Smart Healthcare Monitoring System Using Mobile App, Data Collection using Cloud Storage, and Building a Dashboard for Real-Time Health Analytics and Reporting

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Abstract— The rapid advancement in IoT and cloud computing has revolutionized healthcare monitoring systems. This project proposes a Smart Healthcare Monitoring System that integrates a mobile app (Android-based), cloud storage (Thing Speak), and a real-time analytics dashboard (Power BI) for continuous health tracking. The system collects vital health parameters such as body temperature (LM35 sensor) and heart rate (pulse sensor) via an ESP8266-based IoT module, transmits data to the cloud, and visualizes it for medical professionals and patients. The Android app (developed in Java/Android Studio) enables users to monitor real-time health metrics, while Thing Speak ensures secure cloud-based data storage. Power BI generates interactive reports for predictive analytics, and SQLite manages local data efficiently. RESTful APIs facilitate seamless communication between devices and the cloud. This system enhances remote patient monitoring, reduces hospital visits, and provides timely medical interventions, improving healthcare accessibility and efficiency.

Keywords— IoT-based Health Monitoring,Cloud Computing in Healthcare, Real-time Health Analytics, Remote Patient Monitoring

Introduction

Health monitoring has gained immense significance in modern times due to the increasing prevalence of lifestyle-related diseases such as obesity, diabetes, hypertension, and cardiovascular disorders. With the advancement of technology, traditional health tracking methods, which often required medical visits and manual record-keeping, have evolved into digital solutions. The widespread availability of smartphones and wearable devices has provided an opportunity to leverage these technologies for continuous health monitoring. By integrating mobile applications with cloud computing and data visualization, users can gain deeper insights into their health trends and make informed decisions about their well-being. In today's fast-paced world, people often neglect their physical health due to their hectic work schedules and sedentary lifestyles. The lack of regular physical activity has led to an alarming rise in chronic diseases, making preventive healthcare more critical than ever. While fitness enthusiasts use step counters and fitness trackers to monitor their progress, a significant portion of the population remains unaware of the importance of daily activity. The Smart Healthcare Monitoring System aims to bridge this gap by providing an intuitive and easy-to-use solution that encourages users to track their movement and engage in a more active lifestyle.

I. RELATED WORK

The reviewed literature presents a comprehensive overview of advancements in health monitoring systems, highlighting key technologies such as mobile applications, IoT, cloud computing, AI, and data security frameworks. Smith et al. (2020) emphasize the transformative role of mobile health (mHealth) applications in managing chronic diseases, offering real-time tracking, medication reminders, and personalized health insights. However, they identify limited real-time data visualization as a drawback. Kumar and Mehta (2019) trace the evolution of pedometer technologies from mechanical devices to modern accelerometer-based trackers, underlining their clinical utility and the need for standardized calibration to improve accuracy. Doe and Green (2021) focus on cloud-based data storage, showcasing its benefits in enhancing access to health records and supporting telemedicine, while also pointing out concerns regarding data privacy and internet dependency. Johnson (2018) explores the importance of data visualization in health analytics, advocating for interactive dashboards to improve understanding and patient motivation. Williams and Patel (2020) analyze how IoT and AI integration enables continuous health monitoring and early disease detection, especially in chronic care. Garcia (2022) evaluates Thing Speak, a cloud platform for IoT applications, noting its real-time capabilities but also its limited mobile and advanced analytics features. Banerjee and Singh (2021) propose an IoT and deep learning-based health monitoring system using LoRa for efficient remote healthcare, particularly in underserved areas. Li and Wang (2020) introduce a deep reinforcement learning (DRL) model that adapts health monitoring intensity based on user activity, improving energy efficiency and personalization. Chen and Zhao (2021) present a novel health system using triboelectric sensors integrated with IoT and VR, promoting immersive and self-powered health tracking. Finally, Ahmed and Bose (2022) address privacy and security in IoT-based healthcare through PRISM, a framework that combines encryption, blockchain, and machine learning to protect sensitive medical data effectively.

