iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 **Issue:** IV **Month of publication:** April 2026

DOI: https://doi.org/10.22214/ijraset.2026.81486

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue IV Apr 2026- Available at www.ijraset.com

Road Safety System Simulation Using AI and Maps

Anita S Patil, Mohammad Ashif, H R U Jayanth, Ganesh Lokare, Lalsab, Mrs.Prema
Dept. of Computer Science and Artificial Intelligence Ballari Institute of Technology and Management Ballari, Karnataka, India

Abstract: ***Road safety remains a critical global challenge, with a significant number of accidents caused by overspeeding, poor road conditions, and lack of real-time awareness of hazards such as speed bumps and speed-limit zones. Existing navigation systems primarily focus on route optimization and often lack integrated safety features. This literature review explores various research works related to road anomaly detection, GPS-based navigation, IoT-enabled alert systems, and AI-assisted travel guidance. Studies using smartphone sensors and machine learning techniques demonstrate effective detection of road irregularities, while GIS-based systems enhance route planning and hazard visualization. Additionally, IoT-based solutions provide real-time monitoring and alert mechanisms for improving driver awareness. However, most existing approaches operate independently and lack a unified platform that combines navigation, hazard detection, alert generation, and user interaction.Based on these insights, the proposed Smart Road Safety & Navigation System integrates map-based visualization, real-time alert mechanisms, and a chatbot interface into a single lightweight framework. The system leverages mapping technologies, dataset-driven hazard identification, and rule-based decision logic to provide timely warnings for humps and overspeeding. By combining multiple functionalities into one platform, the system aims to improve driver safety, enhance situational awareness, and provide an intelligent navigation experience. This work highlights the importanceof integrating safety-focused features into navigation systems and sets a foundation for future advancements using IoT and artificial intelligence.***

Keywords—Road Safety, Navigation System, Speed Bump Detection, Speed Limit Monitoring, Real-Time Alerts, Geographic Information System (GIS), Leaflet Mapping, Flask Web Framework, Smart Transportation, Hazard Detection

I. INTRODUCTION

Road transportation plays a vital role in daily life, but it is also one of the leading causes of accidents worldwide. A significant number of accidents occur due to overspeeding, lack of awareness of road conditions, and sudden obstacles such as speed bumps and uneven surfaces. Traditional navigation systems primarily focus on route optimization and traffic conditions, but they often fail to provide real-time safety information related to road hazards. This gap highlights the need for a system that not only guides users from one location to another but also ensures safer driving by informing them about potential risks along the route.

With the advancement of web technologies and geographic information systems (GIS), it has become possible to build intelligent navigation platforms that integrate mapping with safety features. By using tools such as Leaflet for map visualization and Flask for backend processing, a lightweight and efficient system can be developed to display road hazards, monitor speed conditions, and generate timely alerts. Such systems can help drivers anticipate upcoming obstacles, maintain appropriate speed limits, and make better decisions while traveling.

The proposed Smart Road Safety & Navigation System addresses these challenges by combining route planning, hazard visualization, and real-time alert mechanisms into a single platform. The system identifies speed bumps and speed-limit zones using dataset-driven mapping and continuously monitors the driver's position to provide alerts when necessary. In addition, it includes features such as route search and event logging, which enhance usability and allow analysis of driving behaviour.

This project aims to improve road safety by increasing driver awareness and reducing the chances of accidents caused by negligence or lack of information. By integrating simple yet effective technologies into a unified system, the proposed solution demonstrates how modern web-based applications can contribute to safer and smarter transportation.

II. LITERATURE SURVEY

A. Muhammad Shujaat Abid et al. (2026) – Machine Learning-Based Road Safety System

In one of the recent studies, Muhammad Shujaat Abid et al. [1] proposed a machine learning-based approach to improve road safety in smart cities. The system analyzeslarge-scale traffic and accident data to predict accident-prone zones and enhance decision-making. The model uses intelligent data analysis to identify patterns and improve road safety awareness.

