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PREGNANCY WELLNESS MONITORING SYSTEM

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Abstract

In developing countries, pregnant women—particularly those in rural or underserved regions—often face significant barriers in accessing consistent prenatal healthcare, which can result in increased maternal and fetal health risks. To mitigate these challenges, this project proposes a smart and efficient IoT-based health monitoring system tailored for pregnant women, enabling continuous health tracking and timely interventions.

The system employs an array of biomedical sensors, including DHT11 for measuring ambient temperature and humidity, a pulse oximeter for monitoring blood oxygen saturation (SpO2), a heart rate sensor, a blood pressure (BP) sensor, and a MEMS sensor to detect falls or unusual body movements. These sensors interface with an IoT-enabled microcontroller equipped with the ESP8266 Wi-Fi module for real-time data transmission. Health parameters are displayed locally on an LCD for immediate visibility and are simultaneously uploaded to a cloud server, facilitating remote monitoring by healthcare providers or family members.

This IoT-based solution offers a lightweight, cost-effective, and accessible approach to prenatal care, enhancing maternal safety through continuous monitoring and real-time alerts. By bridging the healthcare gap in rural settings, it provides a reliable home-based system to reduce complications and ensure timely medical assistance when abnormalities are detected.

Keywords:

Esp8266, Iot, Dht11 Sensor, Oxygen Sensor, Heartrate Sensor, Accelerometer, Bp Sensor, Adc, Lcd.

Introduction

The health of pregnant women is of paramount importance, as it directly influences the development and well-being of the unborn child. Regular monitoring of maternal health parameters can help in the early detection of potential complications such as hypertension, dehydration, hypoxia, or physical accidents like falls. However, in many developing regions, the lack of regular access to healthcare facilities makes it difficult to ensure timely and continuous prenatal monitoring.

To address these challenges, the advancement in Internet of Things (IoT) technologies presents a promising solution. IoT allows for the creation of smart, connected devices capable of collecting, transmitting, and analyzing health data remotely in real-time. This project

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introduces an IoT-based pregnancy women health monitoring system, designed specifically to assist in prenatal care and maternal safety.

At the core of the system is the ESP8266 Wi-Fi module, which serves as the communication backbone, transmitting data to the cloud or mobile application for real-time access. Various biomedical sensors are used to capture essential health parameters:

DHT11 sensor for monitoring environmental temperature and humidity, which are crucial for maternal comfort and health. Oxygen sensor (SpO2) to measure blood oxygen saturation, indicating the oxygen supply to both mother and fetus. Heart rate sensor to detect abnormal heart conditions like tachycardia or bradycardia. Blood pressure sensor for early detection of preeclampsia or gestational hypertension. MEMS sensor to track sudden movements or falls, which are potentially dangerous during pregnancy. LCD display to provide immediate feedback to the user about their current health status. All collected data is displayed on the local LCD and simultaneously transmitted via Wi-Fi to a remote server or mobile application. If any abnormal reading is detected, alerts can be triggered for immediate action.

This system is not only useful for routine monitoring but also acts as an early warning system, reducing the need for frequent hospital visits and making prenatal care more accessible, especially in rural or resource-limited environments. The integration of technology in maternal healthcare can revolutionize the way prenatal monitoring is done, ensuring a safer, smarter, and more connected experience for expecting mothers.

Literature Survey

The integration of IoT (Internet of Things) technologies into healthcare, particularly maternal care, has become a significant focus in recent research and development. Traditional prenatal monitoring systems often rely on manual checkups and periodic clinic visits, which may not be feasible or reliable for women in rural or underdeveloped regions. Consequently, researchers have explored various methods to automate health monitoring using sensor-based systems, wireless communication, and mobile health applications to enhance accessibility and early detection of complications.

