lack of knowledge or understanding of their condition. It is important to address these barriers to ensure that pregnant women have access to timely and quality healthcare during pregnancy and childbirth.

Statistics on pregnancy death rate due to lack of awareness:

According to the World Health Organization (WHO), approximately 303,000 women die each year due to complications related to pregnancy and childbirth. Most of these deaths are preventable with access to timely and quality care. Lack of awareness and education about maternal health and proper healthcare practices during pregnancy and childbirth can contribute to the high maternal mortality rate. In many developing countries, women may not be aware of the dangers of certain conditions, such as preeclampsia and eclampsia, or may not understand the importance of seeking medical attention in a timely manner. It is important to invest in maternal health education and outreach programs, especially in low- and middle-income countries, to raise awareness about the dangers of maternal health conditions and the importance of seeking medical attention when necessary. This can help to reduce maternal deaths and improve maternal health outcomes.

2. RELATED WORKS

[1] Analysis of Pregnancy Risk Factors for Pregnant Women Using Analysis Data Based on Expert System. It is based on data analysis approach starting from analyzing the description which is to provide recommendation which is analyzed under the symptoms felt by pregnant women during pregnancy. This technology provides the analysis by calculating and considering the symptoms which was observed by the pregnant women during the period of pregnancy. The results of this research are that using this system, doctors can identify the risk level of pregnant women so that the potential to reduce the mortality rate of pregnant woman or the fetus.

[2] An Aid for Health monitoring during pregnancy.There is lack of awareness and facilities in villages and hence they don't bother much regarding health monitoring during pregnancy. To reduce fetal mortality rate and to identify any health related issue, regular check up is very important. This system involves the functionality of health monitoring due to the interaction of doctor and pregnant women. A mobile Application is used for the interaction. Parameters like heartbeat rate, temperature, fetus movement and blood pressure is measured using sensors. All the Results are recorded in cloud. Application is used to access the data stored. There is a Standard set for normal condition so there is a alert message indication in doctor's app for showing the fluctuations happening. Main aim of this system is to monitor the crucial parameters and keep the record so that doctor can take care of the Women's and the fetus health. Without going to the hospital, Health status of the woman can be updated.

[3] Smart ASHA pregnancy monitoring system. Nowadays, the maternal mortality rate (MMR) and the number of births in India and other developing countries are much higher than that of the developed countries. The Smart ASHA Pregnancy Monitoring System (SAPMS) aims to reduce the MMR by digitalizing the work of the health workers in the under developing parts of the country, monitor the pregnancies of the women in their area with the help of smart phones, effectively and efficiently. This will be more helpful to women which is cost efficient and monitoring the birth effectively.

[4] IOT Based Pregnancy Women Health Monitoring System for Prenatal Care. In developing countries most of the people are in rural areas where medical system is not effective to share medical information. Mainly

the pregnant women are not able consult the doctor during their initial period of pregnancy and this cause increase in death count of new born and parental in this areas. The main objective of this technology is to monitor the parameters of pregnant women continuously for treating and handle with more care. This system is preferred as home monitoring device.

[5] Pregnancy Monitoring Mobile Application

User Experience Assessment. Continuous checking in health facilities by a medical doctor has to be performed to measure some parameters, such as blood pressure, weight, baby movement. Nowadays, mobile phone develops rapidly, it can manage many sensors. Those sensors help the medical analyzer to observe some of the parameters automatically. In this research, proposes a mobile application to automatically record pregnant women mobility and the facility of image processing to read the weight of the scale. This paper aims to discuss the user experience in the implementation of the mobile smart birth monitoring application.

[6]. Survey on IoT Based Pregnant Women Health Monitoring System. Pregnancy is an exceptional condition, during the incubation cycle, women's experience various medical issues. Conventional systems for health monitoring are too narrow or too general, so they are not sufficiently versatile to accommodate pregnant women. In any climate, IoT guarantees safe and effective treatment for pregnant women because it fully removes the risks of pregnancy and adverse events, but also improves privacy, religious, legal and societal issues. The motivating assaults of this structure give a convincing reasoning to a tough, clinical preliminary to choose if this pregnant women's' medical services framework improves the guideline of pregnant women's' medical care among pregnant women's with unregulated medical conditions in the network. This technology provides us the detailed survey of women health monitoring system using pregnancy.

