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SMART PUBLIC GRIEVANCE MANAGEMENT SYSTEM USING AI AND GEO-TAGGING

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ABSTRACT

The rapid expansion of urban environments has significantly increased both the complexity and volume of civic grievances, placing substantial strain on traditional administrative frameworks. Conventional grievance redressal mechanisms, which depend heavily on manual processing and fragmented communication channels, frequently exhibit limitations such as delayed response times, lack of transparency, duplicate reporting, and inaccurate complaint classification. To address these challenges, modern smart city initiatives are progressively integrating Artificial Intelligence (AI)-driven solutions to enhance and automate grievance management processes.

This paper presents a comprehensive survey of contemporary digital and AI-enabled grievance redressal systems, tracing their evolution from conventional database-driven platforms to advanced intelligent frameworks. It systematically examines key enabling technologies, including Natural Language Processing (NLP), Computer Vision, deep learning models such as BERT and YOLO, and emerging Retrieval-Augmented Generation (RAG)-based multi-agent systems. A comparative evaluation of these approaches is conducted to highlight their respective strengths, limitations, and applicability within real-world urban governance contexts.

Furthermore, the study identifies several critical research gaps, including challenges related to multilingual processing, data authenticity, infrastructure limitations, and the absence of automated resolution verification mechanisms. In response, a scalable and modular system architecture is proposed, incorporating multimodal AI, geo-tagging, and predictive analytics. The findings indicate that AI-driven grievance systems can substantially improve operational efficiency, enhance transparency, and foster greater citizen engagement, thereby supporting the development of responsive and sustainable smart cities.

KEYWORDS: Smart City, E-Governance, Grievance Redressal, Artificial Intelligence, NLP, Computer Vision, Deep Learning, RAG.

1. INTRODUCTION

Rapid urbanization and the continuous growth of metropolitan regions have led to a significant rise in civic infrastructure challenges. Common issues such as damaged roads, inefficient waste management, water leakages, and malfunctioning public utilities adversely affect both the quality of urban life and public safety [5]. In democratic systems, an effective grievance redressal mechanism is essential for maintaining citizen satisfaction and ensuring governmental accountability [14]. However, the increasing urban population has overwhelmed municipal authorities with a high volume of complaints, exposing the limitations of traditional grievance management systems. Conventional approaches, which rely on manual documentation, telephonic reporting, and fragmented communication channels, are inherently inefficient, often resulting in misclassification, duplication, and delays in resolution [5]. Furthermore, the lack of transparency prevents citizens from effectively tracking complaint status, thereby reducing trust in public institutions [14].

The transition toward digital governance has introduced web-based and mobile-based grievance portals aimed at improving accessibility and centralizing complaint management [14]. While these platforms represent a significant improvement over manual systems, they continue to depend heavily on human intervention for processing and decision-making. As a result, they struggle to scale efficiently with increasing data volumes and often fail to provide real-time responsiveness. Moreover, the absence of intelligent prioritization mechanisms can lead to critical issues being overlooked, while less urgent complaints consume administrative resources [11].

Recent advancements in Artificial Intelligence (AI) offer promising solutions to these challenges. Natural Language Processing (NLP) techniques enable automated interpretation and classification of unstructured textual complaints [1], [2], while Computer Vision technologies facilitate the analysis of visual evidence to detect infrastructure damage from user-submitted images [3], [7]. The integration of these technologies with geo-tagging and multimodal learning frameworks supports a more comprehensive and automated grievance management approach. However, existing systems still face challenges related to integration, scalability, and reliable validation, particularly in combining multimodal data and verifying issue resolution [4]. Motivated by these limitations, this study aims to survey current technologies, identify research gaps, and propose a scalable AI-driven framework for smart grievance management systems.

