

Pregnancy Health Monitor System

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Abstract— Pregnancy related muscle cramps are a frequent occurrence, yet their presence can sometimes signal serious underlying complications, such as preterm labor or compromised uterine blood flow. Ensuring continuous monitoring of key physiological parameters in expectant mothers is paramount for safeguarding both maternal and fetal well-being. A new smart-healthcare solution called the Pregnancy Cramp Detection System, created to help monitor and respond to cramp-related issues during pregnancy. The early prediction and detection of muscle cramps during pregnancy using a synergistic combination that makes use of biosensors along with advanced artificial intelligence and machine learning techniques. The aggregated data then serve as input for a specialized AI/ML model, which is trained to analyse fluctuations in muscle activity, temperature, and heart rate patterns to predict the probability of a cramp event. Upon the detection of an aberrant pattern, the system instantly generates a prediction alert on a dedicated dashboard, enabling prompt intervention by healthcare providers or caregivers.

Keywords—Pregnancy Health Monitor System.

I. INTRODUCTION

Pregnancy represents a critically sensitive phase in a woman's life, necessitating vigilant medical oversight and monitoring. This period is marked by major physiological and hormonal shifts, frequently resulting in symptoms like fatigue, muscular contractions, and abdominal cramps. While mild cramping is often benign, persistent or severe cramps can be symptomatic of deeper issues. The traditional paradigm of maternal healthcare largely relies on periodic clinical checkups. However, this conventional approach inherently lacks the capability for continuous, real-time monitoring, thereby creating potential gaps where critical health deviations might go undetected, leading to delayed intervention. The proposed Pregnancy Cramp Detection System is designed to address and overcome these limitations by seamlessly fusing IoT (Internet of Things)-based biosensors with AI/ML technology into a unified, intelligent health monitoring platform. System Components and Functionality-The system's core relies on three primary sensors. An EMG sensor to accurately record

muscle activity and identify irregular or a typical contractions. A heart rate sensor to measure pulse variability and cardiac response. A DHT11 temperature sensor to simultaneously track the patient's body temperature and the ambient environmentally temperature. These sensors connect to an ESP32 microcontroller which is in charge of gathering all the data. The ESP32's integrated Wi-Fi capability is utilized to transmit the collected data wirelessly and in real time to a secure Google Spreadsheet stored online. This cloud-based data repository ensures persistent logging and allows for continuous visualization, enabling healthcare professionals to keep track of important health signals from a distance.

Predictive Analytics and Intervention The stored data is subsequently processed by a dedicated AI/ML model. This model has been rigorously trained on diverse datasets encompassing both normal and pathologically abnormal physiological patterns. Its function is to meticulously analyze the incoming sensor readings (muscle activity, heart rate, temperature) to calculate and predict the likelihood of an impending pregnancy cramp. The predictive output is then rendered on an intuitive dashboard, offering clear, actionable insights for both clinicians and patients.

II. Literature Survey

Pregnancy-related cramps and uterine contractions are common phenomena that have been studied from both medical and engineering perspectives. In obstetrics, these cramps are understood as resulting from a combination of factors, including uterine expansion, ligament stretching, electrolyte imbalance Continuous monitoring, particularly in high-risk pregnancies, has been shown to be critical for detecting complications such as preterm labor and insufficient placental function, ultimately improving maternal and fetal health. Electromyography (EMG) has become an important tool for tracking muscle and uterine activity. In obstetric applications, uterine EMG, also called electro hystero-graphy (EHG), is used to measure contractions. Key features such as signal amplitude, burst frequency, and spectral properties have been linked to contraction intensity and labor progression. Similarly, surface EMG (sEMG) can capture early indicators of muscle cramps in limbs and the abdomen by detecting increased motor unit activity and distinctive waveform patterns. Standard preprocessing techniques like filtering,

routinely applied to improve signal quality. Monitoring heart rate and body temperature complements EMG measurements by providing insights into maternal physiological stress. Heart rate variability and absolute heart rate reflect autonomic responses associated with pain, stress, or fluid imbalance. Combining these cardiac indicators with EMG signals enhances the detection of early labor or distress. Temperature monitoring, whether through core or skin measurements, helps identify fever or environmental factors that may trigger cramps. Low-cost sensors, such as DHT11 modules, are commonly used in prototype systems to provide basic temperature and humidity data, while higher-precision instruments are preferred in clinical settings.