[7]. IoMT Technology as the Basis of Wearable Online Monitors for Space Distributed Monitoring Systems for Pregnant Women. The Internet of Medical Things (IoMT) is the network of Internet-connected medical devices, hardware infrastructure, and software applications used to connect healthcare information technology. The IoMT technology for development of global systems for monitoring of pregnant women's health state is considered. Monitoring is carried out remotely, transparently for a woman, without involving her in the complications of the process of interaction with a medical institution. The prospects for the widespread use of IoMT in online monitoring devices in the Russian Federation especially in the context of pandemics are assessed. Requirements are given and existing problems of a general nature are shown related mainly to the implementation of communications in the monitoring system. This system of technology was introduced to monitor the health of the pregnant women around global systems effectively and efficiently.

3. PROPOSED SYSTEM

The concept of variable sensor belts wearable sensor belts that can be used to monitor various aspects of a pregnant woman's health, including her fetal heart rate, maternal heart rate, and uterine contractions.

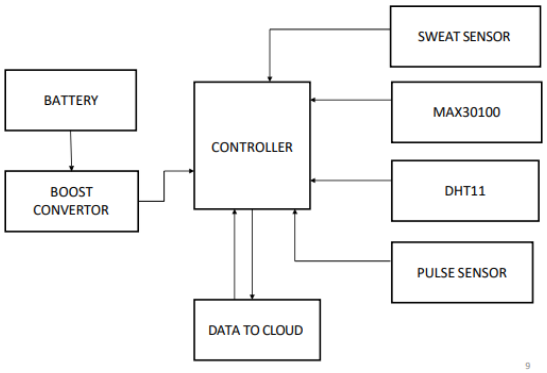

Fig 1: System Architecture

These devices can be helpful for early detection of potential complications and can provide peace of mind for expectant mothers. The system is reliable, cost effective which has a monitoring transmitting parts with NodeMCU as a major controller.

NodeMCU: NodeMCU is an open-source IoT platform that is built around the ESP8266 Wi-Fi chip. Here are some specifications of NodeMCU:

Microcontroller: ESP8266EX. Operating Voltage: 3.3V. Input Voltage: 5V (via micro-USB port). Digital I/O Pins: 11 (can be used as PWM or I2C). Analog Input Pins: 1 (3.3V max input). Flash Memory: 4MB. Clock Speed: 80MHz. Wi-Fi: 802.11 b/g/n (2.4GHz). Antenna: Built-in ceramic antenna or external antenna. Dimensions: 49 x 24.5 x 13mm. Programming Language: Lua, C/C++. Interfaces: UART, SPI, I2C, ADC, PWM. Power Consumption: 170mA (max). Operating Temperature: -40°C to 125°C. Programming and Debugging: via micro-USB port and built-in CP2102 USB-to-Serial converter. Integrated Development Environment (IDE): Arduino IDE, ESPlorer IDE, NodeMCU PyFlasher

[Note that some of these specifications may vary depending on the specific NodeMCU board model.]

DHT11: The DHT11 is a basic digital temperature and humidity sensor that is commonly used in electronic projects. Here are the specifications for the DHT11 sensor:

Supply voltage: 3.3V to 5.5V DC. Operating current: 2.5mA max. Temperature measurement range: 0°C to 50°C with ±2°C accuracy. Humidity measurement range: 20% to 90% RH with ±5% accuracy. Response time: < 5 seconds. Sampling rate: 1 Hz (1 reading per second). Communication protocol: single-wire digital signal with a 40-bit data output. Dimensions: 12mm x 15.5mm x 5.5mm. Pinout: 3 pins (VCC, GND, and data)

MAX30100: It is a pulse oximetry and heart-rate sensor module, which uses infrared and red LED sensors to measure the absorption of light by the blood. The MAX30100 sensor specifications are as follows:

Power supply voltage range: 1.8V to 5.5V. Operating current: 600 µA. Sample rate: adjustable from 50 to 3200 samples per second. **LED current**: adjustable up to 50 mA. ADC resolution: 18 bits. Communication interface: I2C. LED wavelengths: 660 nm (red) and 880 nm (infrared). Ambient temperature range: -40°C to +85°C. Package: 14-pin TDFN (3mm x 3mm)

[The MAX30100 sensor is commonly used in wearable fitness trackers and medical devices for non-invasive monitoring of heart rate and oxygen saturation levels.]

Sweat Sensor: Sweat sensors can be used to measure various biomarkers in sweat, including electrolytes such as sodium and potassium, which can provide an indication of hydration status. By monitoring changes in electrolyte levels in sweat, a sweat sensor can help to provide real-time feedback on a person's hydration status, which can be particularly important for expectant women who may be at risk of dehydration.

Boost Converter: The boost converter operates by storing energy in an inductor during the on-time of a switch and then releasing that energy to the output during the off-time of the switch. Here are some specifications to consider when designing a boost converter:

Input voltage: The boost converter's input voltage should be within the range of the power source you are using.

