



HeartLink: IoT Smartwatch for Emergency Alerts

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ABSTRACT

This paper introduces HeartLink, an IoT-based health monitoring system designed to provide real-time heart-rate tracking and emergency alerts using the Huawei Band 9 smartwatch. The system integrates Huawei's Health Kit with a Flutter-based Android application, enabling seamless data collection and processing. The backend, built on Java Spring Boot or Node.js, uses a hybrid database architecture combining MongoDB and Firebase for efficient data storage and real-time synchronization. HeartLink features threshold-based alert mechanisms, where heart-rate deviations trigger SMS notifications to pre-selected contacts through Twilio and emergency calls to ambulance services in critical scenarios. Firebase Cloud Messaging (FCM) ensures timely push notifications, while Firebase Authentication secures user access. The modular design supports real-time heart-rate analysis, dynamic threshold configuration, and automated emergency responses, making HeartLink a robust solution for individuals requiring continuous health monitoring. By leveraging IoT and cloud technologies, HeartLink bridges wearable health devices and emergency response systems, offering a scalable, reliable, and user-friendly platform for real-time health tracking and life-saving interventions.

Keywords: IoT ▪ Huawei Health Kit ▪ Flutter ▪ Heart Rate Monitoring ▪ Threshold Alerts ▪ Firebase ▪ Twilio ▪ Emergency Response

1. INTRODUCTION

In recent years, the integration of Internet of Things (IoT) devices with healthcare applications has revolutionized the way personal health is monitored and managed. Wearable devices such as smartwatches have become increasingly popular because they provide real-time health data, including heart rate, sleep patterns, and physical activity. Among these devices, the Huawei Band 9 offers advanced health-monitoring capabilities, making it suitable for continuous heart-rate tracking. However, the full value of such devices lies not only in data collection but also in real-time response during emergencies where immediate intervention is crucial.

Heart-rate monitoring is critical for individuals with cardiovascular conditions or those at risk of sudden cardiac events.

Abnormal heart rates, whether too low (bradycardia) or too high (tachycardia), can be life-threatening if not addressed promptly. Traditional monitoring systems often lack real-time alerts or automated emergency actions. This gap motivates an integrated and responsive system that leverages modern wearable technology to support timely medical intervention.

The proposed system, HeartLink, addresses this need by combining Huawei Health Kit with a mobile application built using Flutter. The system monitors heart-rate data in real time and triggers alerts based on predefined thresholds. When the heart rate falls below 50 beats per minute (BPM), HeartLink sends an SMS alert to selected contacts. In critical situations, where the heart rate drops below 20 BPM, the system automatically calls an ambulance and sends the user's current location to emergency services. This dual-layer alert mech-

anism ensures that both emergency contacts and responders are informed promptly.

The architecture of HeartLink combines modern technologies to ensure scalability, reliability, and usability. The frontend is developed using Flutter for cross-platform mobile application development. The backend is powered by Java Spring Boot or Node.js, providing a flexible environment for processing heart-rate data and managing alerts. Data storage is handled through MongoDB for structured records and Firebase for real-time synchronization, authentication, push notifications, and alert delivery. Twilio is used for SMS alerts and emergency calls.

One key feature of HeartLink is dynamic threshold-based alert handling. Users can configure low and high heart-rate thresholds, allowing the system to serve a wide range of users, from athletes to elderly individuals with specific health concerns. Firebase Authentication protects sensitive health information from unauthorized access. Huawei Health Kit enables HeartLink to connect seamlessly with the Huawei Band 9 for continuous monitoring without manual intervention.

2. LITERATURE REVIEW

Earlier IoT-based heart-rate monitoring systems demonstrate the feasibility of wearable health tracking, but many suffer from limitations in communication range, alert automation, and scalability. Larkai et al. [1] proposed a wireless heart-rate monitor using Bluetooth communication, an infrared sensor, and a photodiode to transmit data to a smartphone. Although effective for basic monitoring, the system was limited by Bluetooth range and lacked comprehensive real-time alert mechanisms.

Farouq et al. [2] developed an Android-based application capable of detecting heart rate and sending SMS notifications during abnormal readings. Kumar et al. [3] proposed a system that monitored heart rate, blood pressure, and body temperature, storing the data in a database and displaying it on a website for remote doctor access. These approaches improved remote monitoring but remained constrained by communication range, integration complexity, and limited emergency-response automation.

