

Smart Tourist Safety and Emergency Response System Using Rule-Based Risk Detection

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Abstract

In this research paper, the increasing traveler safety issues due to the growth of tourism have been analyzed, and limitations in current safety systems used to detect traveler risks have been highlighted. For addressing these traveler safety issues, this research proposes Rule-Based Smart Tourist Safety and Emergency Response System, which will ensure monitoring of user safety through real-time data. This system estimates a risk score dynamically depending on multiple parameters like time spent on travel, distance from risk areas, nearby emergency cases, and user's movement pattern from their GPS data. According to the calculated risk score, there is a risk classification module based on rules which categorize the risk scores into Low, Medium, and High levels. In case of any emergency situations, the system can rapidly send the user's location, time stamp of incident along with any visual information related to the situation to a centralized monitoring system. There is also an Incident Visualization Module in the proposed system that ensures proactive decisions by identifying potential hazardous locations in real time. Experimental results indicate a successful detection rate of 90%-92% in negligible time intervals.

Keywords: Artificial Intelligence (AI), Tourist Safety, Emergency Response, Risk Intelligence, GPS Tracking, Smart City Safety.

1. Introduction

With the growth in tourist activities witnessed in the past few years, there is an increasing need for efficient travel safety systems. Tourists traveling through new cities and destinations may experience difficulties due to ignorance about dangerous zones, emergencies, and even local situations. In turn, the probability of accidents, thefts, and other emergency situations might be higher. Thus, ensuring tourist safety has become an important need in the current smart tourism environment.

Most tourist safety apps developed in the past function in a reactive mode. Conventional approaches used in traditional tourist safety solutions include contacting the emergency center by calling them and notifying of a problem. Location tracking apps are also used in providing limited support in terms of continuous monitoring and risk detection, which makes their efficiency lower.

Recent developments in AI, IoT, geofencing, GPS, and mobile communication systems have enabled the development of intelligent tourist safety solutions. Real-time monitoring allows analyzing user location, moving behavior, and the incidents nearby. Communication protocols used in such solutions allow quicker transferring of information to the monitoring center.

This research paper presents a Rule-Based Smart Tourist Safety and Emergency Response System consisting of a mobile application integrated with a centralized web-based administrative monitoring system for proactive tourist safety monitoring. The proposed system will continuously monitor several parameters including location, motion patterns, temporal constraints, and incidents in proximity to determine the dynamic risk level. Depending on pre-established rule-based thresholds, the risk level will be categorized into Low, Medium, and High classes and appropriate alerts will be issued accordingly. In case of an emergency, the system will initiate an SOS feature that will send the user's location and other relevant data to the central monitoring system.

2. Related Work

Emerging developments in artificial intelligence, IoT, geofencing technology, and smart tourism innovations have considerably enhanced tourist safety as well as emergency response solutions. The majority of existing literature addresses issues related to intelligent

monitoring, emergency communication, surveillance systems, and automated tourist safety management.

A smart tourist safety monitoring and incident response system was designed in [1] based on real-time tracking and emergency communication to ensure traveler safety and improve the response process. An intelligent AI-based tourist safety system with geofencing technology and blockchain identity management was proposed in [2], contributing to better authentication and safe access to tourist data.

The application of blockchain, artificial intelligence, and IoT solutions for creating a smart travel safety framework was discussed in [3], with special attention paid to automated emergency management, communication security, and intelligent monitoring. AI-based emergency response frameworks and smart infrastructure safety management approaches were reviewed in detail in [4].

An AI-based intelligent CCTV surveillance system for road safety was described in [5] with an emphasis on the use of computer vision and behavior analysis. An efficient AI emergency response and disaster management system was proposed in [6].

The relevance of AI in smart tourism and intelligent destination management has been emphasized in [7]. The use of AI in enhancing tourist safety and travel experience has been highlighted. In [8], an AI and ML-based accident detection technique has been suggested, which helps detect accidents and automatically generate an emergency response.

A human wearable tracking system based on IoT technology along with distress alerts has been suggested in [9] that allows for continuous GPS tracking and emergency notification services. In [10], the usefulness of AI-based communication strategies in enhancing tourist safety through multilingual warning and communication system has been discussed.

The use of AI technology for developing tourism information systems and destination safety planning has been studied in [11]. It helps enhance safety management in tourism. Basic elements of smart tourism, eTourism, and ambient intelligence have been established in [12].