II. DATASET DISCRIPTION

The given diagram represents the **data flow and functional architecture** of a healthcare monitoring system. It showcases how data is **collected, processed, stored, and presented to users**, ensuring effective monitoring and alert mechanisms. Below is a detailed breakdown of each component and its role in the system:

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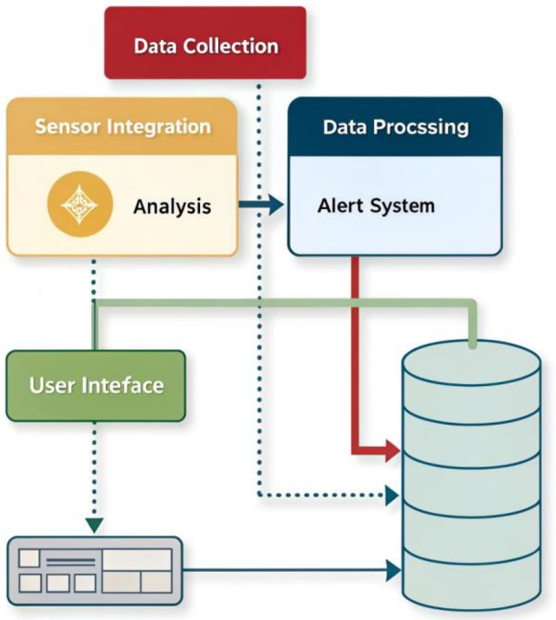


Fig 1 . Data Collection

The given diagram represents the **data flow and functional architecture** of a healthcare monitoring system. It showcases how data is **collected, processed, stored, and presented to users**, ensuring effective monitoring and alert mechanisms. Below is a detailed breakdown of each component and its role in the system:

A. Data Collection (Input Layer):
This stage gathers raw health data from various sensors monitoring parameters like heart rate and step count.
The collected data is sent to the Sensor Integration module for initial processing.

B.SensorIntegrationandAnalysis:
Sensor data is filtered and cleaned to remove noise and enhance accuracy. The structured data is then forwarded for processing and storage.

C.DataProcessing and Alert System:
This module analyzes sensor data and uses alerts to notify users of any abnormalities. It may employ machine learning to predict risks and provide real-time health insights.

DataStage(Database):
Processed data is stored in a centralized database for long-term access. The database supports trend tracking, analysis, and feeds information to the alert system and UI.

F.User Interface (Output Layer):
The UI displays real-time and historical health data in a user-friendly format. Users can customize alerts, set goals, and share reports with healthcare providers.

III. HARDWARE AND SOFTWARE COMPONETS

The **Smart Healthcare Monitoring System** integrates several software tools and hardware tools and platforms to ensure efficient **data collection, cloud storage, real-time synchronization, and visualization**. Below is a detailed explanation of each technology used in the system.

Hardware components

A.ESP8266:
The ESP8266 is a low-cost Wi-Fi microchip with built-in microcontroller capabilities.
It allows devices to connect to Wi-Fi networks and supports interfaces like GPIO, I2C, and UART.
Popular in IoT projects, it can run standalone applications without needing an external controller.

B.HeartBeatSensor:
The Heart Beat Sensor measures heart rate by detecting changes in blood volume through light absorption.
It typically uses an LED and a photodiode to generate electrical signals based on pulse activity.
The sensor output is filtered and processed by a microcontroller for accurate BPM readings.

C.LM35 Temperature Sensor:
The LM35 is a temperature sensor that outputs voltage linearly proportional to the temperature in Celsius.
It offers high accuracy, low self-heating, and operates over a wide temperature range.
Its simplicity and reliability make it ideal for embedded and battery-powered systems.

Software Components

A.AndroidStudio:
Android Studio is the official IDE for Android app development, supporting Java and Kotlin.
It features tools like UI designers, emulators, and debugging utilities.
It helps developers build, test, and deploy mobile apps efficiently.

B.Java/Kotlin:
Java is a robust, object-oriented language commonly used in Android development.
Kotlin is a modern alternative with concise syntax and enhanced safety features.
Both integrate seamlessly with Android Studio to create responsive mobile applications.

C.ThingSpeak Cloud Platform:
Thing Speak is an IoT cloud platform used for collecting and analyzing sensor data in real time.
It supports data visualization and MATLAB-based analytics.
Developers can store health data securely and retrieve it via RESTful APIs.