©IJRASET: All Rights are Reserved

B. Huichao Guo et al. (2024) – IoT-Based Intelligent Transportation System

Huichao Guo et al. [2] developed an intelligent transportation system using IoT and cloud computing technologies. The system integrates sensors, communication modules, and cloud platforms to improve highway safety, traffic management, and user experience.

Although the system enhances infrastructure-level safety, it requires expensive hardware and complex deployment. It is not easily accessible for common users. Our project simplifies this by providing a lightweight, software-based solution using web technologies without requiring heavy infrastructure

C. Vehicular Networking Survey (2021) – Smart Transportation systems

A comprehensive survey on vehicular networks [3] explores various systems, protocols, and applications used for safe and efficient driving. The study highlights the importance of GPS-based navigation, wireless communication, and real-time data sharing between vehicles to improve safety.

However, the system depends heavily on communication protocols and network infrastructure, which may not always be reliable. It also lacks user-friendly visualization and alert mechanisms. Our project overcomes this by providing a simple map-based interface with direct safety alerts to drivers.

D. Smart Roads Guard System (2025) – Obstacle Detection system

Gezawi et al. [4] proposed a Smart Roads Guard system that detects road obstacles and prevents accidents using sensors and embedded systems. The system provides alerts to drivers about obstacles and dangerous conditions.

While the system effectively detects obstacles, it depends on hardware sensors and embedded devices, increasing cost and maintenance complexity. It also lacks route planning and map integration. Our project improves this by combining hazard detection with navigation and visualization using software-based methods.

E. Adaptive Object Detection System (2025) – AI-Based Safety Monitoring

Manisabari et al. [5] introduced an AI-based system using deep learning models for detecting objects such as vehicles and pedestrians in real time. The system enhances safety by providing alerts based on object detection and motion tracking.

However, the system focuses only on object detection and requires high computational power for real-time processing. It does not include navigation or road hazard mapping features. Our system is more lightweight and focuses on practical hazards like humps and speed limits with minimal computational requirements.

.

F. SNSEV System (2025) – Smart Navigation for Emergency Vehicles

A smart navigation system for emergency vehicles [6] uses fog and cloud computing to optimize routes in real time. The system ensures faster and efficient routing by processing data close to the source.

Despite its efficiency, the system is designed mainly for emergency services and requires advanced infrastructure. It is not suitable for general users. Our project adapts similar navigation concepts but makes them accessible for everyday drivers using simple web technologies.

G. Smart Road Stud Sensor Network (2022) – Traffic Monitoring System

Tao et al. [7] proposed a smart road stud sensor network that collects traffic data and supports real-time monitoring using wireless communication. The system helps in traffic guidance and improves road safety.

However, it relies heavily on physical sensor deployment and infrastructure, making it costly and difficult to scale. It also does not provide user-level interaction or navigation features. Our system avoids hardware dependency by using dataset-based mapping and alert mechanisms.

H. Road Safety-Aware Navigation System (2020) – ML-Based Route Safety

Xu et al. [8] proposed a machine learning-based navigation system that predicts the safety level of different road segments using geographic data. The system helps in selecting safer routes instead of just shortest paths.

Although the system improves route safety, it mainly focuses on prediction and lacks real-time alerting features for drivers. Our project extends this idea by adding real-time hump detection and overspeed alerts along with route visualization.