Several studies have emphasized the need for remote monitoring systems for pregnant women. In one research work, a wireless health monitoring system was designed using wearable sensors to track vital signs like heart rate, blood pressure, and oxygen levels, with data being transmitted via Bluetooth to a mobile device. While effective in real-time tracking, the system lacked integration with cloud platforms for long-term storage and remote access by healthcare professionals. Similarly, other systems developed using Arduino and GSM modules provided SMS-based alerts in case of abnormal readings, but these systems often lacked scalability, data visualization, and did not offer continuous real-time data flow.

In a study focusing on IoT in maternal care, researchers used the ESP8266 module to upload sensor data to platforms like ThingSpeak. This approach provided a reliable cloud-based solution, where maternal health data could be continuously monitored and accessed remotely. The use of ESP8266 allowed for

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cost-effective implementation and internet-based communication, making it suitable for rural deployment. However, many existing projects either focused on one or two vital parameters or were not compact and portable enough to be used regularly by pregnant women.

Another relevant development was the use of wearable health bands that collected data such as body temperature and pulse rate. These commercial solutions, while innovative, are often expensive and not customizable to the specific needs of prenatal care, such as monitoring environmental conditions (e.g., humidity and temperature), fall detection, or continuous blood pressure tracking.

More recent literature proposes multi-sensor fusion systems, where data from various sensors such as DHT11, MEMS accelerometers, and biomedical sensors are processed and analyzed collectively to provide a more comprehensive health status. The use of MEMS sensors has been particularly noted for detecting accidental falls—a common risk during pregnancy—enabling timely alerts and preventive action.

Overall, the literature suggests a growing need for a compact, IoT-based, multi-sensor health monitoring system tailored for pregnant women. Such a system should not only measure physiological parameters but also be capable of environmental sensing, movement detection, and real-time data transmission to medical personnel or caretakers. This project addresses the gaps identified in existing literature by combining ESP8266, a cost-effective microcontroller with multiple sensors (DHT11, SpO2, BP, Heart Rate, MEMS) and a display unit (LCD), offering an all-in-one solution that enhances prenatal care and maternal safety through continuous monitoring, remote access, and intelligent alerting mechanisms.

Existing System

In the current healthcare ecosystem, pregnancy monitoring is primarily conducted through manual checkups and hospital visits at regular intervals. These checkups typically involve monitoring blood pressure, body temperature, heart rate, oxygen level, and sometimes fetal movement or ultrasound scans. While effective in urban areas with easy access to healthcare facilities, this model is often inaccessible or inadequate for pregnant women living in remote, rural, or underdeveloped regions, where medical infrastructure is limited and frequent hospital visits are difficult.

Some existing systems use portable devices or wearable technology such as smartwatches or health bands to track parameters like pulse rate, temperature, and oxygen saturation. These devices are often connected to mobile apps that display health data and send notifications. However, such solutions are often commercial and expensive, with limited access to real-time cloud-based monitoring or healthcare professional dashboards. Moreover, many of these devices do not monitor critical pregnancy-specific risks such as blood pressure fluctuations, falls, or environmental conditions, which are crucial for ensuring prenatal safety.

Other studies and products use GSM-based systems that send SMS alerts to a caregiver or doctor when abnormal readings are detected. While useful in areas with no internet, these systems do not offer real-time continuous monitoring, lack cloud integration, and often have

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limited storage and scalability options. Some prototypes developed using Arduino boards support health parameter measurement but are not optimized for IoT connectivity, portability, or integration with user-friendly mobile or web interfaces.

In academic research, IoT-based solutions are slowly being adopted. For example, systems using Raspberry Pi or Arduino + GSM modules have been explored, but many are either bulky, costly, or lack multi-sensor integration. They usually focus on one or two parameters (like temperature and heartbeat), and very few include motion/fall detection which is critical during pregnancy.

Explanation of the Existing System

To summarize, existing systems fall into the following categories:

Hospital-Based Monitoring:

- Manual testing of health parameters.
- Requires physical presence and appointments.
- Not suitable for continuous or real-time monitoring.