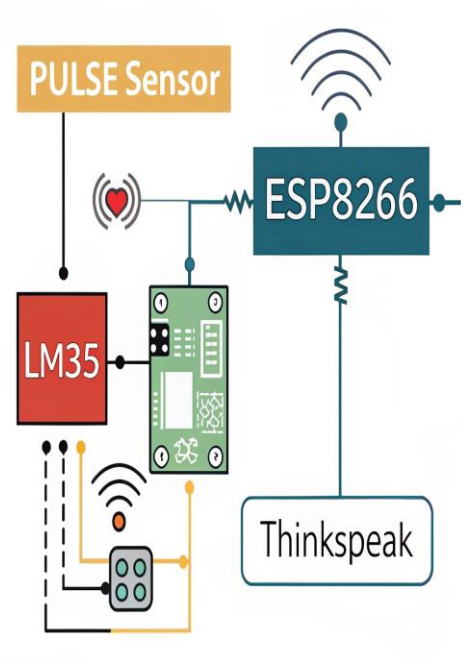
D.PowerBI:
Power BI is a Microsoft tool for transforming raw data into interactive dashboards and reports.
It supports real-time data visualization from multiple sources, including IoT platforms.
Users can analyze trends and make informed decisions using visual insights.

F.SQLiteDatabase:
SQLite is a lightweight, serverless database embedded directly into mobile apps.
It stores data in a single file and supports standard SQL features like transactions.
Ideal for local storage, it ensures fast, reliable access to structured data.

IV. METHODLOGY

This project develops a Health Monitoring App for doctors and patients using IoT and cloud technologies.
Vital health data like heart rate and temperature is collected through sensors connected to an ESP8266 module.
The ESP8266 uploads real-time data to the Thing Speak cloud, enabling continuous remote monitoring.
Doctors can securely log in to view dynamic health data and alerts via a clean, organized dashboard.
The app supports role-based login for patients and doctors to manage health records and ensure data privacy.
Power BI is used for advanced data visualization, showing trends and key metrics through interactive dashboards.
The UI is kept simple and accessible, especially for elderly users, focusing on clarity and usability.
Thorough testing ensures system reliability across various conditions like network loss and background operation.
A modular software architecture supports scalability, future features, and potential integration with AI models.
The final APK is packaged securely and is deployable on Android devices, ready for user installation.

Fig 2. System Architecture



The system starts with a power supply that ensures stable voltage for the Arduino UNO and sensors.
Arduino UNO acts as the control unit, managing sensor inputs and data flow throughout the system.
A temperature sensor records real-time body temperature and sends analog signals to the Arduino.
A heartbeat sensor captures pulse rate and provides vital health data to the microcontroller.
The Arduino processes sensor readings, converting them into readable values like °C and bpm.
This processed data is then transmitted to Thing Speak via an internet connection.
Thing Speak receives and logs the data in real-time for remote access and monitoring.
It presents the data through visual tools such as graphs and charts for easy interpretation.
The system enables early detection of health issues like fever or abnormal heart rate.
It supports remote health monitoring, improving timely care and continuous observation.

V. RESULTS AND DISCUSSION

The Smart Healthcare Monitoring System successfully tracks a user's physical activity using smartphone sensors, automatically logging step counts and distances in real time. Data is securely transmitted to the Thing Speak cloud platform via RESTful APIs, enabling reliable storage and remote access. Power BI visualizes this data, providing users with interactive dashboards that display daily trends and long-term progress. This real-time feedback encourages healthy behavior and simplifies goal tracking. The app is user-friendly, operating efficiently in the background while maintaining privacy and security. It also supports healthcare applications, allowing professionals to remotely monitor patient recovery and activity levels. Overall, the system enhances personal fitness tracking and clinical decision-making through integrated technology.