©IJRASET: All Rights are Reserved | SJ Impact Factor 7.538 | ISRA Journal Impact Factor 7.894 |

Sl. No.	Paper	Technique Used	Objective	Key Contribution	Advantages	Limitations
1	Abid et al. (2026) [1]	Machine Learning	Predict accident-prone zones	ML-based safety prediction model	Data-driven insights	No real-time alerts, no navigation
2	Guo et al. (2024) [2]	IoT + Cloud Computing	Improve traffic and road safety	Intelligent transportation system	Real-time monitoring, scalable	Expensive, complex setup
3	Vehicular Network Survey (2021) [3]	GPS + Communication	Enhance smart transportation	Vehicular communication overview	Efficient data sharing	Depends on network
4	Gezawi et al. (2025) [4]	Sensor-based Detection	Detect road obstacles	Road obstacle alert system	Accurate detection	Hardware required
5	Manisabari et al. (2025) [5]	Deep Learning (AI)	Detect objects for safety	Real-time object detection	High accuracy	High computation, no navigation
6	SNSEV System (2025) [6]	Fog + Cloud Computing	Optimize routes	Smart navigation system	Fast route optimization	Limited to emergency use
7	Tao et al. (2022) [7]	Wireless Sensor Network	Traffic monitoring	Smart road stud system	Real-time monitoring	High deployment cost
8	Xu et al. (2020) [8]	Machine Learning + GIS	Predict safe routes	Safety-aware navigation system	Better route selection	No real-time alert system

Table 1: Comparison of Literature Survey Papers

III. RESEARCH GAP

Despite the rapid advancements in road safety technologies, several critical gaps still exist in current systems. Many research works focus on **road anomaly detection** using sensors, smartphones, or machine learning models to identify potholes and speed bumps. While these approaches achieve good accuracy in detection, they are primarily designed for **data collection and offline analysis** rather than real-time driver assistance. As a result, drivers do not receive immediate warnings about upcoming hazards, limiting the practical usefulness of such systems during actual navigation.

Another major limitation observed in existing systems is their heavy dependence on **hardware-based solutions**, such as IoT sensors, embedded devices, and vehicular communication networks. These systems often require significant infrastructure, high deployment costs, and maintenance efforts. Due to this, they are not scalable for widespread use, especially in developing regions. In contrast, there is a lack of lightweight, software-based solutions that can be easily accessed through web or mobile platforms without additional hardware requirements.

In addition, most existing solutions do not provide a **unified platform** that combines multiple functionalities such as mapping, hazard visualization, route planning, real-time alerts, and user interaction. Systems are often developed as separate modules, leading to fragmentation and reduced usability. The absence of an integrated interface makes it difficult for users to access all safety features in one place, reducing overall effectiveness.

Another important gap is the lack of **user interaction and accessibility features**. Many systems are complex, require technical knowledge, or are not designed with user-friendly interfaces. There is minimal inclusion of interactive components that can assist users in understanding road conditions, querying safety information, or receiving guidance in an intuitive manner.

Additionally, most studies do not emphasize **event logging and data analysis** from the user's perspective. Capturing real-time data such as overspeeding events, frequent hazard encounters, and user behavior can provide valuable insights for improving road safety. However, this aspect is often overlooked in existing systems.

To overcome these limitations, there is a clear need for a system that is **simple, cost-effective, real-time, and user-centric**, while also integrating multiple functionalities into a single platform. The proposed Smart Road Safety & Navigation System addresses these gaps by combining map-based visualization, route planning, hazard detection, and real-time alerts within a lightweight web-based architecture. This approach bridges the gap between complex research models and practical, deployable solutions for everyday users.

IV. PROPOSED FRAMEWORK

The proposed Smart Road Safety & Navigation System is designed to provide a safe and intelligent navigation experience by integrating route planning, hazard detection, and real-time alert mechanisms within a unified architecture. The framework begins when the user opens the system through a web interface and enters the source and destination locations. The system then processes these inputs and fetches map data along with preloaded datasets containing hump locations and speed-limit zones. These datasets are stored locally and can be updated periodically to ensure accuracy. Using a routing engine, the system computes the optimal path between the selected locations, considering geographical constraints and road connectivity.