Wearable Commercial Devices:

- Devices like Fitbits or smartwatches monitor limitedparameters.
- Generally expensive and not customized for pregnancy.
- Do not include sensors like BP or MEMS for fall detection.

GSM-Based Health Alert Systems:

- Monitor selected parameters and send SMS alerts.
- No real-time monitoring or cloud storage.
- Often single-use and not integrated with multiple sensors.

Arduino/Raspberry Pi Prototypes:

- Academic-level systems with sensor integration.
- Lack cloud/IoT capabilities in most cases.
- Limited mobility, battery optimization, and user-friendly interfaces.

Proposed System

The proposed system is an IoT-based smart health monitoring system for pregnant women, designed to ensure continuous, real-time, and remote monitoring of vital health parameters using a suite of biomedical and environmental sensors integrated with a Wi-Fi-enabled microcontroller (ESP8266). The system is capable of monitoring body temperature, humidity levels, heart rate, blood pressure, blood oxygen levels (SpO_2), and physical movement (fall detection).

The core idea is to build a compact, wearable or portable device that automatically collects these health parameters and transmits the data via Wi-Fi to an IoT cloud platform such as ThingSpeak, Blynk, or Firebase. This enables healthcare providers and family members to remotely monitor the condition of the pregnant woman at any time, from anywhere. A 16x2 LCD screen is used for displaying real-time readings locally, and alerts are generated in case

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any abnormality or emergency (e.g., a fall or abnormal BP/SpO_2) is detected.

This system ensures enhanced prenatal care, minimizes the need for frequent hospital visits, and provides early warning signs of health complications, especially in rural or low-resource settings.

Explanation of the Proposed System

The proposed system aims to overcome the limitations of the existing methods by integrating multiple sensors, wireless connectivity, and cloud-based monitoring into one cohesive unit. Here's how it works:

Sensor Integration

DHT11 Sensor: Monitors ambient temperature and humidity, important for maternal comfort and environment regulation.

Heart Rate Sensor: Measures pulse to detect abnormalities like bradycardia or tachycardia.

Blood Pressure Sensor: Tracks systolic and diastolic pressure, essential for early detection of preeclampsia or hypertension.

Pulse Oximeter Sensor (MAX30100/MAX30102): Measures oxygen saturation (SpO_2) and heart rate, indicating respiratory efficiency and fetal oxygen availability.

MEMS Accelerometer (e.g., MPU6050): Detects motion, posture, and falls to ensure the woman has not encountered physical trauma.

16x2 LCD: Displays all current readings on the device itself for the user's awareness.

Microcontroller (ESP8266/NodeMCU)

Acts as the brain of the system. It collects data from all sensors, processes the information, and sends it wirelessly to an IoT platform. It is chosen for:

- Low power consumption
- Built-in Wi-Fi
- Easy integration with sensors and Arduino IDE

IoT Cloud Platform

Collected data is sent to the cloud in real-time using Wi-Fi. Platforms like ThingSpeak, Firebase, or Blynk allow:

- Real-time data visualization
- Storage and history tracking of health parameters
- Sending alerts to caregivers/medical staff if values go out of the safe range

Alert System (Optional)

The system can be enhanced with a buzzer or LED alert to notify the woman in real-time if any abnormal reading is detected—like dangerously high BP, low oxygen, or a fall.

Key Features of the Proposed System

1. Continuous health monitoring without needing hospital visits
2. Remote accessibility for doctors and family members
3. Early warning system for dangerous pregnancy complications
4. Compact and low-cost design suitable for rural areas
5. Fall detection to ensure safety from physical injuries

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6. IoT-based visualization and storage of patient history