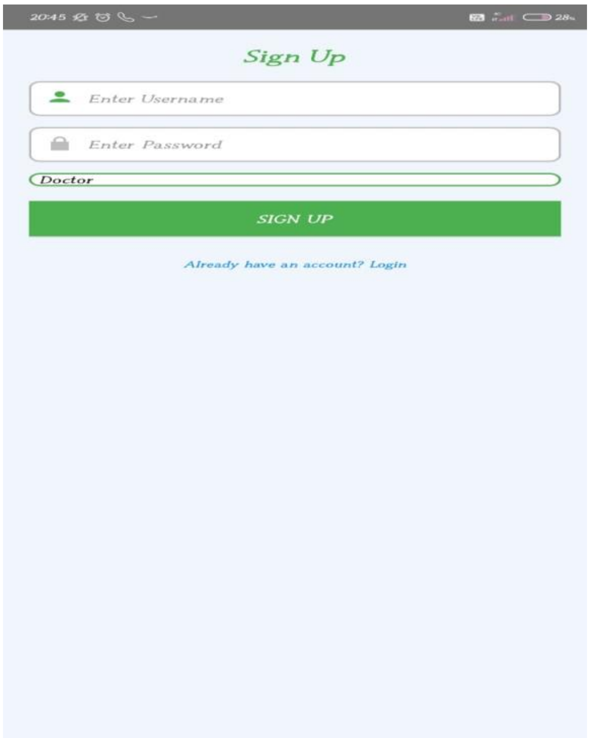


Fig 3 Sign up Screen

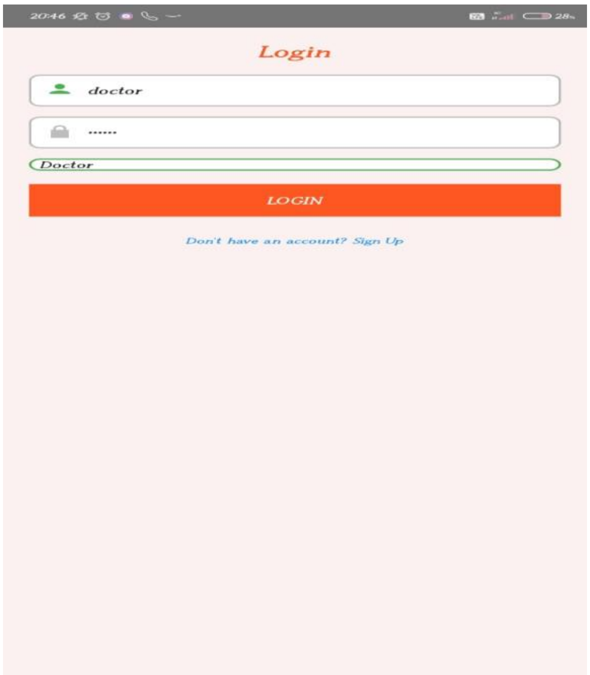


Fig 4 Login Screen

A Sign Up Screen

This is the user **registration interface** of the Smart Healthcare Monitoring System app. It allows new users to create an account by entering a username, password, and selecting their role (e.g., "Doctor"). The design is clean and minimalistic, with green and white as the primary theme, reflecting a sense of health and freshness. A user icon and a lock icon are used alongside the input fields for better UI clarity. At the bottom, a navigation link is provided for users who already have an account to quickly switch to the login page. This screen ensures secure user onboarding and role-based access to the app’s features.

B Login Screen

This screen is the **login interface** where registered users can enter their credentials to access the app. The layout mirrors the sign-up screen but uses an orange theme, possibly to distinguish it visually from the sign-up interface. Users enter their username and password and select their role again (e.g., "Doctor"). Upon successful login, they are directed to their respective dashboards. A clear and accessible link at the bottom redirects users who don’t yet have an account to the registration page

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Doctor Dashboard – Initial View

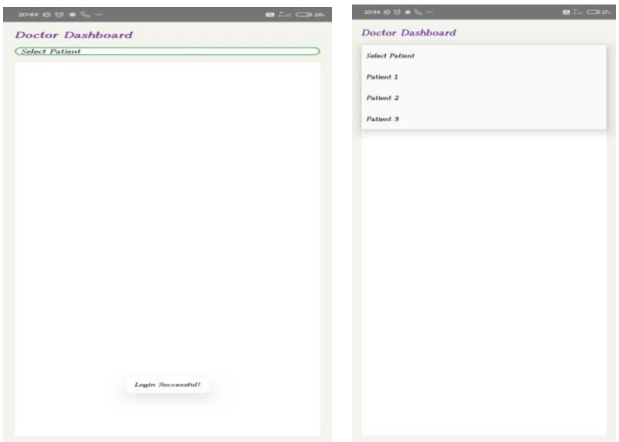

Fig 5 Doctor Dashboard

C. Patient Selection Expanded:. Doctor Dashboard – Initial View
The Doctor Dashboard provides a clean and intuitive interface upon login, tailored for healthcare professionals.
A "Select Patient" dropdown is prominently placed, allowing quick access to individual patient data.
The screen remains minimal until a patient is chosen, reducing distractions and focusing attention.
A "Login Successful!" message confirms secure access to the system's protected features.
This view ensures ease of navigation and readiness for real-time patient monitoring.

D. Doctor Dashboard – Patient Selection Expanded
When the dropdown is expanded, it displays a list of registered patients for selection.
Doctors can easily toggle between multiple patients to monitor individual health stats.
The feature supports scalable, multi-patient management in clinical settings.
Upon selection, real-time or historical health data becomes accessible.
This functionality is essential for remote healthcare and efficient monitoring.