Fig. 1 illustrates the activity flow of the proposed system, showing how user inputs are transformed into actionable safety insights. As depicted in the figure, once the route is generated, the system performs an analysis of the entire path to identify the presence of safety hazards such as humps and speed-regulated zones. This analysis is carried out by comparing route coordinates with stored hazard data. Based on this evaluation, the system determines whether a safer alternative route is available. If a safer route exists with fewer hazards or better driving conditions, it suggests that route to the user; otherwise, the system proceeds with the initially computed optimal route.

After route selection, the system enters the real-time monitoring phase, where it continuously tracks the driver's position along the route. As shown in Fig. 1, the system repeatedly checks for nearby humps by calculating the distance between the driver's current position and the stored hump coordinates. A predefined threshold distance (for example, 20–50 meters) is used to trigger alerts. When the driver approaches a hump within this range, the system generates a visual warning message such as "Hump Ahead," ensuring that the driver can take preventive action in advance.

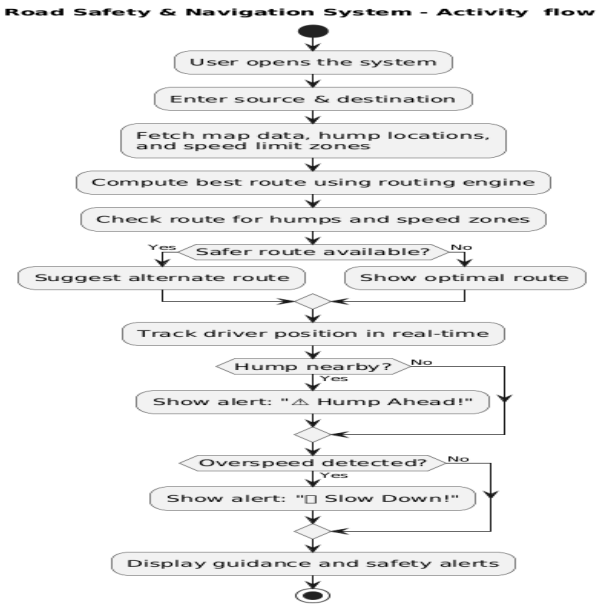


Fig. 1 Activity Diagram of Proposed System

V. APPLICATIONS

The Smart Road Safety & Navigation System has significant applications in everyday transportation and driver assistance. It helps drivers identify upcoming speed bumps, speed-limit zones, and hazardous areas while navigating, especially in unfamiliar locations. By providing real-time alerts and visual guidance on the map, the system improves driver awareness and reduces the risk of accidents caused by overspeeding or sudden obstacles. It can also be integrated into mobile devices or vehicle dashboards, making it a practical tool for daily commuting as well as long-distance travel.

The system is also highly applicable in traffic management and smart city development. Government authorities and urban planners can utilize the collected data, such as overspeed events and frequently encountered hazards, to analyze road safety conditions. This information can be used to identify accident-prone areas, improve road infrastructure, and implement better traffic regulations. Additionally, the system supports data-driven decision-making by providing insights into real-world driving behavior, contributing to safer and more efficient transportation systems.

Furthermore, the proposed system can be effectively used in fleet management, emergency services, and research applications. Logistics companies and transport services can monitor driver behaviour and ensure adherence to speed limits, thereby improving safety and reducing operational risks. Emergency services like ambulances and fire vehicles can benefit from safer route planning to reach destinations quickly while avoiding hazardous road conditions. In the academic and research domain, the system serves as a valuable platform for studying GIS mapping, real-time alert systems, and intelligent navigation, and can be extended with advanced technologies such as machine learning and predictive analytics.

VI. FUTURE WORK

The Smart Road Safety & Navigation System can be further enhanced by integrating real-time data sources and live updates. In the current system, hump locations and speed-limit zones are based on static datasets. Future versions can connect with live APIs from government traffic departments or smart-city platforms to automatically update road conditions, construction zones, and accident-prone areas. This would improve the accuracy and reliability of the system, allowing users to receive up-to-date safety information while navigating. Additionally, incorporating live traffic data can help in suggesting not only safe routes but also efficient routes based on current road conditions.

