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NEXT-GEN HEALTH MONITOR: ENHANCING PRENATAL AND THYROID HEALTH OUTCOMES

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Abstract: The objective of this project is to create and deploy a non-invasive smart monitoring system that makes use of Internet of Things (IoT) technology in order to enhance thyroid and pregnant health outcomes. Vital health data is continuously measured by the system using an ESP32 microcontroller in conjunction with many sensors, including an accelerometer, MLX90614 (temperature), BMP180 (pressure), and MAX30100 (pulse rate and SpO2). The processed data from the sensors is transferred over WiFi to Thingspeak, a cloud-based platform, enabling real-time monitoring and analysis. A mobile application provides a user-friendly interface for accessing and displaying health information, enabling patients and healthcare providers to make informed decisions. As a result of the system's excellent accuracy, reliability, and usability, remote health management can benefit from its use. Providing a noninvasive, scalable, and cost-effective solution to improve health monitoring for patients with thyroid diseases and pregnant women is the aim of this research. The findings show how early diagnosis and timely treatment may significantly enhance patient outcomes and the quality of healthcare provided.

Index Terms **-** Non-invasive monitoring, Internet of Things (IoT), Prenatal health, Thyroid health, Realtime data

I.INTRODUCTION

Recent years have seen a transformation in health monitoring due to the introduction of Internet of Things (IoT) technology, which offers non-invasive, real-time data collection and analysis. This review paper focuses on how IoT may be used to develop a smart monitoring system that would enhance the health of expectant mothers and thyroid patients. By integrating sensors and microcontrollers, these systems can continuously monitor critical health variables. Patients and medical professionals can then immediately access the data by having it sent to cloud platforms. This technology has tremendous promise for enhancing the delivery of healthcare since it can manage health remotely, reduce the need for frequent in-person visits, and give timely medical treatments based on accurate and up-to-date health data.

The need for innovative solutions in healthcare is highlighted by the growing prevalence of chronic diseases and the requirement to regularly monitor high-risk patients. Patients may find routine clinical visits or invasive procedures tiresome and unpleasant while using standard monitoring methods. IoTbased health monitoring systems offer a more patient-friendly alternative by offering continuous, non-invasive monitoring in the convenience of the patient's home.

This article will explore the existing systems and their drawbacks, look at how IoT technology is developing for health monitoring, and offer a detailed analysis of the recommended smart monitoring system. The possible impacts of these systems on patient outcomes, cost-effectiveness, and scalability will also be discussed, emphasizing their significance in the quickly evolving field of healthcare technology.

II. LITERATURE REVIEW

1) *Smart Remote Monitoring System for Prenatal care in Rural areas*

Dhanwanth, B. et al. [1] The ThingSpeak cloud server and Support Vector Machines (SVM), a kind of machine learning technology, are two instruments used by the suggested Smart Remote Monitoring System for Prenatal Care in Rural Areas to enhance prenatal care. The gadget continuously monitors a wide range of physiological parameters, such as blood pressure, temperature, heart rate, blood glucose levels, accelerometer data, and uterine contractions. In remote areas where access to medical facilities may be limited, the system's analysis of these parameters aims to provide timely information and warnings to healthcare practitioners. Sensors are used to test the system by evaluating key health indicators on a sample of 307 individuals.

These comprise sensors for temperature, blood pressure, heart rate, and SpO2, all of which are essential for assessing moms' health. Among the factors that are looked at are maternal heart rates between 80 and 110 beats per minute (BPM), blood pressure between 90 and 140 mm Hg, SpO2 levels under 97%, body temperature between 37.5 and 38.4 degrees Celsius, and maternal weight between 60 and 85 kg. Complete monitoring of maternal health is achieved by include these specific features, which aids in the early detection of any health issues.