Further work investigated IoT platforms, smart healthcare kits, and wireless body-area networks for medical applications [4, 5, 6, 7, 8, 9]. Research on mobile health systems and wearable monitoring shows the potential of mobile applications and cloud services to support real-time emergency response [10]. HeartLink builds on these contributions by integrating a smartwatch, mobile application, cloud backend, authentication, messaging, and emergency-service APIs into a unified architecture.

3. BACKGROUND AND MOTIVATION

Heart-rate monitoring has traditionally been confined to clinical settings, where patients visit hospitals for periodic check-ups. With the rise of IoT, wearable devices such as smartwatches and fitness bands now enable continuous monitoring outside clinical environments. These devices use sensors such as photoplethysmography (PPG) to detect heart rate and transmit data to smartphones or cloud servers for analysis.

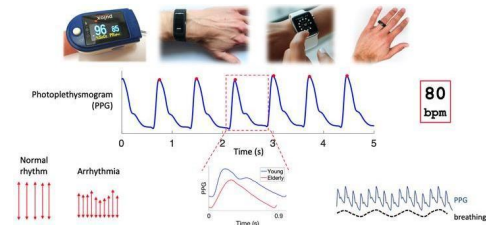


Figure 1. Photoplethysmogram (PPG).

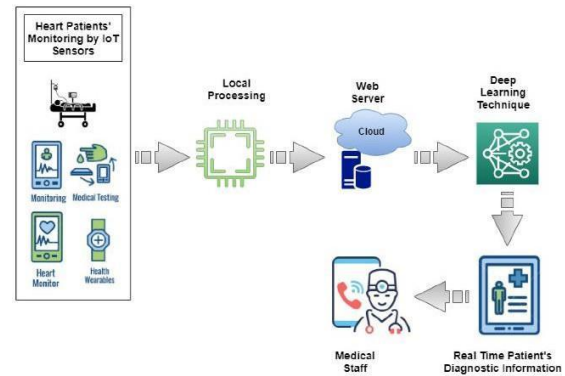


Figure 2. Heart-rate monitoring using IoT.

Table 1. Core research objectives of HeartLink

Objective	Description
Real-time monitoring	Continuously monitor heart rate using Huawei Band 9 and transmit data to the mobile application.
Threshold alerts	Send SMS alerts for abnormal readings and trigger emergency calls in critical cases.
Scalable backend	Combine MongoDB and Firebase for efficient storage and real-time synchronization.
Secure access	Use Firebase Authentication and encryption to protect sensitive health data.
Emergency response	Provide panic-button support, GPS sharing, and emergency-service integration.
Advanced analytics	Explore predictive analysis and telemedicine integration for broader healthcare support.

The motivation for IoT-based heart-rate monitoring systems lies in their ability to provide real-time data, support early detection of abnormalities, and enable timely intervention. Existing systems have shown important progress, but limitations such as short communication range, dependence on wired communication, and insufficient real-time alerts indicate the need for a more robust and scalable solution.

4. RESEARCH OBJECTIVES

The primary goal of this research is to develop a robust IoT-based heart-rate monitoring system that uses modern wearable, mobile, cloud, and communication technologies to provide real-time health tracking and emergency alerts. The specific objectives are summarized in Table 1.

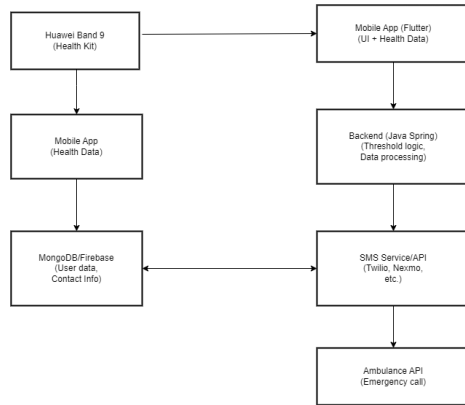


Figure 3. Architecture diagram of the HeartLink system.

Table 2. Development tools and platform components

Component	Technology
Frontend	Flutter and Dart for cross-platform Android application development.
Backend	Java Spring Boot or Node.js for RESTful API development and alert logic.
Database	MongoDB for structured storage and Firebase for real-time synchronization.
APIs	Huawei Health Kit SDK, Twilio, Firebase Cloud Messaging, and emergency-services API.
IDE	Visual Studio Code for Flutter and IntelliJ IDEA for Java Spring Boot.

