Guardian Alert: One-Tap Emergency Help for Women and Elderly People

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Abstract. Safety of women and elderly individuals must be ensured in emergencies to maintain the social balance. This objective effectively attained with a fast and reliable alert system implemented as a mobile application. Yet, existing alert systems have many challenges, such as high energy consumption and reduced accessibility. This paper proposes Guardian Alert, a one-tap emergency assistance system developed to provide immediate help in distress scenarios. The system combines a mobile application and wearable smartwatch device to enable real-time voice-activated SOS alerts, live location tracking, automatic audio/video recording, and AI-based threat detection. It immediately alerts law enforcement, emergency medical services (EMS), pre-set emergency contacts, and local responders upon activation. The system also provides emergency medical assistance services, linking users to local hospitals for immediate medical care, telemedicine support, and ambulance dispatch. To improve accessibility and dependability, the system uses cloud-based data storage, GPS, and IoT connectivity. An intelligent monitoring algorithm detects abnormal movement patterns, voice stress levels, and sudden health emergencies such as falls or cardiac irregularities, and triggers alerts if the user cannot activate the system manually. This model provides a secure, efficient, and user-friendly safety solution, empowering vulnerable individuals with instant access to security and medical assistance.

Keywords: Guardian Alert, Emergency assistance, location tracking, emergency medical services, IoT, Smart watch.

1 Introduction

In modern society, personal safety has become an increasing concern, specifically for elderly individuals and women [1]. The increasing threats and crimes such as assault, abuse, harassment, and violation have enabled the need for an effective and reliable system for responding to emergencies [2]. Additionally, older people frequently experience medical emergencies due to heart attacks, falls, or strokes and require rapid medical treatment. There are various alert and response systems that lack real-time combined solutions and require high energy and decreased accessibility. Technological advancements help develop automated systems, and the advent of AI, wearable smart devices, and IoT systems have created an intelligent alert and response system [3]. The importance of emergency response systems for women and the elderly is due to the increase in sexual harassment, physical assault, and domestic violence. In various situations, the individuals cannot reach for immediate emergency assistance. Elderly individuals are prone to medical emergencies such as sudden falls, cardiac issues, and strokes, requiring swift medical

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intervention [4]. Many elderly individuals live alone, increasing the risk of delayed emergency response and fatalities.

Several emergency response applications and medical alert systems often suffer from various limitations that reduce effectiveness [5]. Many mobile-based safety applications consume excessive energy, leading to rapid battery drainage due to continuous GPS tracking and background processing. Additionally, the models rely on manual activation, making them ineffective when victims cannot use their phones. Communication channels are often limited, with many applications depending on SMS and call, lacking real-time cloud integration and automated emergency response coordination [6]. The poor integration with law enforcement agencies, as current systems do not have robust mechanisms to notify police and emergency responders efficiently, results in intervention delays.

The Guardian Alert system was developed to address the limitations and develop a combined model. This Guardian Alert system (GAS) connects healthcare and personal safety by combining location tracking in real-time, AI-based threat detection and emergency alert systems in manual and automatic ways. The GAS provides a one-tap SOS activation to enable the used send an emergency alert through a mobile app and a smartwatch. The system includes AI-based automatic emergency detection to analyze voice stress levels, movement patterns, and health parameters. Real-time location tracking ensures live GPS monitoring, enabling swift responses from emergency contacts, law enforcement, and medical services. The system establishes a multi-tiered emergency contact and response mechanism that prioritizes alerts based on severity and automatically contacts relevant authorities to ensure timely intervention. The research contributions include

- Guardian Alert used AI algorithms to identify distress signals and medical emergencies that increase efficiency and reliability.
- The system used multiple communication channels, including SMS, email, notifications, and direct law enforcement integration for rapid intervention.
- The GAS intelligently classifies and prioritizes emergency alerts based on severity, to ensure the critical cases receive immediate assistance.