III. Proposed System

The system begins by collecting information from different sensors. These sensors measure values such as ECG, tracking heart rate, temperature, and environmental humidity. All of this raw data is gathered continuously.

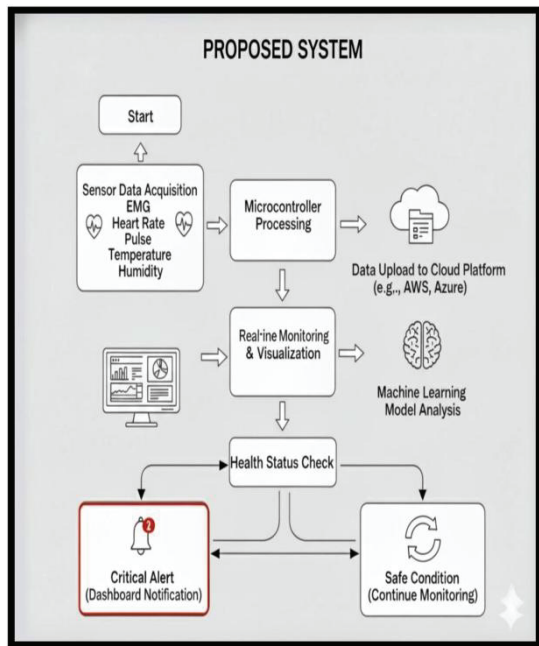


Fig 1: Proposed System

Once the readings are captured, they are sent through an ESP32 Wi-Fi module. This module transfers the data to a cloud server, where it can be safely stored and retrieved as required. At the same time, the sensor data is also displayed on a dashboard. The dashboard offers a live display of the readings so that the user or caretaker can easily watch the current conditions. A real-time monitoring unit takes the incoming data and checks it instantly. This unit passes the data to a machine learning model, which has been trained to understand normal and abnormal patterns in the health readings. The output of the machine learning model goes to a health status checking block. This block decides whether allowing the user or healthcare personnel to respond right away.

- If the readings are within a safe range, the system continues monitoring without any interruption.
- If the readings indicate danger or abnormal behaviour, the system generates a critical alert. This alert appears on the dashboard notification.

In summary, the system automatically collects health data, sends it to the cloud, analyses it using machine learning, and provides instant alerts if it detects anything unusual. The system goal is to detect health issues early and continuously monitor the user's condition.

IV. Hardware Requirements

The following hardware's are used to monitor the Health of pregnant woman.

EMG Sensor

The EMG module uses surface electrodes placed on the skin to capture the faint electrical signals that occur during muscle cramps. These signals are very small and noisy, so the sensor outputs a raw analog waveform that must pass through a conditioning circuit before it can be interpreted. The signal conditioning stage typically includes filtering, amplification, and smoothing to produce a clean version of the muscle activity for further processing.

Heart Rate Sensor

The heart rate sensor measures the user's pulse either through a photoplethysmography (PPG) technique or a embedded digital pulse sensor. It may provide an analog voltage output that needs to be converted using an ADC, or it may offer a digital interface such as I²C or SPI, which allows the ESP32 allowing the data to be read directly. The sensor provides beats-per-minute (BPM) or raw pulse waveform data for analysis.

DHT11

The DHT11 is a simple environmental sensor that delivers temperature and humidity data through a single-wire data transfer protocol. This sensor connects directly to the ESP32 and does not require analog conversion. It sends out calibrated values at regular intervals for further analysis microcontroller reads for monitoring the physical environment.