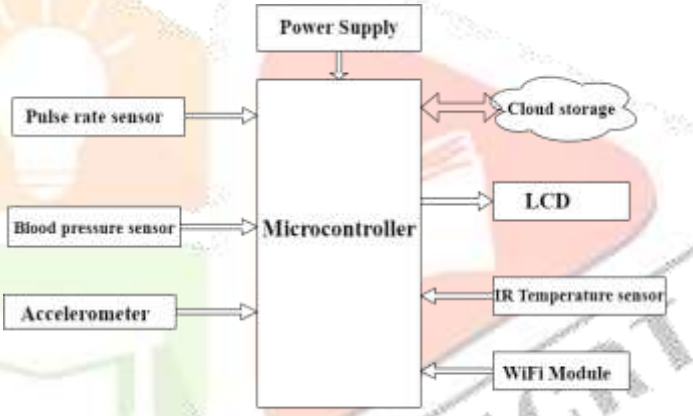

Figure1. Hardware Block Diagram of System.

2) *Thyroid Disease Detection Learning Disease Detection Using Machine Learning Approach.*

Viswanatha V. *et al.* [2] In the realm of medical diagnostics, machine learning has shown a lot of promise for increasing the accuracy and effectiveness of sickness detection. A notable study by Viswanatha V provides a comprehensive machine learning approach for the diagnosis of thyroid disorders. This approach predicts and classifies thyroid illnesses according to significant medical features by utilizing a range of machine learning techniques, including neural networks, SVM, random forests, decision trees, and Naive Bayes.
These samples measure the following parameters: ThyroidStimulating Hormone (TSH): This essential hormone, which can range from 0.5 to 5.0 mIU/L, causes the thyroid gland to create thyroid hormones. Triiodothyronine (T3): This active thyroid hormone, which has typical ranges of 0.9 to 2.8 nmol/L, is essential to the body's metabolic functions. T4 (thyroxine): Since T4 is the main hormone generated by the thyroid gland, levels of this hormone, which range from 5.4 to 11.5 mcg/dL, are essential for understanding thyroid function. Thyroglobulin: Thyroglobulin, a protein generated by the thyroid gland with normal levels between 20 and 25 ng/mL, is frequently employed as a tumor marker in thyroid cancer surveillance.

3) *The technological evolution of fetal monitoring in pregnancy core.*

Cristiano Salles Rodrigues. et al. [3] The majority of pregnant women who utilized mobile apps had similar aspirations, according to a research that looked into why they did so. With the use of specialized equipment like an ESP32 microcontroller with 4 MB of flash memory, a pulse oximeter, a tocodynamometer, and a Fetal Movement Acceleration Measurement Recorder, the study employed artificial intelligence (AI) to track vital

indicators like fetal heartbeats, fetal movements, and maternal pulse rate. Throughout a woman's 4–7 month pregnancy, data was meticulously recorded and analyzed by advanced computer software, providing significant insights on the health of the fetus and the mother.

4) *A Study on Learning and Intelligence Based Techniques In Thyroid Diagnosis*

Sonia Rani et al. [4] The researcher investigated AI approaches for thyroid detection using a range of methodologies, including BPN, SVM, ANN, DSS, MLP, CNN, and deep learning, in addition to machine learning and Internet of Things technologies. The three characteristics that were assessed in 215 samples and categorized as hypo=30, hyper=35, and normal=150 were temperature, pulse rate, and basal body temperature. In addition to sensors like temperature, pulse rate, and infrared thermopile non-contact smart sensors, the following techniques were employed: learning vector quantization, KNN, MATLAB, ANN, BPN, hybrid backpropagation neural network, and SVM.

5) *A Non-Invasive Technique to Detect Thyroid using Infrared Sensor.*

M. Malathi et al. [5] An inexpensive Internet of Things smart sensing gadget aims to non-invasively detect thyroid issues through skin temperature monitoring. This approach tracks important variables such as age (20–41 years), body temperature (32.75-26.09 °C or 95.92–98.22 °F), and pulse rate (69–95 beats per minute). The system's primary components are an Arduino UNO, an output display, a temperature sensor (MLX90614), and a pulse rate sensor. The operational temperature range of the MLX90614 temperature sensor is wide: -40 °C to 125 °C for ambient air and -70 °C to 382.2 °C for objects. Its 10-bit PWM output can convey temperatures from -20 to 120 °C with an accuracy of 0.14 °C, giving precise temperature measurements that are crucial for monitoring thyroid health.

