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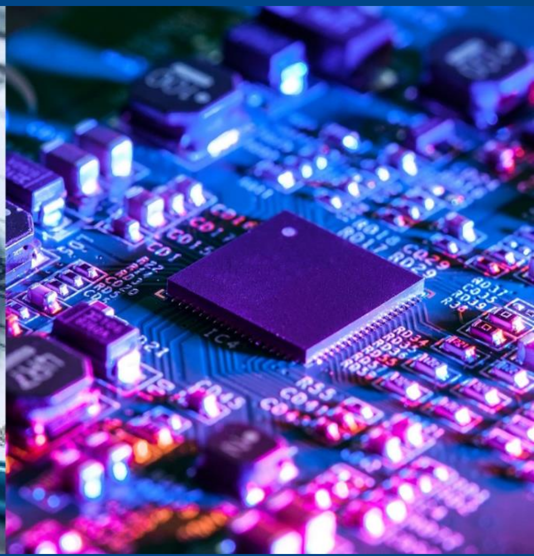

International Journal of Multidisciplinary Research in Science, Engineering and Technology

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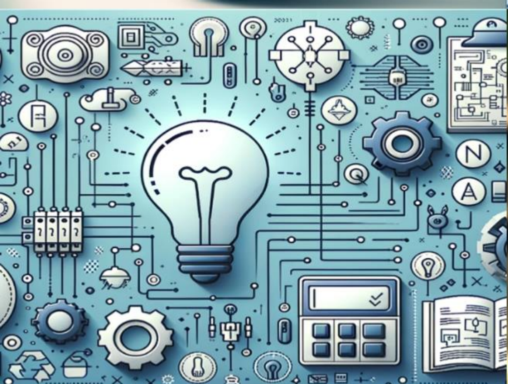

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Smart Health Monitoring System with Real-Time Vital Tracking and Predictive Diagnostics

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ABSTRACT: With the rising global prevalence of cardiovascular diseases and the growing need for accessible healthcare solutions, there is a critical demand for systems that can provide both continuous monitoring and early diagnosis. This project presents a Smart Health Monitoring System with Real-Time Vital Tracking and Predictive Diagnostics, a comprehensive and intelligent health management platform that combines Internet of Things (IoT) technology with machine learning- based predictive analytics.

The system integrates a heartbeat sensor and DS18B20 temperature sensor connected to an ESP32 microcontroller, which continuously captures vital physiological parameters. This data is transmitted wirelessly to a Flask-powered web server, where it is logged, visualized in real time through an interactive dashboard, and stored for further analysis. Users can monitor trends over time, download data in CSV format, and reset logs as needed.

KEYWORDS: IoT ESP32 Flask HTML, CSS, JavaScript, ML, CSV, PDF Repor,t Heartbeat Sensor, DS18B20, Real-Time Monitoring, Health Dashboard, User Auth Predictive Analytics.

I. INTRODUCTION

The rapid advancement of technology in the healthcare sector has paved the way for intelligent systems that enhance patient care, enable early disease detection, and support remote health monitoring. In recent years, cardiovascular diseases (CVDs) have become a leading cause of death globally, accounting for approximately 17.9 million deaths each year according to the World Health Organization. Early detection and continuous monitoring of vital signs are critical for timely intervention and improved patient outcomes.

Traditional health check-ups, which rely on periodic visits to healthcare facilities, often fail to capture real-time physiological changes, especially in high-risk individuals. Moreover, in rural or underserved areas, access to timely diagnostics and medical consultation is limited. To address these challenges, there is an increasing need for smart, accessible, and affordable health monitoring solutions that can operate in real-time and provide actionable insights.

This project introduces a Smart Health Monitoring System that seamlessly combines IoT-based real-time vital tracking with machine learning-driven predictive diagnostics. The system utilizes an ESP32 microcontroller connected to a heartbeat sensor and a temperature sensor (DS18B20) to continuously capture a patient's vital signs. The data is transmitted over Wi-Fi to a centralized Flask web application, where it is stored, displayed on a live dashboard, and made accessible to the user.