ESP32

The ESP32 operates as the central processor. It reads the conditioned EMG signal through its ADC pins, receives heart-rate data through either analog or digital channels, and communicates with the DHT11. Beyond data collection, the ESP32 performs tasks like filtering, segmenting data into windows, and extracting features. It can store or buffer this information and uploads it over Wi-Fi to a cloud platform server or dashboard. Additionally, the ESP32 is capable of running lightweight machine-learning models for on-device analysis when required.

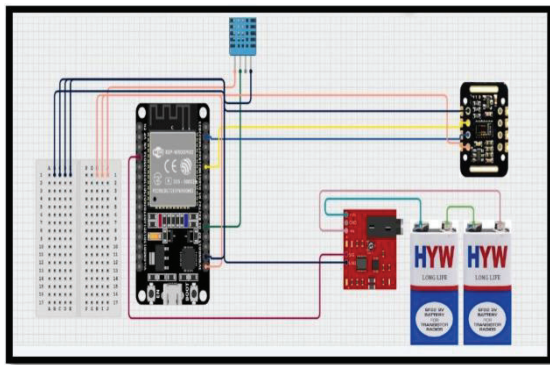


Fig 2: Hardware Pin Diagram

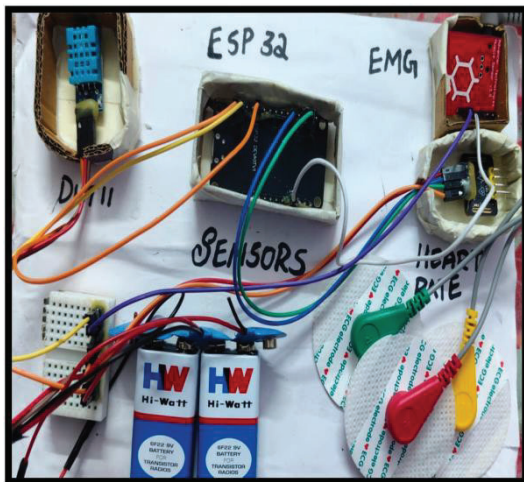


Fig 3: Hardware Circuit

V. Software Requirements

Arduino IDE

We use the Arduino IDE to write and upload code to the ESP32 where the entire firmware—sensor drivers, data formatting routines, and Wi-Fi functions is written and compiled. After compiling, the program is uploaded to the ESP32 board so it can operate independently. Once flashed, the device continuously gathers sensor data, processes it, and communicates with the cloud in real time.

Cloud Machine Learning Processing

Once the cloud receives the incoming data, it forwards it to a machine-learning model trained to detect muscle-cramp patterns or abnormal conditions. After processing, the system returns a prediction score showing how likely a cramp might occur, along with a confidence value and recommended actions. The full ML workflow and response interface are developed using JavaScript, with CSS used for styling and user-side interaction using React JS.

Wi-Fi and Cloud Data Upload

The ESP32 uses its built-in Wi-Fi module to push collected sensor information to a cloud platform. For every upload, the device prepares a file that includes the time of measurement, the raw sensor readings, and any features extracted from the

signals. This packet can be sent to different cloud endpoints such as a Google Apps Script service.

Dashboard and Alert System

A web or mobile dashboard provides users with real-time graphs of all sensor readings and trends over time. It also displays the most recent prediction output from the cloud model. If the system identifies a risk level that goes beyond its safety limit, it immediately sends notifications—such as Dashboard alerts. These alerts help ensure that the user or their caretaker can react quickly whenever the system detects potential danger.

VI. Result And Analysis

The developed system performed reliably during testing, showing that it can effectively monitor physiological signals and predict possible muscle-cramp risks. The EMG sensor provided clear muscle-activity signals after passing through the conditioning circuit, which removed noise and improved the quality of the waveform. Throughout the test, the sensor maintained stable heart rate measurements both rest and movement. All these values were collected smoothly by the ESP32 without delays or data loss.