Block Diagram

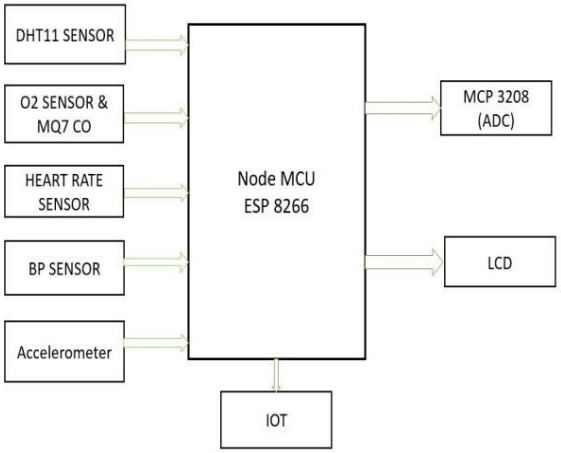

Fig-1: Pregnancy Wellness Monitoring System

Node MCU

NodeMCU is an open-source IoT platform based on the ESP8266 Wi-Fi module. It supports Lua and Arduino IDE, making it easy for developers to build wireless applications. It offers low power consumption, built-in Wi-Fi, and GPIO for sensor integration.

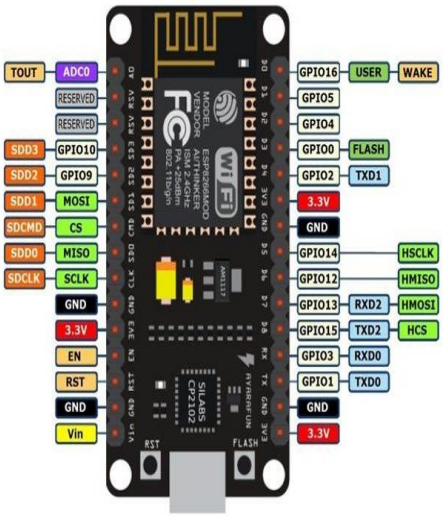

Fig-2: Node MCU

DHT11

The DHT11 sensor is a low-cost digital sensor used to measure temperature and humidity. It provides reliable readings with decent accuracy, making it ideal for basic environmental monitoring in IoT projects, including health and safety applications.

Fig-3: DHT11 Sensor

Oxygen Sensor

An oxygen sensor (SpO_2 sensor) measures the blood oxygen saturation level, indicating how efficiently oxygen is being carried to the body's tissues. It is essential in pregnancy to monitor maternal and fetal oxygen levels and detect hypoxia early.

Fig-4: Oxygen Sensor

Heart Rate Sensor

A heart rate sensor measures the number of heartbeats per minute (BPM) by detecting blood flow changes. It helps monitor cardiac health, identify irregularities like bradycardia or tachycardia, and is essential for tracking maternal well-being during pregnancy.

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Fig-5: Heart Rate Sensor

BP Sensor

A blood pressure (BP) sensor measures the systolic and diastolic pressure of blood flow in the arteries. It helps detect hypertension or preeclampsia in pregnant women, ensuring timely medical intervention for safer prenatal monitoring and maternal health care.

Fig-6: BP Sensor

Accelerometer

An accelerometer is a sensor that measures acceleration forces, including motion, tilt, and vibration. In health monitoring systems, it helps detect body movements, posture changes, and falls, providing critical data for ensuring safety, especially for pregnant women and elderly individuals.

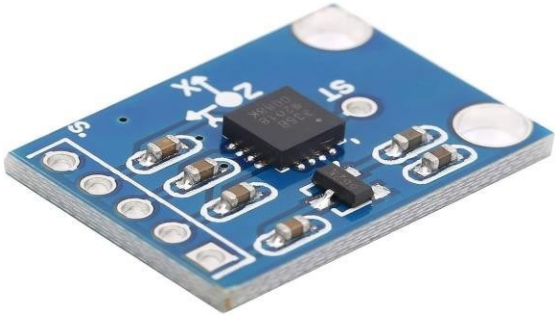

Fig-7: Accelerometer

LCD

An LCD (Liquid Crystal Display) is a low-power, flat-panel display used to show real-time data. In health monitoring systems, it displays vital parameters like temperature, heart rate, and blood pressure, providing immediate feedback to users for quick awareness.