Table 1. Comparative Analysis of Existing Tourist Safety and Emergency Response Systems

Reference	Merits	Demerits
[1]	Enables real-time tourist monitoring and faster emergency response through live location sharing	Primarily reactive; lacks predictive risk evaluation
[2]	Integrates geo-fencing and blockchain identity for secure tourist protection	Does not support dynamic risk scoring or incident visualization
[3]	Combines AI, IoT, and blockchain for secure automated emergency management	Blockchain integration increases computational complexity
[4]	Provides comprehensive analysis of AI-based emergency response architectures	No deployable tourist-centered implementation proposed
[5]	AI-based CCTV surveillance improves anomaly and unsafe activity detection	Requires high processing power and raises privacy concerns
[6]	Supports rapid emergency communication with low-latency alert mechanisms	Focuses mainly on communication infrastructure rather than risk monitoring
[7]	Highlights the importance of AI in smart tourism and traveler safety	Practical implementation details are limited
[8]	Accurate accident detection and automated emergency response using AI/ML	Mainly focused on road accident scenarios
[9]	Continuous GPS tracking with integrated distress alert mechanism	Lacks centralized monitoring and environmental risk analysis
[10]	Intelligent multilingual risk communication improves traveler awareness	No detailed real-time risk prediction model provided
[11]	Enhances tourism management through intelligent information systems	Limited support for direct tourist emergency assistance
[12]	Establishes theoretical foundation for smart tourism and ambient intelligence	Conceptual framework without practical safety implementation

Previous research shows remarkable development in intelligent tourist safety, emergency communication, AI surveillance, IoT monitoring, and smart tourism infrastructure. Inspired by such developments, the designed solution incorporates risk detection through rules, real-time monitoring, emergency management, and real-time incidents display into an integrated tourist safety mechanism.

3. Proposed System and Methodology

The proposed system has been designed to monitor the safety of tourists on a constant basis and provide them quick support in emergency situations by using the latest technological advancements in this regard. The working mechanism of the proposed tourist safety management system has been shown in Figure 1.

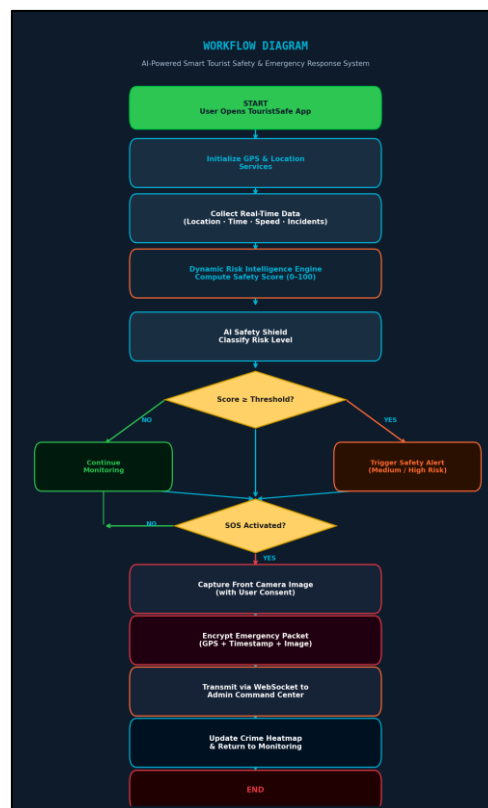


Figure 1. Overall Workflow of the Proposed Smart Tourist Safety and Emergency Response System

The process involves continuously gathering real-time data through the use of GPS and movement sensors in the user's mobile device. Real-time data gathered includes geographical location, speed of movement, direction of travel, time-dependent data, and incidents in the vicinity. Data collection will be ongoing to provide up-to-date information about the surrounding environment and travel conditions of the user. This data is then analyzed by the risk evaluation module to generate a risk score for the user that reflects his or her risk status at any given moment.

This risk score will be based on many parameters:

$$\text{RiskScore} = w_1x_1 + w_2x_2 + w_3x_3 + w_4x_4$$

where:

- x_1 = proximity to risk zones
- x_2 = movement variation
- x_3 = nearby incident density
- x_4 = time-based risk factor
- w_1, w_2, w_3, w_4 = weighting coefficients

The risk score obtained by the system is then tested against pre-defined threshold values. Values ranging from 0–30 are considered Low Risk, those between 31–60 are considered Medium Risk, and scores greater than 60 are considered High Risk. The system can quickly classify risks into different levels based on predefined rules without incurring high computation costs. Depending on the level of risk determined, appropriate notifications and alarms will be triggered. Notifications are provided for Medium Risk scenarios, while emergencies will receive warnings. In case the SOS function is activated, the location of the user and other relevant details will be sent to the centralized server.