2. PROBLEM STATEMENT

Current grievance redressal systems face several technical and operational challenges that reduce their effectiveness. A major issue is the lack of transparency, as citizens have limited visibility into the status and progress of their complaints, which lowers trust in governance systems [5]. In addition, manual routing and classification of complaints often lead to delays and errors, especially when handling large volumes of unstructured data [2], [14]. Another challenge is spatial ambiguity, since these systems rely on manually entered location details that may be incomplete or inaccurate, making it difficult for field personnel to locate issues precisely [3], [14]. The absence of duplicate detection mechanisms further results in multiple reports of the same problem being processed separately, leading to inefficient use of resources [2]. Moreover, most systems lack proper verification mechanisms to confirm whether issues have actually been resolved, as they depend on manual updates from officials [4]. Overall, addressing these limitations requires the integration of automation, accurate location tracking, and real-time validation to improve efficiency and accountability.

3. METHODOLOGY

The development of a robust and highly responsive Smart Public Grievance Management System requires a systematic, multi-phased methodology. This development lifecycle integrates conventional software engineering practices with advanced machine learning pipelines to ensure scalability, security, and operational accuracy.

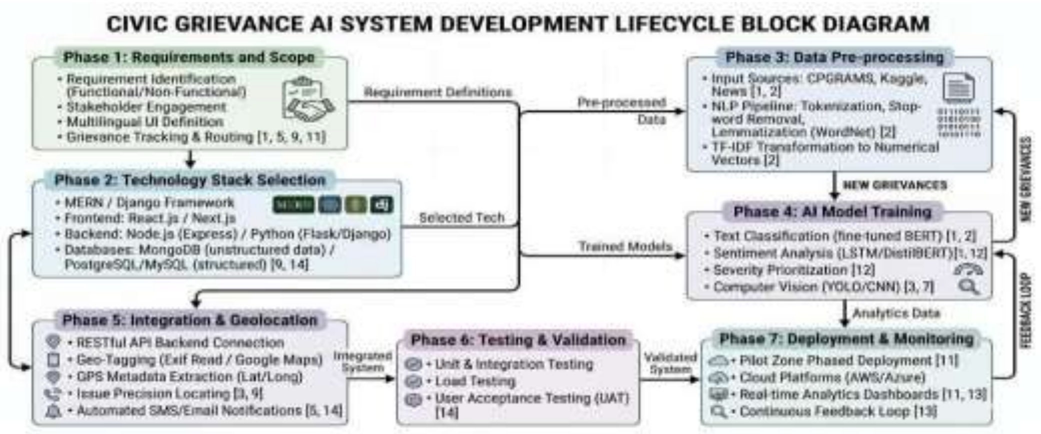

Fig.1 Civic Grievance AI System Development Life Cycle Block Diagram.

The initial phase focuses on identifying both functional and non-functional requirements through stakeholder engagement involving citizens, municipal administrators, and field personnel [1], [5], where key requirements include multilingual interfaces, real-time grievance tracking, and automated routing to departments [1], [9], along with KPIs such as resolution time and user satisfaction [11]. Selecting the technology stack follows, with scalable options like MERN (MongoDB, Express.js, React, Node.js) [9],
[14] or Django [14], where React.js/Next.js are used for responsive frontends, Node.js or Flask/Django handle backend APIs and authentication [9], [14], and a hybrid database model uses MongoDB for unstructured data and PostgreSQL/MySQL for structured records [9]. Data collection and preprocessing involve sourcing grievances from CPGRAMS, Kaggle, and web data [1], [2], followed by NLP steps like tokenization, stop-word removal, and lemmatization using WordNet, while TF-IDF converts text into feature vectors for classification [2]. AI model development includes transformer-based BERT for text classification into departments like sanitation or water services [1], [2], sentiment analysis using LSTM and DistilBERT for urgency detection [1], [12], and computer vision models like YOLO and CNNs for detecting infrastructure damage such as potholes and waste [3], [7]. System integration connects AI modules via RESTful APIs for real-time processing [9], with geo-tagging using Exif tools or Google Maps APIs to extract GPS coordinates automatically [3], [9], along with SMS/email notifications for user updates [5], [14]. Testing and validation include unit and integration testing, load testing for scalability, and user acceptance testing with stakeholders [14]. Finally, deployment is done in phases using cloud platforms like AWS or Azure [11], with real-time analytics dashboards monitoring trends and performance [11], [13], and a continuous feedback loop ensures model retraining using new grievance data for ongoing system improvement [13].