6) *Hypothyroidism Disease Diagnosis by Using Machine Learning Algorithms*

Awad Bin Naeem et al. [6] In this work, hypothyroidism is identified using advanced machine learning techniques. The following factors are taken into account for the diagnosis: patient ID, age, sex, history of illness, history of radiation therapy, current medication, stage of pregnancy, presence of neck edema, low pulse rate, high blood sugar levels, and slow resting pulse rate. Support vector machines (SVM), logistic regression, K-nearest neighbors (KNN), and RAPID MINER, an open-source collection of machine learning algorithms and data processing tools, are just a few of the tools employed in the study. The examination of 370 samples revealed that SVM and KNN were 84.72% and 79.25% accurate, respectively, demonstrating the effectiveness of these machine learning algorithms in the diagnosis of hypothyroidism.

These results demonstrate how machine learning may be used to medical diagnostics, leading to the development of more accurate and efficient health monitoring systems. Future investigations may concentrate on expanding the dataset and examining other variables in order to further increase diagnostic accuracy.

7) Virtual prenatal care: A review of pregnant women's and healthcare proffesionals experiences, needs, and preference for quality care.

Ghimire, S. *et al.* [7] The study focuses on mobile applications that employ asynchronous telehealth methods to control pregnancy risk, including mobile messaging, SMS, and expert consultations. Important indicators that are monitored include readings from the sphygmomanometer (SFIG), data from the cardiotocograph (CTG), blood pressure (BP), blood glucose (BG), body weight (BW), and fetal heart tone (FHT). Using machine learning techniques like support vector machines (SVM) and K-nearest neighbors (KNN) on a dataset of 350 samples, the study monitored through phone and video consultations. Combining the SFIG and mobile app made monitoring throughout the three to seven month pregnant period easier, which led to timely and effective treatment of pregnancy-related dangers.

8) Barriers to Prenatal Care Among Food-Insufficient Women: Findings from the Pregnancy Risk Assessment Monitoring System.

Jackson, D.B. et al. [8] A study that used data from the Pregnancy Risk Assessment Monitoring System (PRAMS) covering the years 2009 to 2016 revealed a number of unfavorable outcomes associated with prenatal treatment when food insufficiency occurred during pregnancy. Researchers have shown a correlation between dietary insufficiency and delayed commencement of prenatal care as well as fewer total prenatal

visits using negative binomial and logistic regression models. Furthermore, a greater number of obstacles to obtaining prenatal care are linked to dietary insufficiency. Among these are lack of funds, inability to get about, trouble taking time off work, inability to receive Medicaid, and trouble organizing child care.
Food insecurity has a negative impact on mother and child health, which emphasizes the need for focused measures to increase pregnant women's access to prenatal care. By removing these obstacles, maternal and newborn health outcomes may improve as well as the quality of prenatal care.

III. METHODOLOGY

1) System Design and Implementation.

The non-invasive smart monitoring system incorporates Internet of Things (IoT) sensors to monitor fetus and thyroid health. The primary device features an accelerometer for movement detection, an MLX90614 for infrared temperature, and a BMP180 for blood pressure. The secondary device is equipped with a MAX30100/02 pulse rate sensor. These devices have a switch button that lets you use them for tracking pregnancy issues and thyroid issues separately. The main device will be positioned in the abdomen to monitor the fetus and on the neck to check the thyroid. The additional gadget will be worn on the wrist to measure pulse rate. The system uses ESP32 and WiFi for connectivity, and the Things peak cloud platform for data processing and storing.

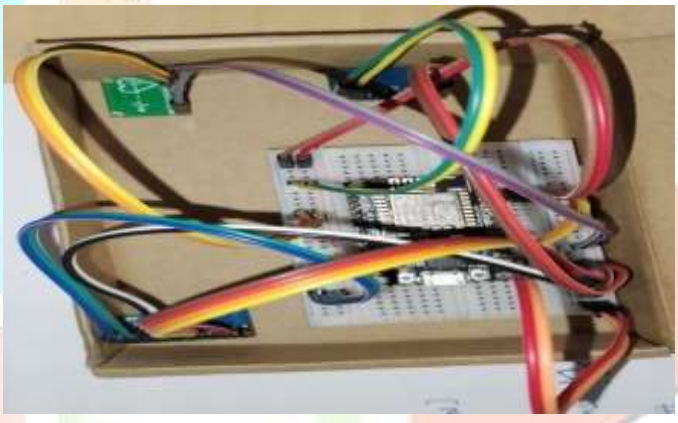

Figure 2. Design of Monitoring system.