Fig-8: LCD

RESULT

The implemented IoT-based health monitoring system effectively tracks vital parameters like temperature, humidity, SpO_2, heart rate, blood pressure, and body movement in real time. Using biomedical sensors integrated with the ESP8266 microcontroller and LCD, it enables continuous local and remote monitoring. Real-time data transmission and alerts support timely medical response, enhancing maternal safety. This low-cost, efficient solution is especially valuable for prenatal care in rural or underserved areas, offering practical, accessible support for expecting mothers.

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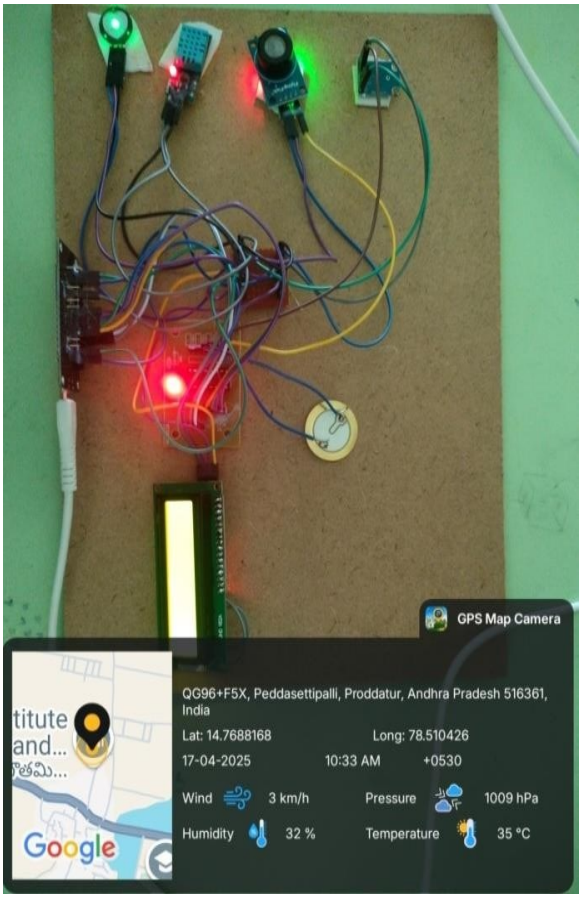