2 Related Works

Parlewar et al. [7] developed an IoT-based emergency security system. The system has two models, including manual activation via the panic button and automatic activation. After activation of the system, the videos and images are gathered by a camera module and stored in the SD card, GPS to track location, and emergency SMS with location to contacts and police. The system has night vision ability to address vulnerability during evening hours. Yet, the system has privacy issues and lacks quantitative performance. Berawi et al. [8] developed a prioritization module for victims by creating a mobile application called SaveMyLife. The model used the Mandani algorithm with the Min-Max rule for fuzzy inference and decision tree to minimize the fuzzy rules to relevant rules. The centroid techniques are utilized for defuzzification. The model collected data from Indonesia's natural disaster, and the decision tree module obtained 79.8% accuracy, 73.8% AUC, and 76.3% F1 score in detecting priority victims. However, the system remains at the conceptual level without actual testing. Intawong et al. [9] introduced a mobile and IoT-based pre-hospital emergency service called the A-SA-SOS system for older people. This application is developed for the village health volunteers (VHV) to receive emergency requests, find older people through geolocation data and coordinate with medical equipment transporters for emergencies. The A-SA-SOS system includes a cloud system with a broadcasting module, a web monitor module, and a management module for querying user details. The results include an incident report to order time of 0.31 ± 0.09 minutes, an incident report to departure time of 4.60 ± 0.64 minutes, and an incident report to arrival at scene of 4.91 ± 0.56 minutes. The system lacks battery capacity, requiring manual reactivation after battery discharge.

Monalisa et al. [10] introduced a SuperWomen application. This application integrates security features such as SMS alerts, location sharing, chatbot, self-defense techniques, and psychological support. The application combined technologies such as PocketSphinx for voice recognition and help mode for chatbot functionality. It computed that 83.2% of users expressed high satisfaction, an app start-up time of 1s, and battery consumption of 0.2% per hour, internal storage usage of 55.15 MB, and compatibility with 97% for Android devices. However, the model does not analyze and detect the vulnerabilities and depends on the provided manual data. Kommeyet al. [11] presented a portable personal emergency alert system called the digiRESCUE system. The system includes embedded hardware with a button interface, integrated electronics, and mobile software, allowing users to configure emergency contacts and messages. The system provides accurate emergency and geolocation data transmission. However, the system has battery constraints and refers to time-to-time charging. Mahinay et al. [12] developed a unified assist mobile application to increase the safety and security for visually impaired users. The visual impairment assistance detects obstacles and warns users through notification and vibration. The system improved safety for visually impaired individuals through obstacle detection. Yet, the system cannot operate offline and has limited area coverage.

Sil et al. [13] developed a Shohayota mobile application. This system comprises modular components such as voice mode, manual mode, Chat Bot, and app setting. The manual model consists of options to call and SMS emergency contacts, and the help model uses a chatbot interface to search for nearby police stations and other services. Yet, the system is power and network-dependent and cannot function if the device or the network is turned off. Rani et al. [14] presented a standalone safety device for women that operated on smartphones during emergencies. The system contains a hidden hardware device embedded in women's accessories and a cloud-based infrastructure that handles emergency contacts and communication. Yet, the system lacks dynamic contact management. Philip et al. [15] developed an EmpowerHer project for wearable safety technology. The model integrated various sensors, and the alert system focuses on automated emergency alerts to notify pre-determined contacts. The GPS module shares the current location of the emergency contacts and authorities. Yet, the model has technical complexity and lacks proper interfaces. Jadhav et al. [16] presented an AlertWrist, an Emergency Communication Wrist Band for safety and emergency. This smart band monitors user location and sends it to emergency contacts in emergency health situations. Yet, the system cannot track moving users or predict their movements.

3 Methodology

To ensure rapid intervention, the GAS system incorporates multi-channel emergency communication via SMS, email, push notifications, and direct law enforcement integration. By synchronizing a wearable device, such as a smartwatch, with a mobile application, the system provides a dual-layer safety mechanism that maximizes accessibility and usability. The system also utilizes real-time data processing and cloud storage, leveraging IoT and cloud technology to ensure secure and efficient data handling for emergency response teams. The GAS has the capabilities of emergency assistance, crime prevention, and healthcare support. The GAS model is designed in two layers, including front end and back end layers. The layers in the front end are user interaction and GAS components with emergency medical services (EMS) and back-end layers are systems architecture with video, audio (V/A) recording and emergency response activation (ERA). Fig 1 represents the system overview of the GAS model.