Output voltage: The boost converter's output voltage should be set to the desired voltage level for your application. The output voltage is determined by the ratio of the duty cycle and the input voltage.

Battery: A lithium-ion battery is a type of rechargeable battery that uses lithium ions as the main component of its electrochemical reaction. It consists of one or more cells, which each contain a positive electrode (cathode), a negative electrode (anode), and an electrolyte solution that allows the lithium ions to move between the electrodes during charging and discharging.

Lithium-ion batteries are commonly used in portable electronics such as smartphones, laptops, and tablets, as well as in electric vehicles and energy storage systems. They are known for their high energy density, long cycle life, and low self-discharge rate, which make

them a popular choice for applications where long-lasting and reliable power is needed.

Fig1 shows a diagrammatic representation of the working. Fig 2 shows all the sensors and devices are fixed in the belt. The NodeMCU microcontroller acts as a controlling unit for all the connected sensors. All the sensors work between 3.5V but we require 5V so we are using a boost converter to increase the operating voltage of the sensors. A lithium ion battery is used to store the energy.

When a person wears the belt all the devices measure the values of the particulars like pulse, heartbeat, sweat and temperature of the person and sends the measured value to a website trough cloud. Thinkspeak is an Iot platform service that is used to analyse live data trough cloud.

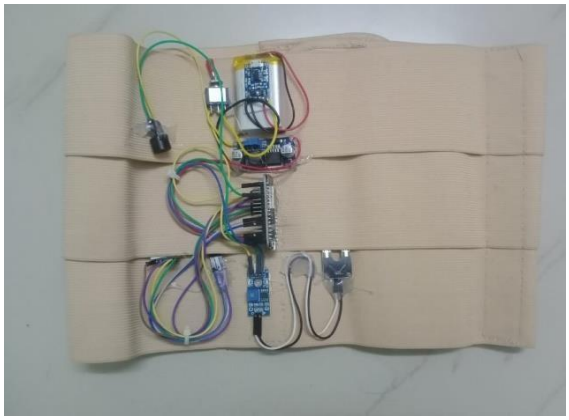

Fig 2: Experimental Design

4. RESULT

The performance of the proposed system was experimentally executed with a complete hardware setup, website and cloud storage.

The output of the device is sent through cloud using thinkspeak. There are two websites for displaying the details. One is for the doctor or the health care center and the other is used for the pregnant women's relative or care taker.

In the doctor's website he/she will be able to check or go through the latest results of the women. There is a threshold value set for each sensor, when threshold value increases or decreases, The alarm will indicate the pregnant women.

Figure 3 shows There are 5 graph that represents measured value of BPM, Temperature, Sweat, SP02, Pulse sensor. The doctor will be able to monitor expectant women using the measured values shown in the graph and give immediate response through comment section. The graph shows all the value starting form the first value, when the person uses it for the first time. Figure 4 shows the measured value and comments from the doctor. Only the current value will be visible in this website and the number of times we have used the device will also be displayed with present date and time.

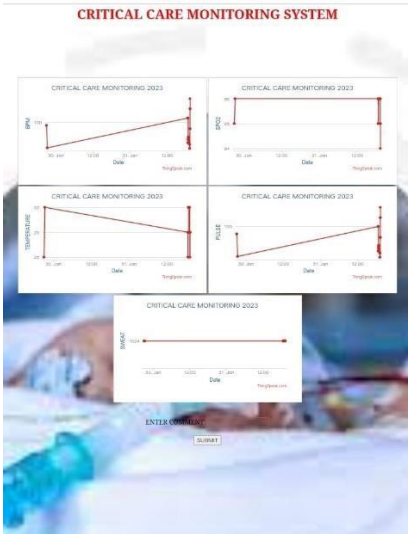

Fig 3: Doctor's website

Fig 4: Guardian's website

5. CONCLUSION

Based on a project to monitor pregnant women using an IoT device, the following conclusions can be drawn: The IoT device provides real-time data on the health and well-being of the pregnant woman, helping medical professionals make informed decisions on her care.

The device enables remote monitoring, which helps in reducing the need for frequent hospital visits, making it more convenient and accessible for pregnant women. The device can collect data on vital signs, such as heart rate and blood pressure, which are critical indicators of the health of the mother and fetus. The data collected by the device can be used to detect potential complications early on, allowing medical professionals to take proactive steps to mitigate the risk.

The use of the IoT device can lead to improved maternal and fetal outcomes and increased patient satisfaction, as it provides peace of mind and improved communication between the pregnant woman and her healthcare provider. Overall, the use of an IoT device for monitoring pregnant women has the potential to revolutionize prenatal care and improve health outcomes for both mother and baby.

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