The internal data flow and communication structure of the system are shown in Figure 2 below. Data collected from sensors mounted on the user's gadget will be sent to the processing unit for risk assessment and notifications generation. Information collected under emergency conditions will be relayed to the monitoring facility.

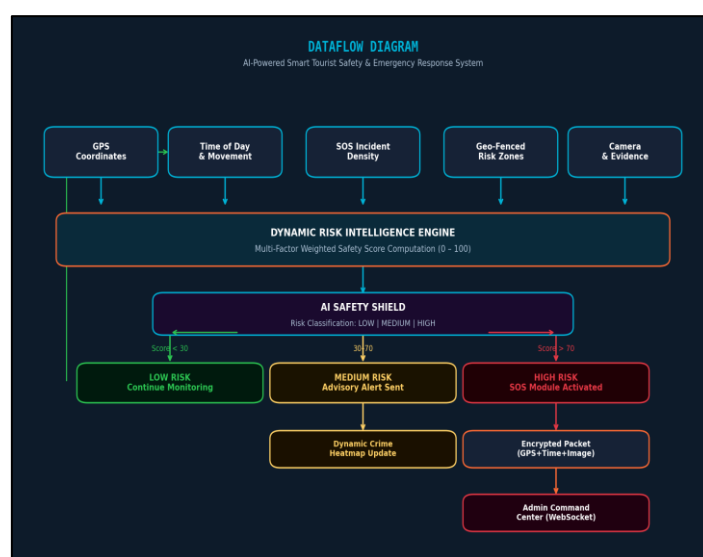


Figure 2. Data Flow Architecture for Real-Time Tourist Safety Monitoring

The operational flow chart of the suggested Smart Tourist Safety and Emergency Response System is presented in Figure 3. The operational cycle starts with initializing the GPS location and other data gathering capabilities. Thus, the system collects real-time data including the user's location, duration of the journey, speed, and number of incidents nearby. Then, all these indicators are analyzed by the risk assessment unit to calculate the weighted safety value between 0 and 100.

Once the safety value is obtained, the system evaluates whether the traveler is inside a geo-fenced risk area. Depending on the safety value received, the system defines the current status as one of the risk categories. In case when the score is higher than the medium risk threshold, the system raises a Medium Risk Alarm. Similarly, once the safety value passes the high risk boundary, the system alarms the user about the emerging threat. In case when the safety value stays below the critical levels, the system proceeds with the background activity.

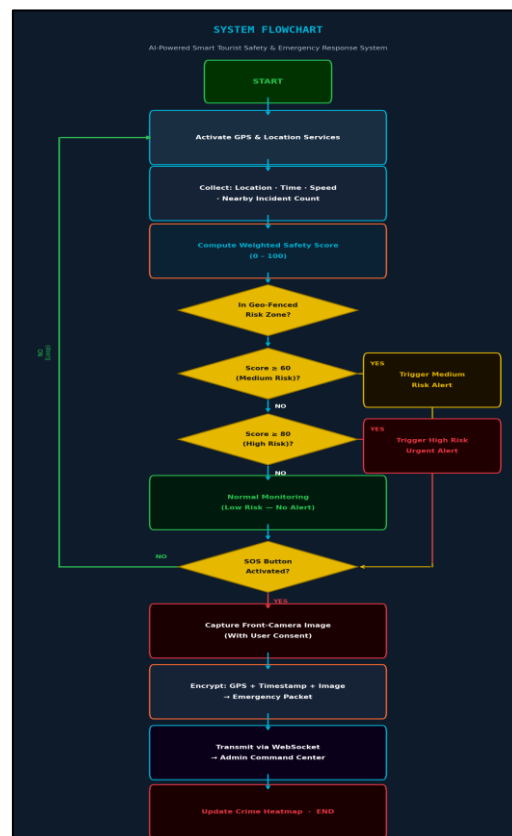


Figure 3. Operational Flowchart of the Proposed Tourist Safety Monitoring System

The monitoring process works in an endless loop so that it can continuously adapt to the changes in the environment. For any emergency situations, users may use the manual SOS function to inform others about their emergency status. After the activation of the SOS

function, more emergency details will be collected, such as photos taken by the front camera, geographical location, and time stamps. The collected emergency data will then be encrypted and packed into an emergency response packet.