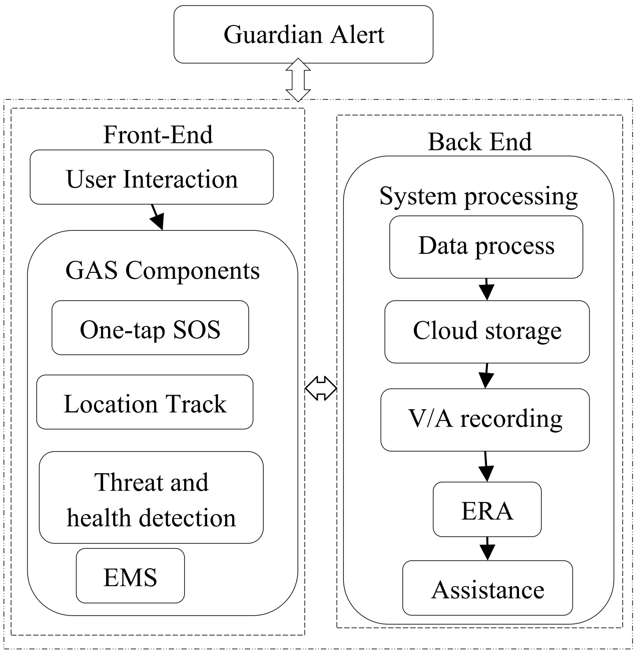


Fig.1. Overview of the Guardian Alert System model.

3.1 Component of Guardian alert

The One-Tap SOS activation method includes tapping an SOS button on a wearable or mobile application. When the button is pressed, the alarm is sent to law enforcement, emergency services, and pre-configured emergency contacts. The real-time location tracking system gathers and updates GPS coordinates in real-time when an emergency is detected. The location of the user is continuously transmitted to emergency contacts and enables faster assistance by generating live tracks for law enforcement and medical teams. In the automatic audio and video recording, the system automatically records audio and video from the user's device. The recorded video and audio are stored in the cloud, which can be utilized to identify potential threats. Cloud-based storage encrypts data to prevent unauthorized access.

The AI-based threat and health emergency detection model used AI algorithms to detect emergencies without manual activation. This method analyses voice stress levels for detecting panic and distress speech, abnormal movement patterns such as sudden falls and aggressive movements, and health anomalies such as irregularities and unconsciousness. If the system detects a threat or a health emergency, it automatically triggers an alert. Emergency medical help services directly connect to medical professions and provides telemedicine support, ambulance, and hospital connectivity.

3.2 System Architecture

The back-end includes the core infrastructure, and the processing unit for data handling, cloud storage, and threat analysis. This process contains mobile application components, IoT, wearable device, and cloud-based data processing. The mobile application component is the main user interface for triggering alerts, monitoring real-time tracking, and managing emergency contacts. This component shows the emergency response status and law enforcement coordination. The wearable device connects smart watches and IoT devices to provide an alternative alert mechanism. The cloud technique uses IoT methodologies to improve and evaluate real-time data such as alerts, location details, and video and audio recordings, which are securely stored. For data security, the process used encryption and privacy measures to protect user information.

The emergency contact and response module utilized communication with the emergency contact and through automated alert prioritization. When an alert is triggered, real-time notifications are sent to multiple channels. The messages are sent to emergency contacts, law enforcement, and medical services such as ambulance and telemedicine professionals. Automated alert prioritization includes an AI-based system to analyze emergencies and prioritize alerts by analyzing the high-risk emergencies sent to authorities.