4. LITERATURE REVIEW

1. AI and Multilingual Chatbot Integration [P. Gupta et al., 2025]

Gupta et al. proposed an AI-driven system that integrates a fine-tuned BERT model for complaint classification with LSTM for sentiment analysis. Their approach combines a decision tree with heuristic rules to achieve a routing efficiency of 95%. A key contribution is the inclusion of a multilingual AI chatbot, which assists users in submitting complaints and improves accessibility for individuals with limited digital literacy.

2. Rural Accessibility and Multimodal Inputs [P. Patil et al., 2025]

Patil et al. addressed the urban–rural digital divide by developing a system capable of processing multimodal inputs, including text, voice, and images. The proposed system utilizes a Random Forest classifier to prioritize complaints and is optimized for low-connectivity environments. It achieved a 65% reduction in response time, emphasizing the significance of offline support and regional language accessibility in improving rural service delivery.

3. Computer Vision and Fused Location Services [F. Shama et al., 2024]

Shama et al. introduced CitySolution, a mobile application that uses deep learning models based on Google’s Teachable Machine (MobileNets) to classify civic issues such as damaged roads and waste accumulation. The system integrates fused location services to automatically capture GPS coordinates, eliminating manual address entry. However, it is limited to predefined visual categories.

4. RAG-Based Multi-Agent Architecture [K. Patil et al., 2024]

Patil et al. proposed a Retrieval-Augmented Generation (RAG) multi-agent framework utilizing Small Language Models such as Llama-3-8B. By linking complaint embeddings to a vector database (ChromaDB) containing government policies, the system dynamically processes grievances without frequent retraining, reducing processing time from 30 minutes to under 3 minutes.

5. Multimodal MERN Stack Framework [Maruthi S. T. et al., 2025]

Maruthi et al. developed the *Nagarik Connect* platform using a MERN stack architecture. The system integrates BERT-based NLP for complaint classification and Google Maps API for spatial tracking. Additionally, Flask-Babel is used to provide multilingual support, enabling users to submit complaints in regional languages such as Kannada and Hindi.

6. Deep Learning for Image Severity and Community Up-Voting [H. Rane et al., 2022]

Rane et al. designed an Android-based grievance system that employs a two-layer CNN to classify the severity of uploaded images into low, medium, and high categories. The system also incorporates a crowdsourcing feature where users can up-vote complaints. Priority is dynamically determined based on a combination of severity score, elapsed time, and community engagement.

7. Automated Analytics and Predictive Heatmaps [S. Raj & A. Kumar, 2025]

Raj and Kumar focused on administrative analytics by integrating NLP-based classification with interactive dashboards built using Chart.js. Their system generates area-wise heatmaps and predictive trends, enabling authorities to shift from reactive grievance handling to proactive infrastructure management.

8. Advanced Duplicate Detection and Priority Scoring [V. D. Nandhini et al., 2024]

Nandhini et al. developed a system that combines BERT-based classification (achieving 92% accuracy) with VADER and TextBlob for urgency detection. The study introduces cosine similarity and DBSCAN clustering to automatically identify and group duplicate complaints, reducing redundancy and improving system efficiency.

9. Decision Support for Critical Priority Routing [H. Srivastava et al., 2022]

Srivastava et al. proposed a statistical multi-method framework to compute a “severity redressal value.” The system uses DistilBERT for sentiment analysis and BERT-based similarity measures to rank complaints into priority levels. It achieved an AUC-ROC score of 0.930, demonstrating high effectiveness in prioritizing critical issues.

5. COMPARATIVE ANALYSIS

AI-based grievance management systems demonstrate clear advantages over traditional approaches in terms of scalability, automation, and accuracy. While TF-IDF-based models are computationally efficient [2], deep learning models offer superior contextual understanding [1]. Computer Vision systems enable real-time validation of reported issues [3], whereas multimodal systems provide more comprehensive analytical capabilities by integrating multiple data sources.

Table 1: Comparison of grievance redressal approaches.