Afterward, the emergency response packet will be transferred to the centralized monitoring system via WebSocket real-time communication. Finally, the monitoring system updates the current live crime map and the incident monitoring database. In this way, the process helps the safety monitoring, emergency warning, security emergency communication, and situational awareness for tourists.

4. Results and Discussion

The effectiveness of the proposed Rule-Based Smart Tourist Safety and Emergency Response System was tested under varying tourism conditions to investigate the efficiency of real-time risk assessment, alerts, and emergency management. This involved evaluating the system under normal tourism conditions, medium-risk scenarios close to geofencing zones, and high-risk scenarios featuring abnormal user movement and late night travel.

The system consistently tracked the location and behavioral pattern of tourists and monitored nearby incidents to calculate the safety score dynamically. During low-risk scenarios, the calculated scores fell within the safe zone, and there were no false alerts generated by the system during such instances. In medium-risk scenarios, the system correctly detected that the surrounding area had an increased risk level and raised alerts for the user's information.

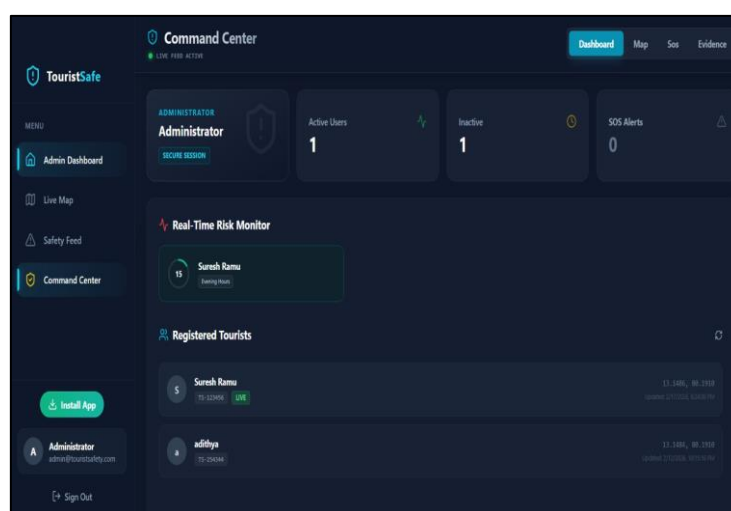


Figure 4. Application Dashboard for Tourist Safety Monitoring

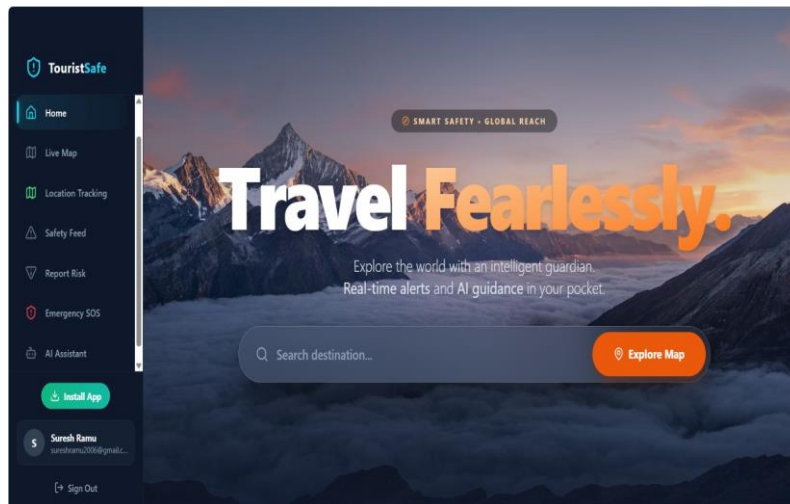


Figure 5. Real-Time Geo-Fenced Risk Zone Visualization Interface

The mobile application interfaces used during experimental analysis are displayed in Figure 4, Figure 5, and Figure 6. The real-time monitoring dashboard interface in Figure 4 made monitoring possible in real time through system monitoring features. The live map interface in Figure 5 successfully visualized geo-fenced risky areas and nearby incident locations, helping users detect hazardous places.