4 Technical Implementation

4.1 Hardware and Software Requirements

The GAS system utilized Android 15, Java language, and SQLite database for software requirements evaluated on an Intel Core i5 processor with a CPU of 1.8GHz, 8GB RAM, and the Windows 10 OS. The Netbeans IDE17 and the JDK SE 23 are utilized. The SQLite version 3.43.0 is applied for embedding in the Android app to save the user profiles, emergency contacts, and location tags. The hardware requirement includes the smartwatch with wear OS 5 version the primary wearable with various sensors. The smartwatch also has a wireless chipset with cellular, GPS, Bluetooth, NFC, Wi-Fi for transmitting data and various sensors and microphone to enable voice commands. Testing Scenarios

4.2 Mobile and Wearable Device Communication

The user downloads the GAS application and registers their profile, medical details, and emergency contacts. The smartwatch is paired with the mobile app through Bluetooth for connectivity and transmitting data. The smartwatch also provides one-tap SOS activation for emergencies, which is integrated with GPS for location sharing. The app triggers an alert if an emergency is detected, sending notifications to the added contacts. Fig 2 depicts the mobile and wearable device communication.

4.3 AI and ML for Threat Detection

The AI-based system continuously analyses voice stress, motion patterns, heart rate fluctuations, and irregular movements to identify anomalies and classify threats. Fig 3 presents the Ai and ML for threat detection.

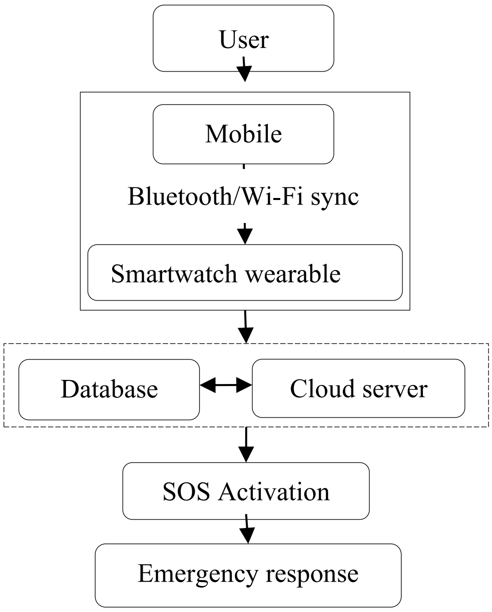


Fig.2. Mobile and Wearable Device Communication.

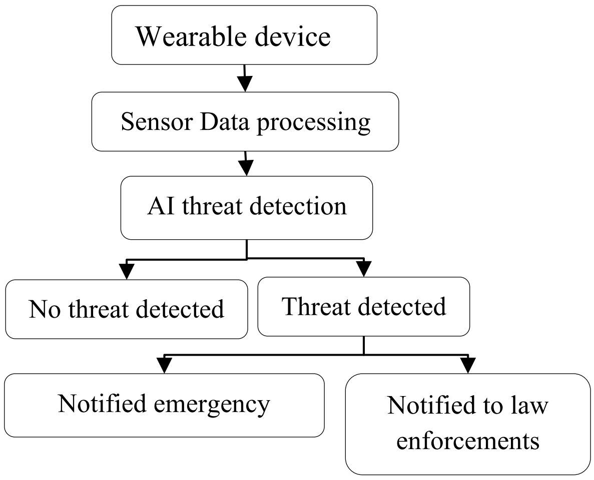


Fig.3. AI and ML for Threat Detection.

4.4 GPS, IoT Integration and cloud data storage for Real-Time Tracking

The GPS module tracks the user location. The location data is sent to the IoT cloud server for real-time processing and to send the user's current location to the emergency contacts and emergency responders. The AI system automatically triggers an alert if it detects a medical emergency or safety threat. This system automatically notifies emergency medical services

(EMS) such as hospitals, ambulances, and telemedicine services for immediate medical support. Fig 4 represents the GPS, IoT integration and cloud storage for real-time tracking.