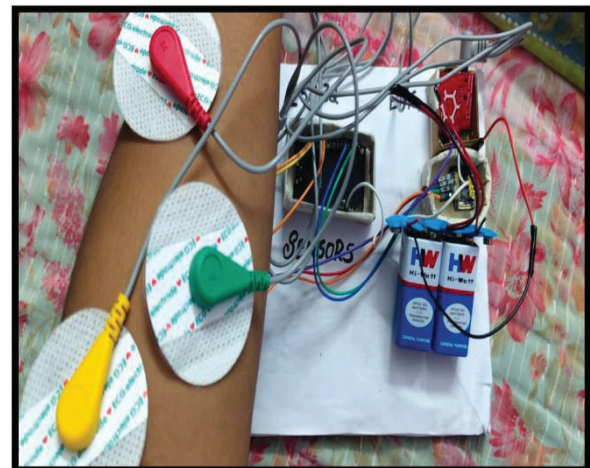


Fig 4: Connecting Electrodes to detect Cramp

The ESP32 successfully connected to Wi-Fi and uploaded the processed sensor readings directly into Google Sheets. This ensured that all data was stored securely and could be accessed remotely at any time. The time-stamped logs confirmed that the system maintained continuous and reliable communication with the cloud. The machine-learning model running on the cloud analyzed the uploaded data and generated predictions about the muscle cramps. The dashboard displayed real-time readings and historical data in a clear and easy-to-understand format. Users could view live graphs of EMG, heart rate, temperature, and humidity, along with the prediction results from the machine-learning model. When the system detected a high risk of muscle cramps, it immediately triggered alerts via notifications, allowing quick action. Overall, the results showed that the system worked smoothly, provided accurate predictions, and could be a practical tool for continuous health monitoring and early detection of potential muscle cramps.