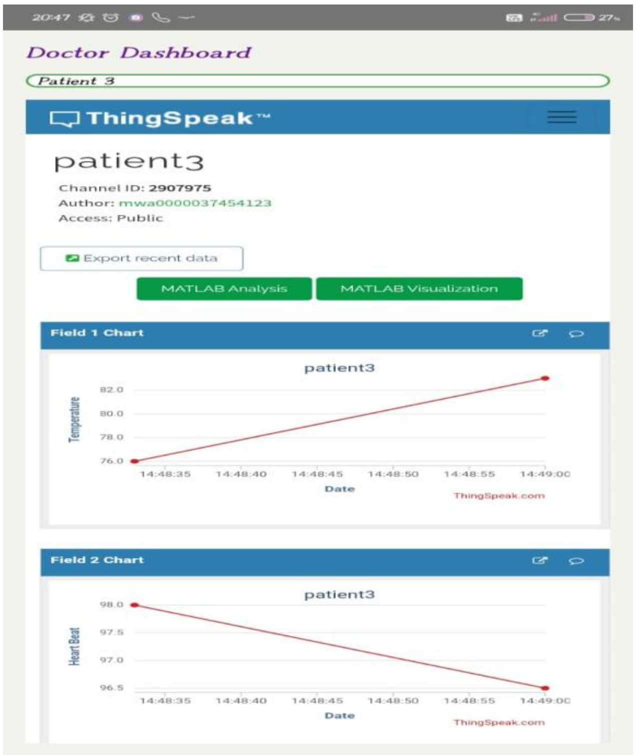

Fig 6 Patient Data Visualization

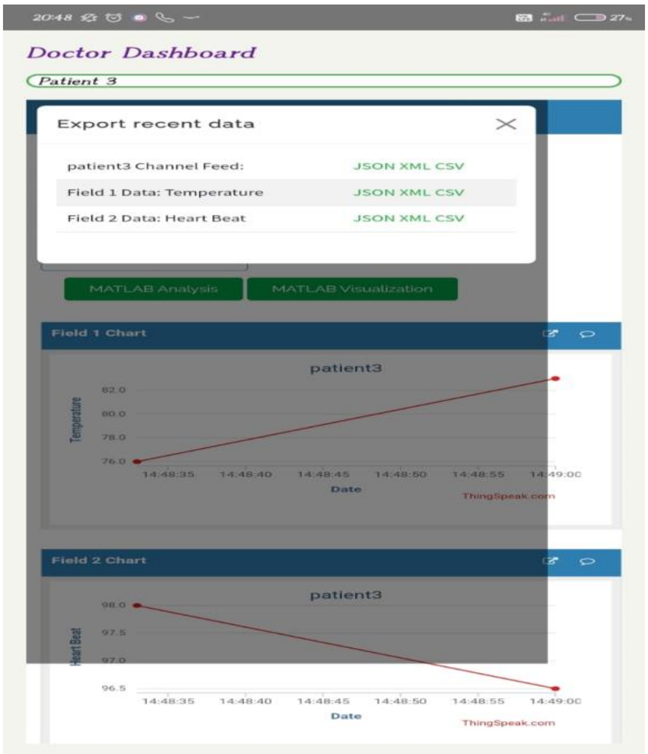

Fig 7 Data Export Options

5.1.5 Patient Data Visualization (Thing Speak Integration) This screen displays real-time health data of a selected patient through Thing Speak, helping doctors monitor vital signs graphically. It shows important metadata to confirm data authenticity and accessibility. Advanced options allow further analysis using MATLAB tools for deeper clinical insights.

E.DataExportOptions

The export feature enables doctors to download patient data in formats like JSON, XML, and CSV for flexible use. It offers selective export of overall channel data or specific fields like temperature and heartbeat. This supports easy integration with other healthcare systems and data analysis tools**.**

F. Patient 1 Health Data Overview

This screen shows the **Doctor Dashboard** displaying health data for **Patient 1** using the Thing Speak platform. The interface includes patient identification details like channel ID and public access settings, confirming secure and traceable data. Two health metrics are visualized: **Heart Beat** and **Temperature**, each represented in its own field chart. The heart rate chart shows a gradual increase from around 72 to 78 BPM over several days, indicating possible changes in physical activity or recovery status. The temperature chart remains mostly stable but ends with a noticeable drop from about 97.5°F to 95°F, which could prompt further investigation. These real-time graphs enable the doctor to spot trends or anomalies at a glance. Buttons for **MATLAB Analysis** and **Data Export** allow deeper data exploration or integration into medical records. Export options in JSON, XML, and CSV make it versatile for reporting and research. Overall, the dashboard supports efficient and data-driven remote health monitoring.