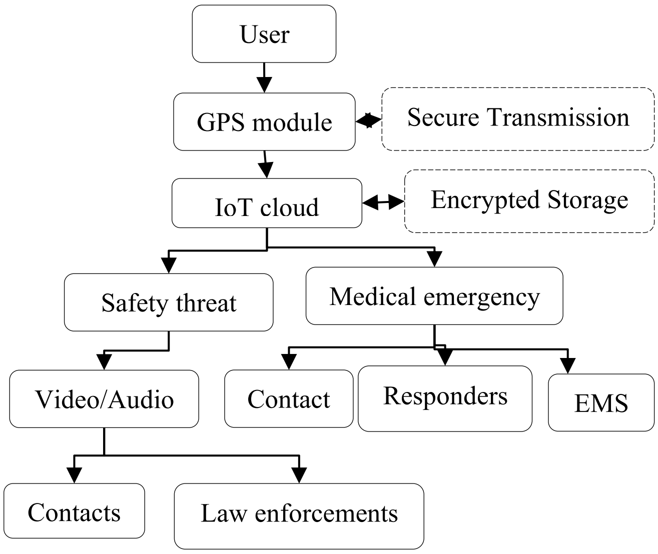


Fig.4. GPS, IoT Integration and cloud storage for Real-Time Tracking.

5 Performance Evaluation and Experimental Results

The proposed GAS model is implemented in Java language, SQLite for database, and smartwatch as a hardware device. The model is computed using accuracy metrics to analyze threats and detect health emergencies. Table 1 illustrates the comparison results for the proposed model. The GAS system performs better than other models, achieving 95.77% accuracy, 94.79% precision, 97.54% recall, and 96.15% F1 score.

Table 1. Comparison results for the proposed model.

Model	Accuracy	Precision	Recall	F1 score
SaveMyLife [2]	79.8	76.15	76.44	76.3
SuperWomen [4]	83.2	81.2	83.73	82.44
Shohayota [8]	89.34	84.64	88.74	86.65
EmpowerHer [10]	78.42	76.33	74.91	75.61
AlertWrist [12]	87.79	82.46	85.97	78.71
Proposed Guardian Alert	95.77	94.79	97.54	96.15

Table 2. Response Time Analysis.

Model	Report time (min)	Arrival time (min)
A-SA-SOS [3]	0.31 ± 0.09	4.91 ± 0.56
SuperWomen [4]	0.46 ± 0.12	6.52± 1.03
Shohayota [8]	0.52± 0.20	8.84± 1.13
Guardian Alert	0.22± 0.06	3.75± 0.42

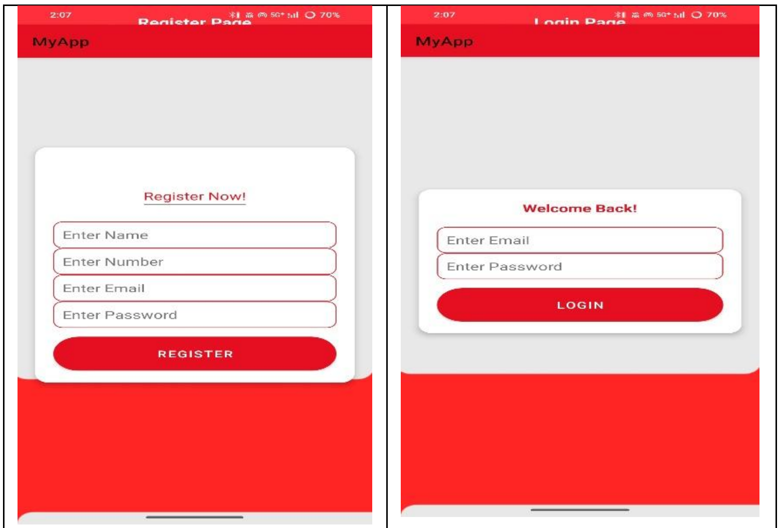
Table 2 illustrates the response time for different emergency response systems. The GAS model demonstrates the fastest performance with an report time of 0.22 minutes and arrival time of 3.75 minutes effective for emergencies.