Another important area for future development is the integration of advanced technologies such as IoT and machine learning. IoT devices like road sensors and vehicle-mounted modules can be used to detect real-time road conditions such as potholes, slippery surfaces, or sudden obstacles, and send alerts to the system. Machine learning algorithms can analyze historical data to predict accident-prone zones and recommend safer alternative routes. These enhancements would make the system more intelligent, proactive, and capable of adapting to dynamic environments, thereby improving overall road safety.

Furthermore, the system can be expanded into a full-fledged mobile application with enhanced user features and scalability. Developing Android and iOS versions with voice-based navigation, offline map support, and background alert systems would make it more accessible for everyday users. Cloud integration can be added to store user data, generate safety reports, and allow authorities to monitor road conditions at a larger scale. The system can also be extended to support multiple users, real-time tracking, and integration with vehicle systems, making it suitable for large-scale deployment in smart transportation and urban infrastructure.

VII. CONCLUSION

The Smart Road Safety & Navigation System presents a practical approach to improving road safety by combining mapping, hazard awareness, and alert mechanisms into a single solution. Instead of focusing only on reaching a destination, the system emphasizes how safely the journey is completed. By displaying speed bumps and speed-limit zones on the map, it helps drivers become more aware of road conditions before they encounter them.

A key strength of the system is its ability to provide timely alerts during navigation. As the user moves along a route, the system continuously checks for nearby hazards and notifies the driver when necessary. This reduces sudden reactions and supports better driving decisions, especially in unfamiliar areas. The system therefore shifts navigation from being purely directional to being safety-oriented.

Another important aspect is the simplicity of the implementation. The use of lightweight technologies allows the system to run efficiently without requiring specialized hardware or complex setup. This makes it more accessible and easier to adopt in real-world scenarios, particularly in regions where advanced infrastructure is limited.

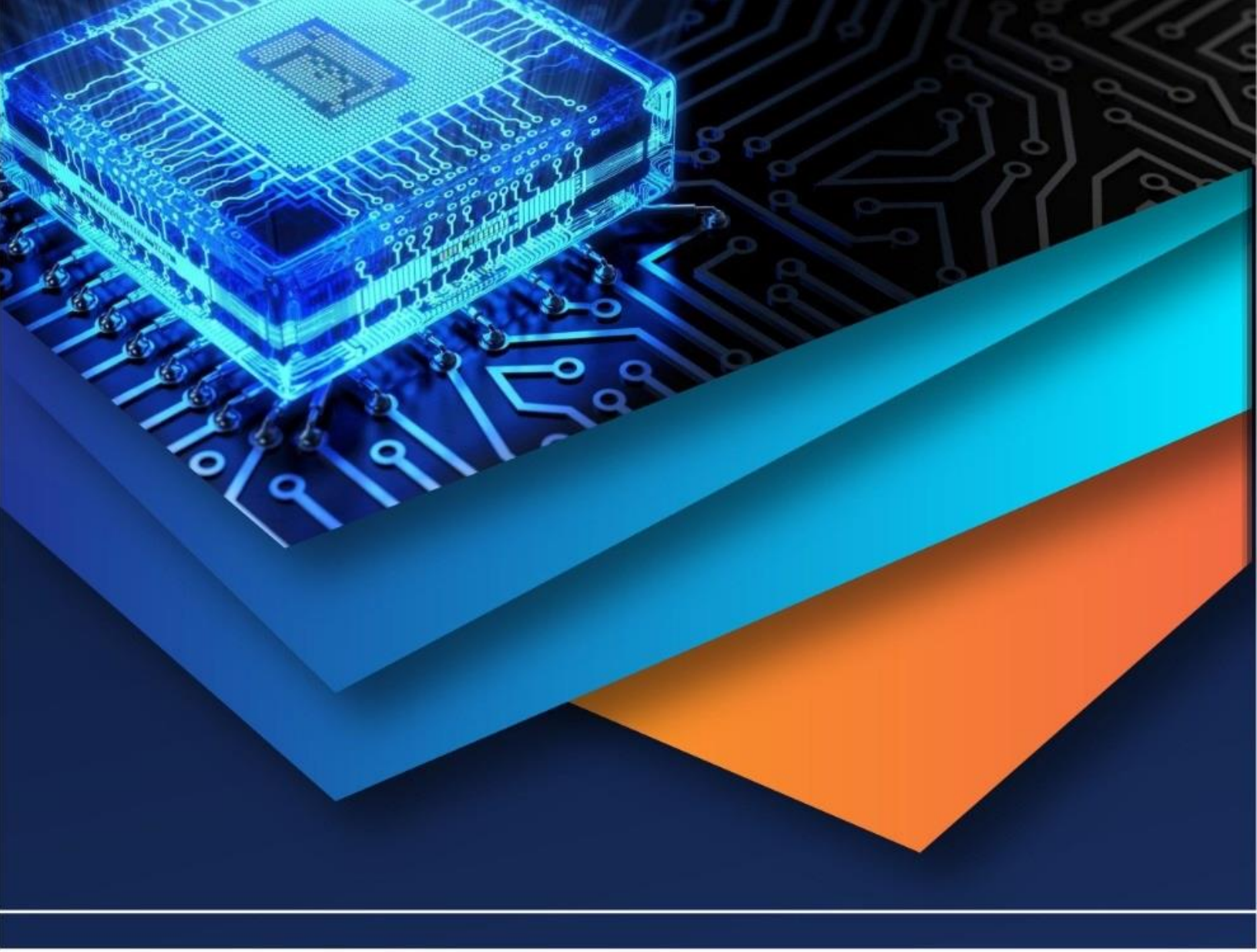
©IJRASET: All Rights are Reserved | SJ Impact Factor 7.538 | ISRA Journal Impact Factor 7.894 |