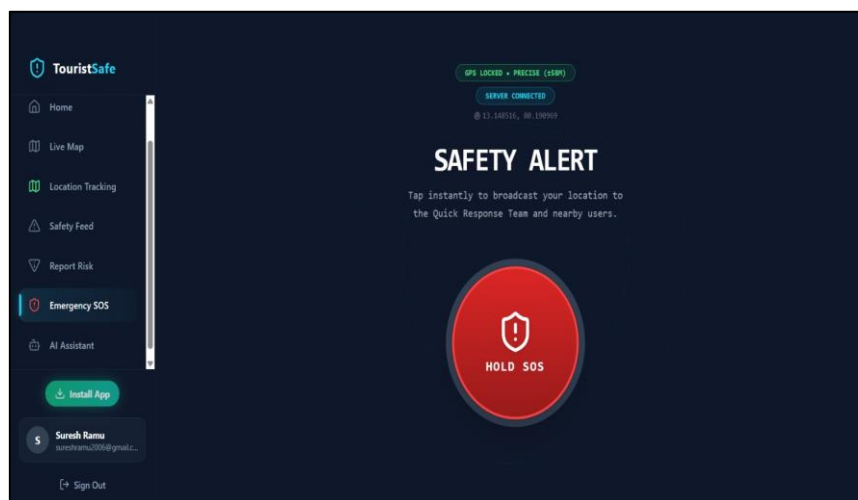


Figure 6. Emergency SOS Interface with GPS and Server Connectivity Status

The emergency SOS interface in Figure 6 showed GPS synchronization, emergency alert functionality, and server connection capability during emergency alerting tests. The centralized monitoring dashboard in Figure 7 was used to monitor tourists' location and active alarms. Command center interface helped in monitoring users' status in real time and coordination during emergency response.

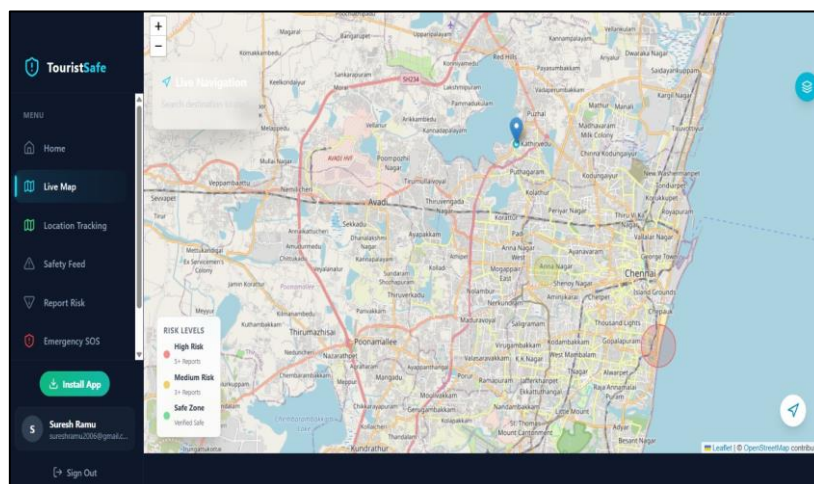


Figure 7. Centralized Web-Based Administrative Monitoring Dashboard

The response behavior of the proposed system for various levels of risk is detailed in Table 2. Risk values ranging from 0-30 were marked as Low Risk where monitoring was carried out but no alerts were issued. Scores between 31-60 resulted in Medium Risk alerts, whereas risk scores greater than 60 indicated High Risk alerts as well as SOS calls.

Table 2. Risk Classification Levels and Corresponding System Actions

Risk Score	Zone Classification	Alert Status	SOS Response
0 – 30	Low Risk (Green)	No Alert — Monitoring Active	Loop Continues
31 – 60	Medium Risk (Orange)	Advisory Notification Sent	SOS Available
61 – 100	High Risk (Red)	Urgent Alert Triggered	Emergency Response Activated

Results from experimental observation reveal that an acceptable accuracy rate of around 90-92% was obtained with minimal latency in alert delivery. Rule-based systems are relatively reliable and require minimal processing capacity. As a result, the system can be deployed on-the-go on mobile devices. With features such as dynamic risk assessment, live visualizations of incidents, and emergency communication, it greatly enhanced the system's ability to provide tourist safety monitoring services.

5. Conclusion and Future Work

The paper developed a Rule-Based Smart Tourist Safety and Emergency Response System as a way of ensuring tourist safety through monitoring and intelligent risk assessment. The proposed system is composed of various functionalities such as GPS tracking, geofencing, risk assessment, and real-time alerting and emergency communications that help to ensure tourist safety proactively. Various factors are considered during the process of risk evaluation, which includes user location, user behavior, time-based, and incident-based conditions in the area of operation to be able to identify risks. The experiments conducted showed that there was a great accuracy of risk detection with low response delay, thus making it ideal for application in mobile scenarios for smart tourism applications. Future work will consider making the system intelligent using better ways of assessing risks as well as incorporating information from other sensors found in smart wearables and IoT gadgets.

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