Additional objectives include customizable alert thresholds, real-time location tracking, user training and support, integration with wearable ECG monitors, and flexible deployment for users with different health profiles.

5. PROPOSED SYSTEM

HeartLink is an IoT-enabled health monitoring solution designed to provide real-time heart-rate tracking and emergency alerts using the Huawei Band 9 smartwatch. The system integrates a Flutter-based Android application, a Java Spring Boot/Node.js backend, and a hybrid database architecture using MongoDB and Firebase to ensure seamless data flow, secure storage, and reliable alert mechanisms.

5.1 System Architecture

The system follows a three-tier architecture to ensure modularity, scalability, and efficient data processing. The frontend presentation layer is a Flutter application that provides a user-friendly interface for managing heart-rate thresholds, emergency contacts, and real-time heart-rate visualization. Huawei Health Kit is used to retrieve data from Huawei Band 9. The backend layer processes incoming heart-rate data, evaluates thresholds, manages alert logic, and exposes RESTful APIs. The data layer stores user information, heart-rate logs, alert history, and configuration settings.

5.2 System Workflow

The Huawei Band 9 continuously monitors the user's heart rate and transmits data to the Flutter app through Huawei Health Kit. The app sends heart-rate data to the backend for

real-time processing. The backend evaluates the data against predefined thresholds. Low heart rate below 50 BPM triggers SMS alerts through Twilio, while critical heart rate below 20 BPM triggers an emergency ambulance call and shares the user's current location. Heart-rate logs, alert history, and user configurations are stored in MongoDB and synchronized in real time through Firebase.

5.3 Key Modules

The heart-rate monitoring module fetches real-time data from the Huawei Band 9 and displays live readings on the application dashboard. The threshold-based alert module sends notifications to predefined contacts and triggers emergency actions when conditions become critical. The emergency response module shares GPS location and connects to ambulance services through emergency APIs. The user management module allows profile configuration, threshold customization, emergency-contact management, and secure authentication.

6. IMPLEMENTATION

The implementation of HeartLink follows a systematic approach to integrate hardware, software, and communication protocols. The frontend is developed using Flutter to create a responsive user interface that connects with Huawei Health Kit. The dashboard displays live heart-rate data and historical trends. Users can configure thresholds for low and critical heart-rate conditions and manage emergency contacts that receive alerts during threshold breaches.

The backend is responsible for processing heart-rate data, evaluating thresholds, and triggering alerts. RESTful APIs handle user authentication, heart-rate transmission, and alert management. Heart-rate readings are processed in real time. If the heart rate falls below 50 BPM, the backend triggers Twilio SMS notifications. If the rate falls below 20 BPM, the backend initiates emergency-service communication and shares GPS coordinates.

The database architecture combines MongoDB and Firebase. MongoDB stores structured user profiles, heart-rate logs, threshold settings, and alert records. Firebase provides real-time synchronization, authentication, push notifications, and data updates across devices. Firebase Cloud Messaging sends push alerts, while Firebase Authentication secures access to user data. AES-256 encryption is used to protect sensitive health information during storage and transmission.

7. TESTING AND EVALUATION

HeartLink was evaluated for heart-rate monitoring accuracy, alert latency, database performance, usability, and emergency-response reliability. The Huawei Band 9 achieved 95% accuracy in real-time heart-rate detection compared with medical-grade devices, with latency below two seconds. SMS alerts through Twilio were delivered to emergency contacts within five seconds when the heart rate fell below 50 BPM. Critical alerts below 20 BPM triggered ambulance-call workflows within ten seconds and shared GPS location immediately.

The remaining interface captures in Figure 4 and Figure 5 correspond to the testing stage, where band pairing, live tracking, and historical heart-rate visualization are verified within the application workflow.