Fig-9: Pregnancy Wellness Monitoring system

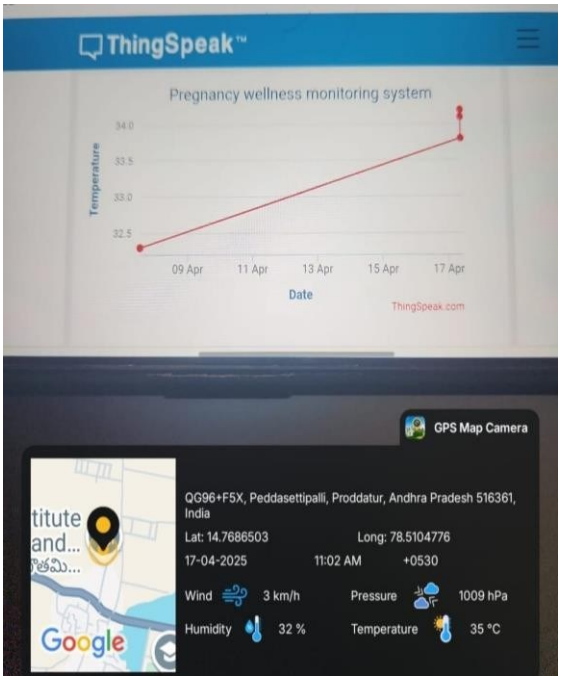

Fig-10: ThingSpeak results for Temperature

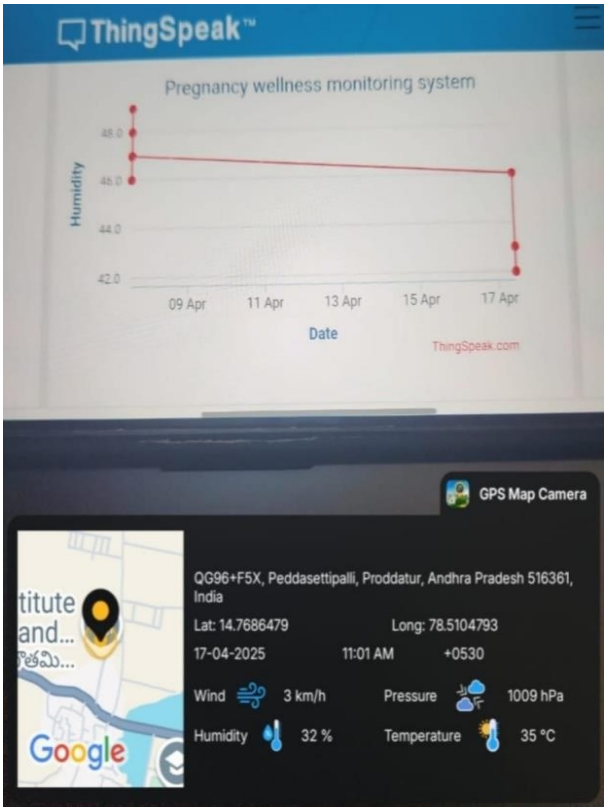

Fig-11: ThingSpeak results for Humidity

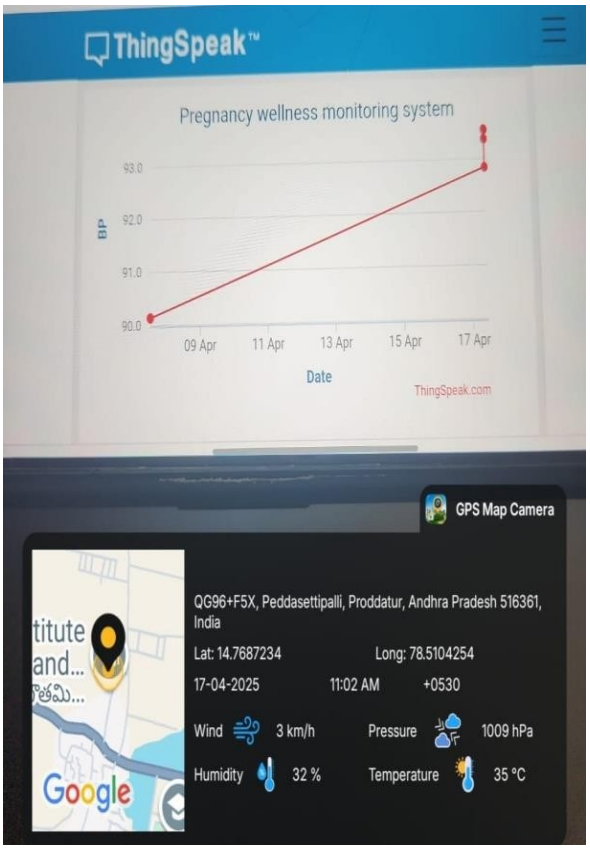

Fig-12: ThingSpeak results for BP

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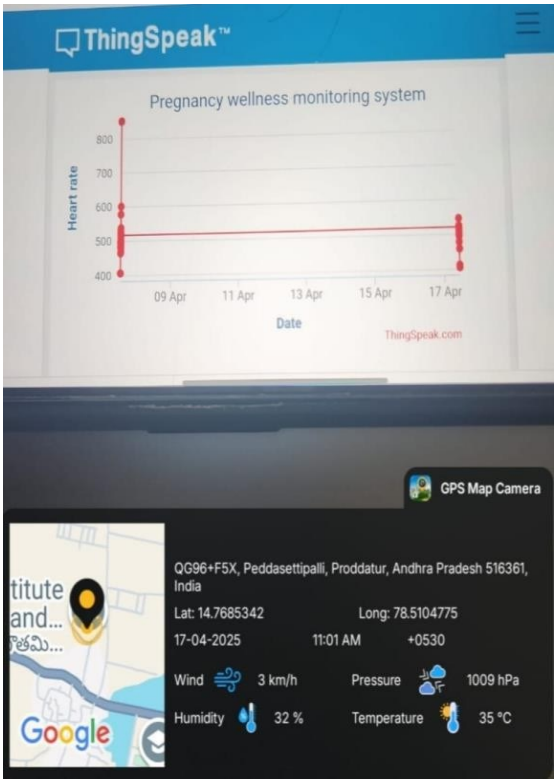