In addition, the project shows the value of integrating multiple features—such as route planning, hazard visualization, and alert generation—into one platform. This integration improves usability and provides a more complete experience compared to systems that handle these functions separately. It also creates opportunities for further development and expansion.

Overall, the system demonstrates how even a simple, well-designed solution can contribute to safer transportation. With future improvements and real-world data integration, it has the potential to become a useful tool for both individual users and larger traffic management systems.

REFERENCES

[1] OpenStreetMap Foundation, "OpenStreetMap," 2024. [Online]. Available: https://www.openstreetmap.org
[2] LeafletJS, "Leaflet – JavaScript Library for Interactive Maps," 2024. [Online]. Available: https://leafletjs.com
[3] Python Software Foundation, "Flask Web Framework Documentation," 2024. [Online]. Available: https://flask.palletsprojects.com/
[4] Folium Developers, "Folium – Python Data Visualization Library," 2024. [Online]. Available: https://python-visualization.github.io/folium/
[5] Ministry of Road Transport and Highways (India), "Road Accident Data," 2023. [Online]. Available: https://morth.nic.in
[6] World Health Organization, "Global Status Report on Road Safety," 2023. [Online]. Available: https://www.who.int/publications
[7] Google Developers, "Maps and Geolocation APIs," 2024. [Online]. Available: https://developers.google.com/maps
[8] P. Kaur and M. Singh, "GPS and GIS-Based Navigation System for Road Safety," *International Journal of Computer Applications*, 2021.
[9] J. Bhatt and S. Patil, "IoT-Based Smart Road Safety System," *International Journal of Scientific Research in Engineering and Technology*, 2022
[10] L. E. et al., "Characterisation of Road Bumps Using Smartphones," 2016
[11] Sensors Journal, "Abnormal Road Surface Recognition Using Smartphone Sensors," 2020.
[12] Celaya-Padilla et al., "Speed Bump Detection Using Accelerometric Features," 2018.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089 (24*7 Support on Whatsapp)