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StreetSense: Civic Issue Reporting Platform with Real-Time Safety Heatmaps

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Abstract - *Rapid urbanization has significantly increased civic infrastructure problems and public safety concerns in modern cities. Existing grievance portals mainly operate as static complaint systems with limited geospatial interaction, while women safety applications generally depend on historical data instead of real-time environmental awareness. This project presents StreetSense, a full-stack geospatial platform designed to combine civic issue reporting and live safety monitoring within a unified interactive environment. The system enables users to report civic issues such as potholes, garbage dumping, drainage failures, and damaged streetlights through GPS-based location tagging and image-supported submissions. In addition, the platform generates a real-time crowd-density safety heatmap using temporary and privacy-preserving location sharing. The application is developed using the MERN stack along with Leaflet.js for map visualization and MongoDB geospatial indexing for efficient spatial processing. An administrative dashboard is also provided for issue verification, complaint tracking, and resolution management. The proposed system improves transparency, public participation, and environmental awareness by integrating urban governance and public safety into a single scalable platform.*

Key Words: **Civic Reporting, Geospatial Platform, MERN Stack, Public Safety, Heatmap, Leaflet.js, Urban Governance, GPS Mapping, Crowdsourcing**

1. INTRODUCTION

Urban areas experience a wide range of infrastructure-related problems on a daily basis, including potholes, waste accumulation, drainage overflow, broken streetlights, and unsafe public spaces. Citizens often face difficulties while reporting these problems because traditional complaint systems lack proper geospatial interaction and transparency. Most government grievance portals operate as form-based systems where users manually describe issue locations without accurate map integration. As a result, complaints are frequently delayed, duplicated, or poorly managed.

At the same time, public safety and women safety have become major concerns in rapidly developing cities. Existing safety applications primarily depend on historical incident reports and static datasets rather than current environmental conditions. A location considered safe during daytime may become isolated and unsafe at night due to reduced public movement. Current systems fail to provide dynamic situational awareness based on real-time crowd activity.

StreetSense is proposed as a unified geospatial platform that integrates civic issue reporting and public safety monitoring into a single interactive system. The platform enables users to report infrastructure problems directly through a live map interface using GPS coordinates and image uploads. Simultaneously, the system generates a real-time crowd-density heatmap using temporary user location broadcasting to help users identify safer public areas.

The application is developed using modern full-stack technologies including React.js, Node.js, Express.js, MongoDB, and Leaflet.js. The system focuses on improving urban transparency, increasing public participation, and providing better environmental awareness through interactive geospatial visualization.

1.1 Problem Statement

Existing civic issue reporting systems mainly function as digital complaint portals without proper interactive visualization or transparent status tracking. Users often submit complaints without precise location references, resulting in poor complaint management and inefficient resolution workflows. Many systems also fail to provide users with updates regarding complaint progress.

Similarly, existing women safety applications focus mainly on historical safety analysis rather than live environmental awareness. These systems cannot dynamically reflect real-time public movement or current crowd density conditions.

Furthermore, no unified platform currently exists that combines civic issue reporting, crowd-density visualization, public safety awareness, and administrative monitoring into a single environment. This creates a strong need for an integrated system capable of addressing both urban governance and public safety challenges simultaneously.

1.2 Objectives

The major objectives of the proposed system are:

- To develop a geospatial civic issue reporting platform
- To enable GPS-based complaint tagging with image uploads
- To provide real-time safety monitoring using crowd-density heatmaps
- To improve transparency in issue tracking and resolution
- To preserve user privacy through temporary location broadcasting
- To encourage community participation in urban governance

2. RELATED WORK

Several systems related to civic issue reporting and public safety monitoring have been developed in recent years. Platforms such as FixMyStreet and SeeClickFix allow users to report civic infrastructure issues using location-based submissions and photographic evidence. These platforms simplify complaint registration and improve communication between citizens and authorities. However, they mainly focus on complaint management and do not provide live safety monitoring features.

Applications such as SafetiPin and SafeCity focus on women safety and unsafe area awareness using historical reports and survey-based analysis. Although these systems are useful for long-term safety analysis, they do not provide real-time crowd-density visualization or dynamic environmental awareness.

Navigation systems such as Google Maps provide traffic information and route guidance, but traffic density does not necessarily indicate human presence or safety conditions. Social media platforms are also commonly used to report civic problems, but these systems lack structured workflows, organized tracking, and transparent resolution mechanisms.

The analysis of existing systems clearly reveals the absence of a unified platform capable of combining civic issue reporting, public safety monitoring, and real-time geospatial visualization into a single environment. StreetSense addresses this limitation by integrating both civic governance and public safety within one interactive geospatial platform.

Table -1: Comparison of Existing Systems

System	Civic Reporting	Real-Time Safety	Complaint Tracking
Government Portals	Yes	No	Partial
SafetiPin	No	Partial	No
SafeCity	No	No	No
Social Media Platforms	Partial	No	No
StreetSense	Yes	Yes	Yes

3. PROPOSED SYSTEM

StreetSense is designed as a real-time geospatial civic intelligence platform that combines complaint reporting and safety monitoring into a single interactive system. The platform provides users with a live map interface where civic issues can be reported directly using GPS-based location tagging.