Fig-6: ThingSpeak results for Heart Rate

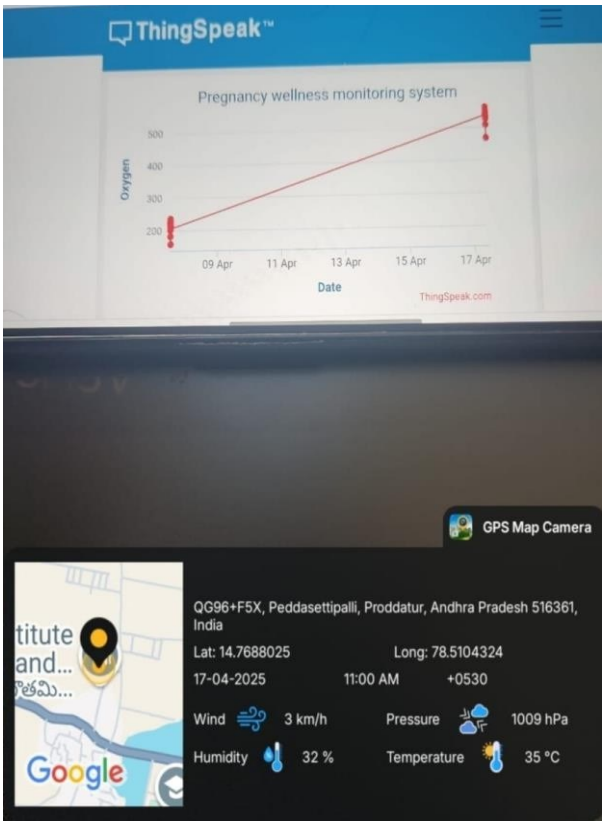

Fig-7: ThingSpeak results for Oxygen

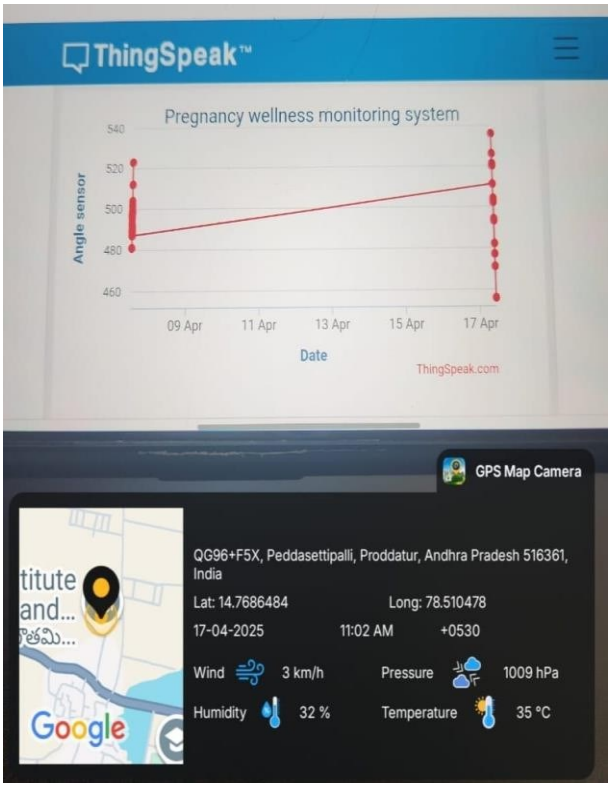

Fig-8: ThingSpeak results for Angle Sensor

Applications

- Prenatal Health Monitoring in Rural Areas

Ideal for regions lacking hospitals or specialist doctors, where regular maternal checkups are difficult.