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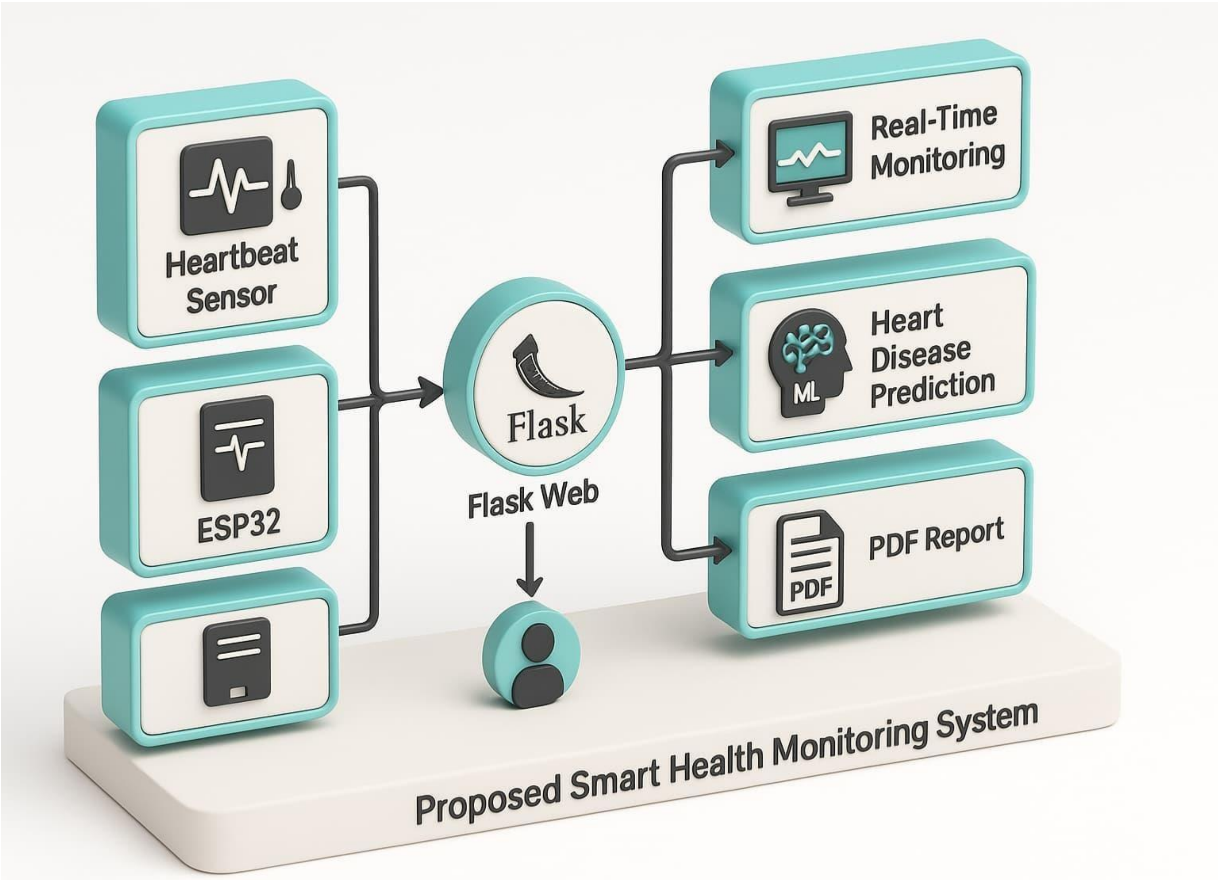

II. EXISTING SYSTEM

Traditional health systems require periodic visits to clinics or hospitals, which do not provide continuous real-time monitoring. IoT-based systems exist but often lack predictive diagnostic capabilities using AI. Some available systems are too expensive or not user-friendly, especially in rural setups. Most systems do not provide downloadable reports, AI-based heart disease risk prediction, or sensor integration with live dashboards.

III. NEED OF THIS PROJECT

Cardiovascular diseases are the leading cause of death globally and require early detection and continuous monitoring. There is a gap in remote and real-time healthcare solutions, especially in underserved and rural regions. Patients need a low-cost, user-friendly, and reliable system to manage their health proactively. The system enables doctors to monitor patients remotely, reducing hospital load and providing telehealth support. Combining IoT and AI bridges the gap between healthcare professionals and patients through data-driven care.

IV. PROPOSED SYSTEM

An IoT-based system using ESP32, a heartbeat sensor, and a DS18B20 temperature sensor to track vitals. Real-time data is sent via Wi-Fi to a Flask web server, displayed on a live dashboard and saved in CSV format. Includes a machine learning model trained to predict heart disease risk based on clinical inputs (age, sex, blood pressure, etc.). Generates PDF health reports including patient data and prediction outcomes. Offers user registration, login, and personalized dashboard for privacy and user-specific data visualization. Admins can monitor all users, view logs, and manage data. Promotes scalability, supports remote monitoring, and is ideal for telemedicine applications.