5.1 User mobile interface

The user mobile interface (UMI) is developed to allow users for quick assistance. The UMI is created with a user-friendly layout to ensure accessibility for all users.

Fig.5. Home page.

Fig 5 depicts the home page of the web interface. This page is the entry point for users. The home page ensures accessibility and guides users toward logging in or registering.



a) Registration page

b) Login page

Fig.6. Registration page and Login page.

Fig 6 depicts the registration and login page. The registration process includes entering basic details such as name, number, email, and password steps to maintain the security of the data.

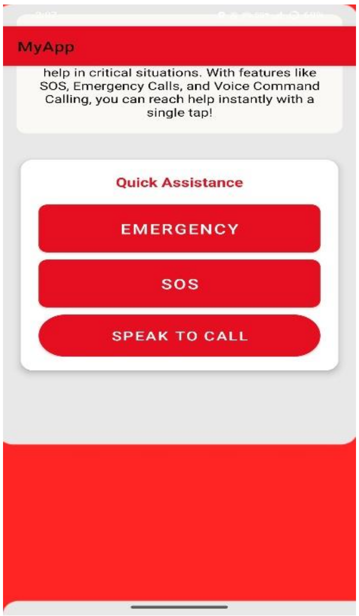


Fig.7. Emergency assistance page.

Fig 7 displays the emergency assistance page. The Users can use the one-tap method for quick assistance in emergencies. This process consists of assistance to medical emergencies, SOS for safety issues, and quick assistance.

5.2 Comparison with Existing Solutions

The proposed GAS model exhibits higher speed, accuracy, AI-based threat analysis and multi-channel emergency response performance. The SuperWomen application consumed a battery of 0.2% per hour but lacked power optimization features. Shohayota app with chatbot integration but lacks AI-based false alarm reduction, EmpowerHer project stores data but struggles with security protocols, the Unified assist app for visually impaired users does not have direct medical intervention, and the AlertWrist wristband is developed with emergency alerts but lacks movement tracking.

The proposed GAS model increased the power efficiency by optimizing battery consumption. For false alarm reduction, the GAS model used AI-based prioritization to prevent unwanted alerts. The GAS model uses encrypted cloud storage with real-time data access. For medical emergency support, the system is combined with health monitoring, direct ambulance, and telemedicine, and the system is integrated with the wearable device. The GAS provides a reliable and effective safety solution compared to other developed models.

5.3 Challenges and Limitations

The GAS model is developed for real-time emergency response by combining AI-based health and threat detection, GPS tracking and cloud coordination. The model has technical constraints such as battery life and network connectivity. The constant monitoring of heart rate, motion, location, and voice increases the energy and drains the battery life in smart watches, and the AI processing requires higher energy. This can be reduced by implementing low-power AI models, which are active only when anomalies are detected. The GAS system depends on internet connectivity, which delays and prevents alerts in poor cellular signal areas. The system collects personal data, including location, biometric, audio, and video recordings, which can lead to unauthorized access and hacking, leading to privacy breaches. End-to-end encryption secures all emergency data before storing and transmitting it. AI-Based Filtering of False Positives, including sudden movements and loud noises, may trigger unnecessary emergency responses. This false alarm is reduced by using multi-sensor verification to confirm emergencies. The system works with multiple devices lack sensors or processing power.

6 Conclusion and Future Work

The GAS model integrated wearable technology, cloud storage, and AI-based analysis with multi-channel emergency communication. The model provided quick SOS activation through the mobile app or wearable smartwatch for sending single-tap alerts. The multi-channel communication that sends SMS and notifications to responders and law enforcement enhanced the effectiveness of emergency alerts. The GAS model attained 95.77% accuracy. The system's real-time GPS tracking, AI-based anomaly detection, and encrypted cloud storage increased data security, reliability, and efficiency in emergency response situations. In future, AI filtering can be integrated for multi-sensor validation to further improve the accuracy and reduce false alarms. The system can be also integrated with oxygen level monitoring, and stress level detection to increase medical emergency response.

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