- Smart Hospitals and Clinics

Can be integrated into smart hospital frameworks for real-time monitoring and digital patient records.

- Home-Based Maternity Care

Enables pregnant women to stay safely at home while still being continuously monitored.

- Emergency Health Alert Systems

Sends alerts to caregivers and hospitals in case of abnormal readings or fall detection.

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- Wearable Pregnancy Monitoring Devices

Can be developed as a wearable belt or band to constantly collect health data without user input.

- Remote Medical Consultation Platforms

Advantages

1. Real-Time Monitoring

Continuous tracking of critical health parameters ensures timely response to emergencies.

2. IoT and Cloud Integration

Health data is stored securely online and can be accessed remotely by doctors or caregivers.

3. Cost-Effective

Uses affordable components like ESP8266, making it feasible for low-income communities.

4. Reduces Hospital Dependency

Minimizes frequent hospital visits, which is especially beneficial during pandemics or for women in remote areas.

5. Portable and Compact

Can be worn or carried easily, ensuring health monitoring on the go.

6. Early Detection of Complications

Helps in identifying issues like high BP, oxygen drop, or falls before they become life-threatening.

7. User-Friendly Interface

LCD provides instant feedback to the user, and mobile apps offer easy visualization of health data.

Disadvantages

- Internet Dependency

Requires a stable Wi-Fi connection; may not function properly in areas with poor network access.

- Sensor Accuracy

Consumer-grade sensors may not be as accurate as professional hospital equipment.

- Power Supply Limitations

Needs a constant power source or battery management system for portability.

- Privacy Concerns

Health data stored online must be secured properly to avoid unauthorized access.

- Limited Detection Range

Does not monitor fetal movements or contractions, which are also vital in advanced stages of pregnancy.

Future Scope

- Integration with AI/ML for Predictive Analysis

Use machine learning models to predict potential health risks based on patterns in data.

- Mobile App Development

A dedicated mobile app for personalized health dashboards and medical consultation booking.

- Fetal Monitoring Add-ons

Integration of ultrasound or fetal heart rate sensors for complete pregnancy tracking.

- GPS and GSM Module Addition

For location-based emergency alerts in case of critical health situations or falls.

- Voice Assistant Integration

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Hands-free system for pregnant women to check health parameters via voice queries.

- Battery-Optimized Wearables

Develop energy-efficient wearable versions using Li-ion batteries and flexible electronics.

- Integration with National Health Records

Link patient data directly to government or private hospital systems for centralized prenatal care.

Conclusion

The proposed IoT-based health monitoring system for pregnant women is a reliable, affordable, and intelligent solution that addresses the limitations of traditional prenatal care systems. By leveraging sensor technologies, ESP8266 Wi-Fi microcontroller, and cloud platforms, it offers a comprehensive approach to monitoring vital signs such as temperature, blood pressure, oxygen level, heart rate, and movement. The system not only ensures real-time alerts and remote monitoring but also empowers expecting mothers and their caregivers with data-driven healthcare decisions.

This innovation is especially impactful in rural and resource-poor areas where access to medical professionals is limited. While there are some challenges like internet dependence and sensor precision, the potential for enhancing maternal health and reducing prenatal risks is significant. With future enhancements like AI integration, fetal monitoring, and mobile app development, this system can evolve into a complete prenatal digital health companion, transforming the landscape of maternal care.

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