Feature	Traditional	Database-Driven	AI/NLP Integrated	Computer Vision
Routing	Manual	Digital Admin	Automated (BERT)	Automated (Visual)
Latency	High (Weeks)	Moderate (Days)	Low (Hours)	Real-time
Evidence	None	Photo/GPS	Sentiment Ranking	Visual Validation
Scalability	Low	Moderate	High	High
Transparency	Minimal	ID-based Tracking	Automated Alerts	Visual Proof

6. PROPOSED SYSTEM ARCHITECTURE

The proposed "Smart Public Grievance Management System" adopts a modular, three-tier architecture designed to support immediate deployment via relational databases while facilitating future AI integration [9]. The workflow progresses from JWT-based authentication and GPS-tagged submission to centralized database persistence and eventual automated routing via NLP models. The proposed system is structured as a four-layer architecture: Presentation Layer: Provides a web and mobile interface for complaint submission Application Layer: Manages authentication and request processing AI Layer: Performs NLP-based classification, sentiment analysis, and image processing [1], [2] Data Layer: Stores complaint data and supports analytical operations This layered design ensures scalability, automation, and efficient resource utilization.

7. LIMITATIONS AND FUTURE SCOPE.

Although the proposed system demonstrates promising capabilities, it exhibits several limitations across technical, practical, and system-level dimensions. Technically, the absence of geo-tagging restricts its ability to accurately handle location-based complaints, while its reliance on text-only input limits applicability in scenarios where visual evidence is crucial [9]. The relatively small dataset of approximately 5000 complaints may further constrain the model’s generalization capability [2]. Additionally, the system primarily supports the English language, reducing accessibility for users who rely on regional languages [9]. From a practical perspective, the system depends heavily on stable internet connectivity and requires well-trained AI models, resulting in increased development and maintenance costs. Its performance may also decline when processing complex or multi-faceted complaints. At the system level, the lack of real-time integration with government infrastructure, absence of a mobile application, and the omission of predictive analytics further limit its effectiveness in real-world deployments [14].

To address these shortcomings, the proposed project, “Smart Public Grievance Management System using AI and Geo-Tagging,” extends the base system by incorporating several key enhancements. The system retains core AI functionalities such as NLP-based classification, sentiment-based prioritization, and automated routing, while introducing geo-tagging through GPS and Google Maps APIs to accurately identify complaint locations and enable hotspot detection [3], [9]. It further integrates image and video upload capabilities, allowing Computer Vision techniques to assess issue severity [7], and supports multiple languages, including Kannada, Hindi, and English, to improve accessibility [9].

Additional improvements include the development of a dedicated Android mobile application with notification support, an advanced analytics dashboard featuring heatmaps and performance tracking [11], a chatbot interface for user assistance [1], and predictive analytics to forecast potential issues. Collectively, these enhancements aim to create a more scalable, efficient, and user-centric grievance management system for smart city governance.

8. CONCLUSIONS

The proposed “Smart Public Grievance Management System” is designed using a scalable, multi-tier architecture that effectively bridges the communication gap between citizens and municipal authorities. At the presentation layer, users interact through responsive web and mobile applications developed using modern frameworks such as React.js and Next.js [9]. When a citizen encounters a civic issue, such as a damaged road or uncollected waste, they can easily submit a multimodal complaint that includes both a textual description and supporting images. To address the limitations of manual address entry, the system automatically captures precise geographical coordinates (latitude and longitude) using mobile GPS sensors and mapping APIs, embedding this spatial information directly into the complaint [3], [9]. The collected data is then securely transmitted to a Node.js-based backend, where user authentication and session management are handled before forwarding the request to the AI processing pipeline [9], [14].

Once the complaint reaches the core processing layer, a combination of Artificial Intelligence techniques is employed to automate analysis and routing. Natural Language Processing (NLP) models, particularly fine-tuned BERT architectures, interpret the semantic content of the complaint text and classify it into the appropriate municipal department [1]. At the same time, computer vision models such as YOLOv8 and YOLOv9 analyze the uploaded images to validate the reported issue and estimate its severity [3], [7]. To improve efficiency, the system applies cosine similarity measures to compare incoming complaints with existing records, enabling the identification and grouping of duplicate reports [2].

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