Users can select exact locations on the map and submit complaints related to potholes, garbage dumping, drainage overflow, damaged roads, streetlight failures, and unsafe public areas. The system also allows users to upload supporting images and descriptions to improve complaint accuracy and transparency. Once submitted, the reports become visible on the public map and can be tracked by both citizens and administrators.

A major feature of the system is the Safety Heatmap module, which provides real-time crowd-density visualization using temporary user location sharing. Users who voluntarily enable safety mode contribute anonymous live-location data that helps generate the heatmap. Areas with higher public activity appear brighter, indicating relatively safer environments, while isolated regions appear darker.

The system also includes a dedicated administrative dashboard for complaint verification and workflow management. Administrators can monitor reports, update complaint status, remove spam or duplicate submissions, and export data for analysis and planning purposes.

To ensure privacy, user location broadcasts automatically expire after a limited duration using MongoDB TTL indexing. The system avoids permanent storage of

sensitive live-location information and focuses on privacy-preserving geospatial monitoring.

The proposed platform improves public participation, enhances urban transparency, and provides users with better environmental awareness through modern geospatial technologies.

4. METHODOLOGY

The methodology of StreetSense consists of multiple stages including user interaction, authentication, issue reporting, backend processing, geospatial visualization, safety heatmap generation, and administrative moderation. The system is designed using a modular full-stack architecture where each component performs a specific task while maintaining efficient communication with other modules.

4.1 User Authentication and Access Control

The process begins when the user accesses the StreetSense platform through the web application. Users can register accounts and securely log in using authentication mechanisms implemented using JWT tokens and encrypted password storage.

After successful authentication, users gain access to the live map interface and civic reporting functionalities. Administrative users receive additional privileges such as issue verification, moderation, and complaint management through a dedicated admin dashboard.

4.2 Civic Issue Reporting

The civic reporting module allows users to submit complaints directly through the interactive map interface. Users can select precise GPS locations by placing markers on the map and provide details such as issue category, descriptions, and supporting images.

The submitted complaint data is processed through REST API requests developed using Express.js. Uploaded images are handled using Multer middleware and linked to corresponding issue reports. MongoDB geospatial indexing enables efficient storage and retrieval of nearby issue markers.

Once submitted, the complaints immediately become visible on the public interface, improving transparency and public awareness.

4.3 Safety Heatmap Generation

The safety heatmap module is responsible for generating real-time crowd-density visualization. Users can voluntarily enable safety mode, which temporarily broadcasts anonymous location data to the backend server. The backend continuously processes active user-location points and generates heatmap layers using Leaflet.heat integration. Regions with higher user activity appear brighter and indicate relatively safer public areas, while darker regions represent isolated zones.

Temporary location data automatically expires after a fixed duration using MongoDB TTL indexing to preserve user privacy and prevent permanent storage of sensitive information.

4.4 Administrative Workflow Management

The administrative module provides complaint moderation and issue management functionalities. Administrators can review complaints, update issue statuses, remove spam or duplicate submissions, and monitor complaint-resolution workflows.

Issues are categorized into stages such as Submitted, In Progress, Verified, and Resolved. This workflow improves accountability and allows users to monitor complaint progress in real time.

4.5 Geospatial Data Processing

StreetSense uses MongoDB geospatial indexing and Leaflet.js map rendering for efficient spatial-data management. The backend performs location-based queries to retrieve nearby issues and active safety points dynamically.

The frontend continuously communicates with the backend using Axios-based API requests to refresh map data and maintain real-time interaction. Marker clustering techniques are also implemented to improve visualization in high-density urban areas.

Overall, the methodology ensures scalable geospatial processing, efficient issue management, and improved urban awareness through an integrated full-stack system.

5. SYSTEM ARCHITECTURE

The architecture of StreetSense is designed using a modular multi-layer structure consisting of frontend, backend, database, and external service layers. The system ensures efficient communication between users, geospatial services, authentication modules, and cloud storage while maintaining scalability, responsiveness, and real-time interaction.

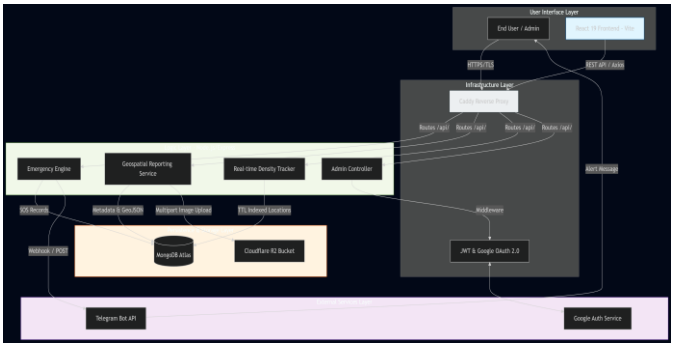

Fig -1 : System Architecture of StreetSense Platform

The architecture of StreetSense is designed using a modular three-layer structure consisting of frontend, backend, and database components. This architecture enables efficient communication between users, servers, and geospatial data services while maintaining scalability and real-time responsiveness.