2) Data Prediction and Analysis

The sensor data will be utilized to forecast the patients' health statuses using state-of-the-art data analytic techniques. Temperature, blood pressure, and heart rate are just a few of the variables that the prenatal monitoring system continuously tracks to determine the health of the mother and the fetus. To test thyroid function and detect potential thyroid issues, the same set of criteria is used for thyroid examination. The sensor data will be examined using statistical models or machine learning approaches to anticipate and categorize health concerns. These algorithms will become more reliable and accurate predictors of numerous medical problems by learning to recognize patterns and anomalies associated with certain diseases. In order to enhance its predictive capabilities, the system will also leverage contextual and historical data. In order to enhance its predictive capabilities, the system will also leverage contextual and historical data. The primary objective of predictive analysis is to provide timely and valuable insights that facilitate early condition management and intervention. The objective of this approach is to improve patient outcomes by offering proactive, tailored treatment through real-time data analysis.

3) User Interface and Power Management

On a mobile website, patient states will be identified and sensor data will be shown through an intuitive and user-friendly interface. Graphs and charts, which are real-time data visualization tools, will allow users to instantly monitor their health statistics on this platform. It will provide customers access to data analysis tools that provide insights into the data and help them understand their current health status and any anomalies discovered. High-capacity lithium-ion batteries will power the devices in an efficient manner. Because of

their compact design, extended lifespan, and ability to be recharged, these batteries are chosen to guarantee that the gadgets may be used for extended periods of time without requiring frequent recharging.

IV. **RESULTS**

The goal of this project is to produce a novel, non-invasive smart monitoring gadget that monitors prenatal health and diagnoses thyroid abnormalities using Internet of Things technology. Among the several sensors built within the system are the MLX90614 infrared temperature sensor, the BMP180 blood pressure sensor, the accelerometer, and the MAX30100/02 pulse rate sensor. One wearable device monitors pulse rate, while the other is designed to assess thyroid function and track the progress of pregnancy. Customers may effortlessly go between tracking their thyroid and pregnancy health with a single button press. Using an ESP32 and a WiFi module, data is transferred to the Thingspeak cloud platform for analysis and storage.

The collected sensor data will be programmed and processed using the Arduino IDE tool. This data will be used to forecast and categorize health diseases, providing crucial insights and alerts for potential health problems. The predictive capabilities of the system aim to enhance the health outcomes of thyroid issue patients, mothers, and fetuses by improving early detection and care.
A mobile website with real-time data visualization and interpretation features will be developed to present sensor data in an understandable way to users so they can appropriately monitor their health. Once these batteries are adjusted to guarantee consistent and long-lasting functioning, the monitoring gadget will be practical and portable for everyday usage.

The final goal is to provide a comprehensive, user-friendly solution for continuous health monitoring and early health issue identification in order to enhance patient treatment and outcomes.

V. **CONCLUSION**

In conclusion, this research successfully develops a noninvasive smart monitoring system for thyroid diagnosis and pregnant health monitoring by leveraging a range of sensors and Internet of Things technologies. The design of the system consists of two devices: a primary device with temperature, acceleration, and blood pressure sensors, and a secondary device worn on the wrist for pulse rate monitoring. Thanks to the inclusion of a switch button, users may quickly transition between the prenatal and thyroid monitoring modes. These sensors collect data, which is then sent by WiFi and ESP32 to the Thingspeak cloud platform for analysis and storage. Utilizing the Arduino IDE tool simplifies programming and data processing.

Users may effectively monitor their health by seeing and understanding data in real time using an easy-to-use mobile website. This comprehensive monitoring system aims to improve patient outcomes by proactively managing health concerns and identifying them early on through the provision of insightful information and timely alarms. By using innovative IoT technology with a robust design, this project delivers a significant improvement in the field of non-invasive health monitoring, ultimately enhancing patient care and wellbeing.

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