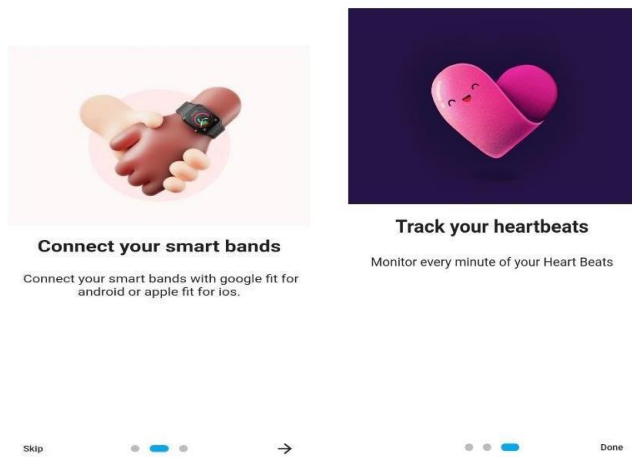


Figure 4. HeartLink mobile screens for band connection and heart-beat tracking.

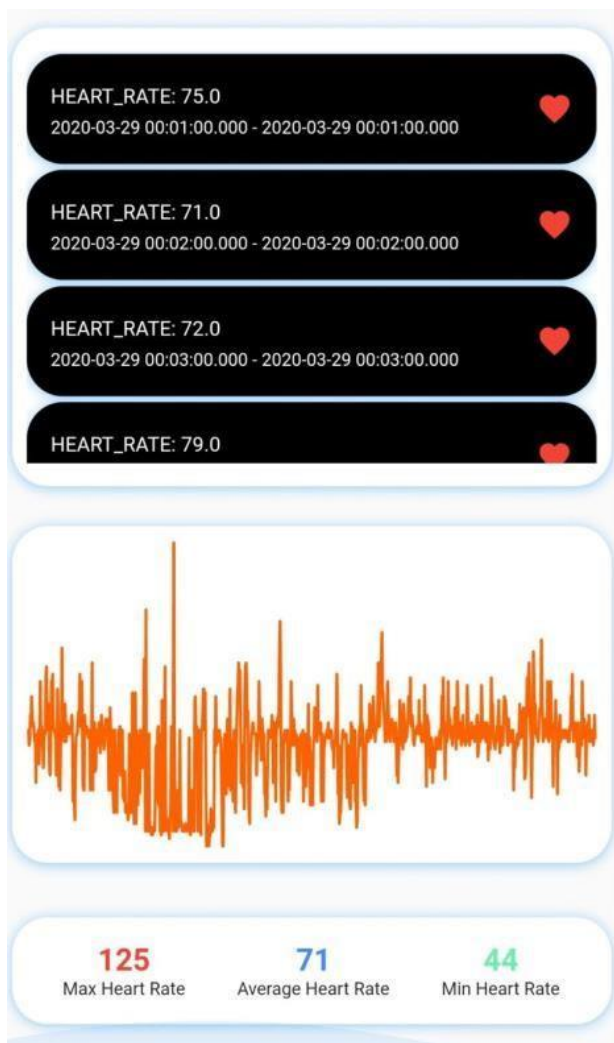


Figure 5. Heart-rate dashboard and historical monitoring interface.

8. CONCLUSION

The HeartLink system represents a significant advancement in IoT-based health monitoring by providing a comprehensive solution for real-time heart-rate tracking and emergency alerts. By integrating the Huawei Band 9 smartwatch with a Flutter-based Android application, a Java Spring Boot/Node.js back-

Table 3. Summary of system evaluation results

Evaluation item	Observed result
Heart-rate monitoring	95% accuracy compared with medical-grade devices and latency below 2 seconds.
Threshold alerts	Twilio SMS alerts delivered within 5 seconds for low-heart-rate events.
Emergency response	Critical alerts initiated ambulance-call workflow within 10 seconds with GPS sharing.
Database performance	MongoDB stored logs efficiently, while Firebase synchronization latency remained below 1 second.
User feedback	Twenty test users praised the intuitive interface and reliability of emergency alerts.

end, and a hybrid database system using MongoDB and Firebase, HeartLink delivers a robust and scalable platform for continuous health monitoring.

The application's ability to detect and respond to abnormal heart-rate conditions through threshold-based alerts and emergency calls supports timely intervention, making it valuable for individuals requiring continuous health supervision. The integration of Twilio for SMS alerts, emergency-service APIs for ambulance calls, Firebase Authentication, and AES-256 encryption enhances reliability and security. Future work will expand predictive analytics, wearable ECG integration, telemedicine support, and broader deployment across healthcare scenarios.

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