The frontend layer is developed using React.js and Bootstrap to provide an interactive and responsive user interface. Leaflet.js and React-Leaflet are used for live geospatial map rendering and visualization. The frontend handles user authentication, issue visualization, image previews, safety heatmap rendering, and real-time map interaction.

The backend layer is implemented using Node.js and Express.js. This layer acts as the processing engine of the system and handles authentication, REST API communication, complaint processing, image uploads, geospatial queries, and administrative operations. The backend validates requests, processes issue data, and communicates with the database layer.

MongoDB serves as the primary database layer and stores user accounts, civic reports, uploaded media references, administrative records, and temporary safety-location data. MongoDB geospatial indexing using 2dsphere indexing enables efficient location-based queries and rapid retrieval of nearby issues and active user points.

The system also integrates Multer middleware for image upload handling and JWT-based authentication for secure access control. Temporary user-location broadcasts used for safety monitoring are automatically removed after expiration using MongoDB TTL indexing.

When a user submits a complaint, the frontend sends the issue data and uploaded image through API requests to the backend server. The backend validates the request and stores the information in MongoDB. The frontend then refreshes the live map dynamically to display the newly submitted issue marker.

Similarly, active safety-location points are continuously processed by the backend to generate real-time crowd-density heatmaps. These heatmaps are dynamically rendered on the frontend using Leaflet.heat integration.

The modular architecture improves scalability, maintainability, responsiveness, and efficient real-time geospatial interaction.

6. RESULTS AND DISCUSSION

The proposed StreetSense platform was tested under multiple reporting and safety-monitoring scenarios to evaluate its performance, responsiveness, and usability. The system successfully handled GPS-based complaint submission, image upload processing, live map rendering, crowd-density heatmap generation, and administrative moderation workflows.

The civic issue reporting module accurately displayed newly submitted complaints on the interactive map within a short response time. Users were able to place issue markers using precise GPS coordinates and upload supporting images successfully. Marker clustering improved visualization in high-density regions by grouping nearby complaints into organized clusters.

The safety heatmap module effectively generated real-time crowd-density visualization using temporary user-location broadcasts. Regions with higher public movement appeared brighter on the map, while isolated areas appeared darker. The heatmap refreshed dynamically without requiring manual page reloads, improving real-time situational awareness.

Administrative functionalities such as complaint verification, issue-status updates, and report moderation were tested successfully through the admin dashboard. Administrators could efficiently categorize complaints into different stages and monitor resolution workflows.

The use of MongoDB geospatial indexing significantly improved query performance for retrieving nearby reports and active safety points. The integration of React.js, Express.js, and Leaflet.js contributed to smooth frontend responsiveness and efficient real-time interaction.

Experimental observations showed that the platform can effectively improve urban transparency, public participation, and environmental awareness. The integration of civic issue reporting and public safety monitoring into a single geospatial environment provides practical advantages over traditional grievance systems and standalone safety applications.

Although the current implementation performs effectively, certain limitations still exist. The platform

currently operates as a web application and does not yet provide native mobile support. In addition, the system does not include AI-based predictive safety analysis or direct government API integration for automated complaint forwarding.

Overall, the results demonstrate that StreetSense is a scalable, efficient, and practical solution for modern civic intelligence and smart-city monitoring applications.

7. CONCLUSION

StreetSense successfully combines civic issue reporting and real-time public safety monitoring into a unified geospatial platform. The system addresses major limitations present in traditional grievance portals and existing safety applications by integrating live map-based interaction, GPS-enabled reporting, transparent issue tracking, and dynamic crowd-density visualization into a single environment.

The platform enables users to report infrastructure-related problems efficiently while simultaneously improving environmental awareness through real-time safety heatmaps. The integration of temporary location broadcasting and privacy-preserving mechanisms ensures that users can contribute to safety monitoring without compromising sensitive personal information.

The use of modern full-stack technologies such as React.js, Node.js, Express.js, MongoDB, and Leaflet.js provides a scalable and responsive foundation for real-time geospatial applications. The administrative dashboard further improves transparency and accountability through organized complaint management and resolution tracking.

Experimental evaluation demonstrated that the platform performs efficiently under real-time conditions and provides smooth user interaction across different functionalities. The proposed system improves public participation, strengthens urban transparency, and creates a more accessible approach toward civic engagement and environmental monitoring.

Overall, StreetSense represents a practical and scalable smart-city solution capable of supporting modern urban governance through interactive geospatial technologies and community-driven monitoring systems.

8. FUTURE WORK

The proposed system can be further improved by integrating advanced technologies such as machine learning and predictive analytics for intelligent safety forecasting and automated issue prioritization.

Future enhancements may include:

- Native Android and iOS mobile applications
- AI-based unsafe zone prediction
- Integration with government complaint APIs
- Real-time safer route recommendation systems
- Push notification and alert mechanisms
- Multi-agent emergency response integration
- Offline reporting support

The platform can also be expanded to support smart-city analytics and large-scale urban infrastructure monitoring systems in future deployments.

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