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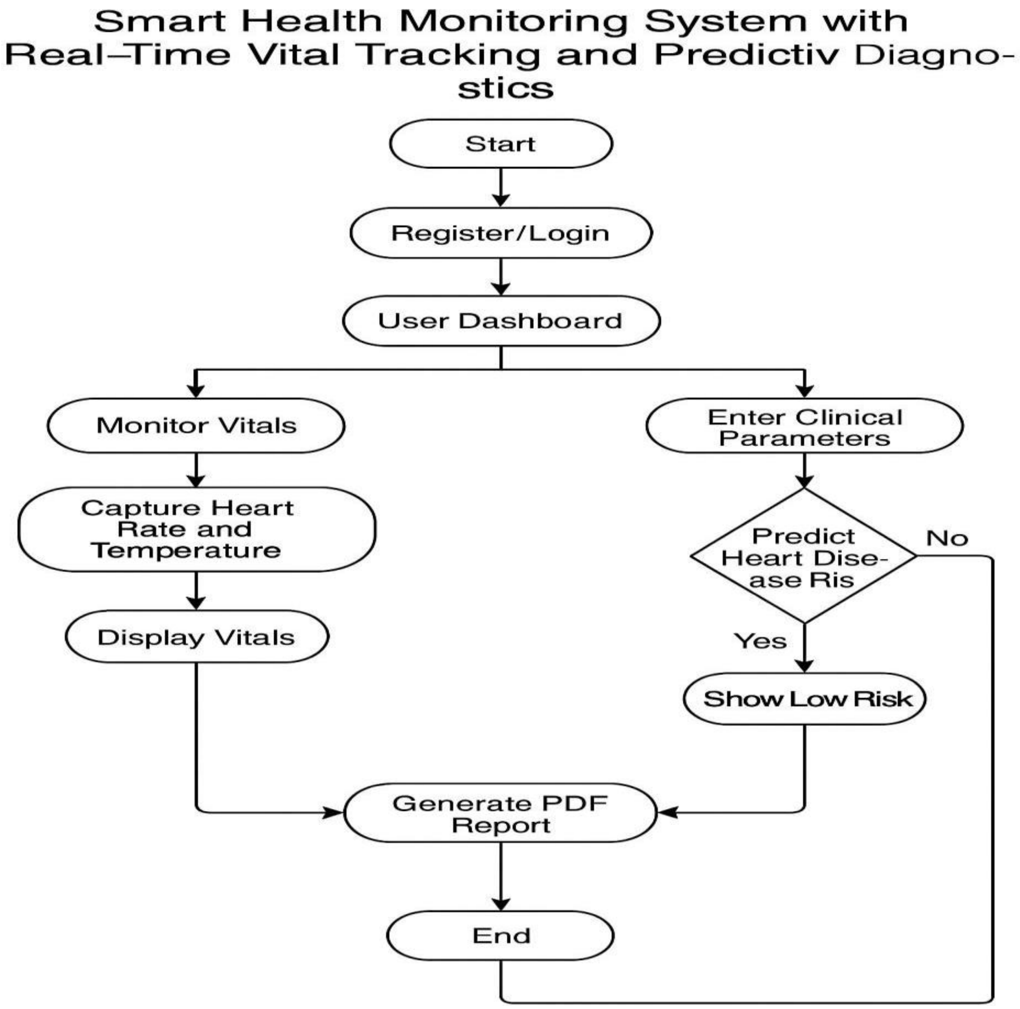
V. METHODOLOGY

The development of this project follows a modular and iterative methodology involving several phases — data preparation, machine learning model training, sensor integration, web application development, and system testing. Each component was developed independently and then integrated to form smart health monitoring system.

1. **Data Collection and Pre-processing**
   Relevant patient datasets were collected containing attributes like age, gender, Age, Sex, ChestPainType , RestingBP, Cholesterol, FastingBS, RestingECG, MaxHR, ExerciseAngina, Oldpeak, ST_Slope, HeartDisease.
   The data was cleaned and preprocessed to handle missing values, normalize numerical data, and encode categorical features such as soil type. Label encoding and standardization techniques were applied to prepare the data for model training.

2. **Machine Learning Model Development**

- A supervised machine learning algorithm (such as Random Forest Classifier) was selected for crop recommendation.
- The model was trained using the preprocessed dataset and evaluated using accuracy, precision, and confusion matrix.
- The trained model was saved using joblib in .pkl format for later integration into the Flask web application.
- Feature extraction: Symptoms are converted into a binary feature vector.
- Label encoding: Diseases are encoded into numerical classes.



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VI. CONCLUSION

The Heart Disease Prediction System developed using Flask provides a comprehensive and user-friendly platform for assessing cardiovascular health risks. By integrating machine learning models with a web-based interface, the system enables users to input their health parameters and receive immediate predictions about their heart disease risk. The inclusion of features like PDF report generation, real-time IoT data logging, and secure user authentication makes it a practical tool for both individuals and healthcare providers. This project successfully bridges the gap between medical diagnostics and accessible technology, empowering users to proactively monitor their heart health.

One of the system's key strengths is its modular and scalable architecture. The use of Flask ensures lightweight yet efficient performance, while SQLAlchemy and Bcrypt provide robust data management and security. The machine learning model, trained on clinical data, offers reliable predictions, and the dynamic report generation enhances usability. Additionally, the IoT integration allows for continuous health monitoring, making the system adaptable for future expansions, such as mobile app integration or advanced analytics.

VII. FUTURE WORK

Integration with mobile applications for better accessibility and notifications. Advanced analytics using deep learning models to improve prediction accuracy. Expansion to monitor more health parameters like oxygen saturation (SpO2), blood pressure, and ECG patterns. Cloud storage integration for long-term and large-scale data storage. Real-time doctor consultation feature via video call within the web interface. Emergency alert system that notifies doctors or family during abnormal readings. Multi-language support to improve accessibility in rural areas.

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