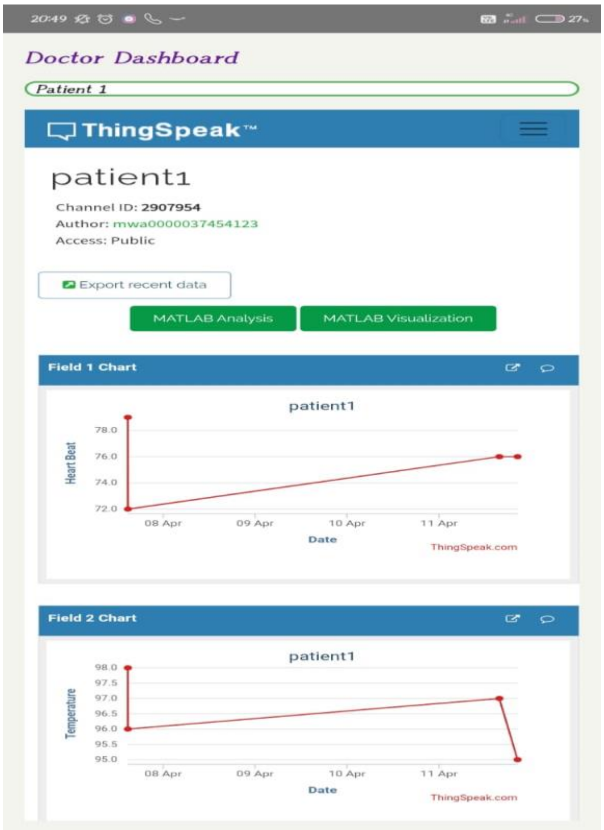

Fig 8 Patient 1 Health Data Overview

The Smart Healthcare Monitoring System is a mobile application that continuously tracks physical activity in real time using the smartphone's built-in pedometer sensor. It automatically records steps and distance traveled, providing users with instant feedback to encourage a more active lifestyle. The collected data is securely transmitted to the Thing Speak cloud platform via encrypted API communication, ensuring the protection and integrity of sensitive health information. Users can access detailed visual insights through Power BI dashboards, which display trends and progress using various graphs and charts. These features help users stay motivated by setting goals and tracking improvements over time. Additionally, the app supports remote patient monitoring, allowing healthcare providers to oversee patient activity and make informed decisions. Its modular design allows easy expansion by integrating other sensors such as heart rate or sleep trackers. Built on the Android platform, the app operates efficiently in the background on a wide range of devices. Overall, the system combines security, user-friendliness, and scalability to offer an effective digital health tracking solution.

CONCLUSION

The Healthcare Monitoring App is a cutting-edge step tracking and fitness analysis system that integrates IoT, cloud computing, AI-driven analytics, and data visualization to help users monitor, analyze, and improve their daily physical activity. By leveraging smartphone sensors, the app provides real-time step tracking, distance calculation, and activity monitoring, ensuring users stay active and engaged with their fitness goals. The Thing Speak cloud platform ensures that all activity data is securely stored and synchronized, enabling users to access their historical records anytime. The integration of Power BI transforms raw data into insightful visualizations, allowing users to track their progress through interactive dashboards and reports. Additionally, AI-powered health insights provide personalized recommendations, helping users make data-driven decisions to improve their fitness.

The app also prioritizes user convenience and security with Google Firebase authentication, ensuring safe login and data access. The inclusion of offline functionality via SQLite ensures that users can track their step count without an internet connection, with automatic cloud synchronization once they go online. Furthermore, RESTful APIs facilitate seamless data communication between the mobile app, cloud storage, and visualization tools. Overall, the Healthcare Monitoring App is an intelligent, user-friendly, and efficient fitness companion that motivates users, tracks progress, and enhances health awareness. By combining real-time monitoring, cloud storage, AI-based insights, and interactive data visualization, this app provides a comprehensive solution for individuals striving to achieve their fitness goals and maintain an active lifestyle.

FUTURE WORK

The integration of machine learning algorithms could transform raw health data into predictive insights, enabling early detection of abnormalities (e.g., arrhythmias, fever patterns). By training models on historical patient data, the app could forecast potential health risks (e.g., hypertension crises) and alert users/preemptively notify healthcare providers. Techniques like anomaly detection (using LSTM networks) and personalized health baselines would improve accuracy, reducing false alarms.

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