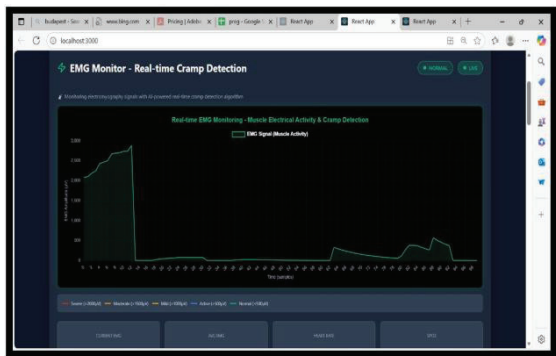


Fig 5 :EMG Monitor Real-Time Cramp Detection

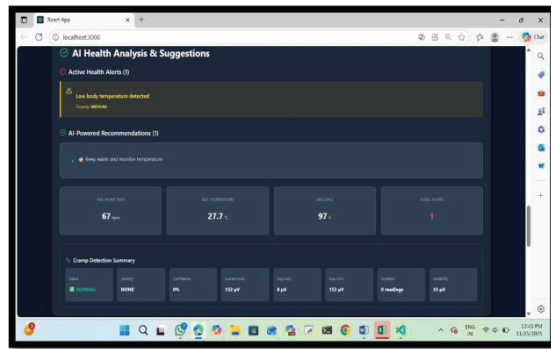


Fig 9: AI Health Analysis & Suggestions

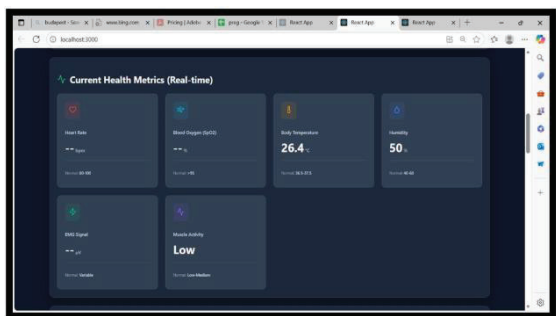


Fig 6: Health Metrics

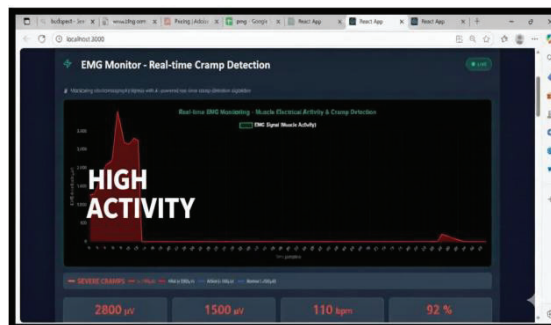


Fig 10 : Cramp Detected

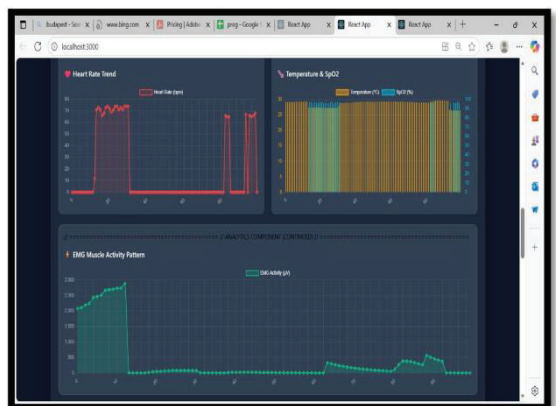


Fig 7: Heart Rate, Temperature, EMG Activity Pattern

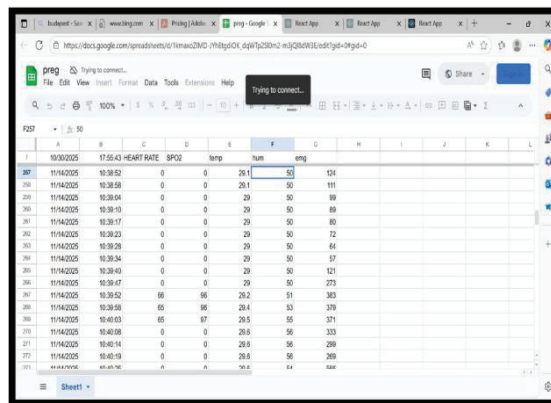


Fig 11: Google Spread Sheet Data

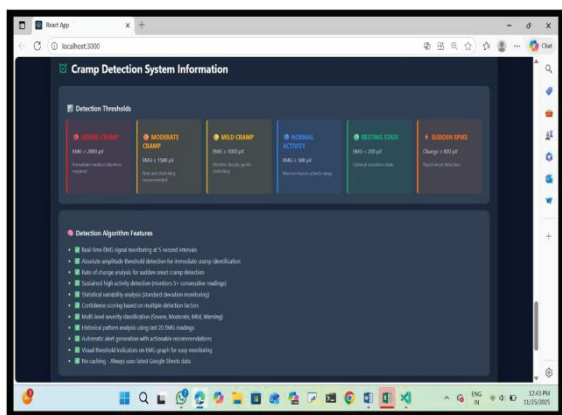


Fig 8 : System Information

VII. Conclusion

In this conclusion, the Pregnancy Cramp Detection System demonstrates a practical and innovative approach to improving the health and safety of expectant mothers. By combining wearable sensors, IoT technology, and AI/ML prediction models, the system continuously monitors vital signs such as muscle activity, heart rate, and body temperature. This enables mothers and healthcare professionals to receive real-time insights, bridging the gap between periodic check-ups and ongoing health supervision.

AI and machine-learning algorithms analyze the information to detect patterns and predict the likelihood of muscle cramps, triggering early warnings through a dashboard or notifications. This proactive feature helps prevent complications and supports timely decisions, reducing stress for both patients and caregivers. Unlike traditional hospital monitoring, this system is portable, non-invasive, and cost-effective, making it suitable for both home and clinical use. Overall, this system highlights how

technology can enhance maternal care, improve safety, and provide peace of mind for mothers while promoting better pregnancy outcomes.

VIII. References

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