International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 03 | March - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

AI-Driven Grievance Redressal System for Public Service Enhancement

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Abstract - The growing demand for parking in densely populated urban areas has led to significant challenges, including congestion, inefficient space utilization, and frustration among drivers. Traditional parking systems often struggle to manage high volumes of vehicles, resulting in wasted time and increased environmental impact. The Automated Car Parking System (ACPS) addresses these issues by using advanced sensor technologies to monitor parking space availability in real-time. The system provides accurate, up-to-date information to drivers, guiding them to open parking spaces and improving overall traffic flow. If all parking spots are occupied, the system automatically closes the parking entrance to prevent further congestion. This automated approach reduces the time spent searching for parking, optimizes space usage, and alleviates traffic congestion. The ACPS offers a seamless, efficient, and user-friendly parking experience, particularly suited for busy urban environments, shopping malls, office complexes, and public parking areas. By enhancing the efficiency of parking operations, the system contributes to a more sustainable and convenient urban transport experience.

Key Words: AI Grievance Redressal, NLP, Chatbot, Public Service Efficiency, OpenCV, Complaint Automation, Secure Authentication, Cloud-based System.

1. INTRODUCTION

In the modern digital era, the increasing volume of citizen grievances in public service sectors has become a significant challenge. Traditional grievance redressal mechanisms often rely on manual processing, leading to inefficiencies, delays, and a lack of transparency. These challenges result in frustration among users and hinder the timely resolution of complaints. Additionally, the absence of an intelligent system to prioritize and categorize grievances leads to mismanagement and prolonged response times.

The AI-Powered Grievance Redressal System (AIGRS) offers a modern, automated solution to address these challenges by integrating Natural Language Processing (NLP), Generative AI, and Machine Learning (ML). This system enables users to submit complaints through multiple channels, including text, voice, and image/video uploads, via a web or mobile interface. An AI-driven chatbot assists users in filing complaints and provides real-time status updates. NLP-based text classification and sentiment analysis help prioritize grievances based on urgency, ensuring that critical issues receive immediate attention. Additionally, speech-to-text conversion allows voice-based complaint registration, while OpenCV-powered image and video analysis enhances verification and evidence processing.

To ensure security and reliability, AIGRS incorporates PBKDF2:SHA-256 for password encryption, SCRAM-SHA-256 for database security, and Two-Factor Authentication (2FA) for login and registration. All complaint data is stored in MongoDB, and automated email notifications are sent via NodeMailer. The platform is hosted on AWS Cloud, ensuring scalability, security, and high availability.

By automating the grievance redressal process, the AIGRS significantly improves response time, efficiency, and user satisfaction. It minimizes manual intervention, enhances transparency, and provides a seamless, user-friendly experience for citizens. The system is particularly well-suited for public service departments, government agencies, corporate complaint management, and urban governance, where efficient grievance handling is essential.

2. BACKGROUND

In the digital age, public service sectors play a crucial role in addressing citizen concerns and grievances. However, traditional grievance redressal mechanisms often suffer from inefficiencies such as manual processing, delayed responses, lack of prioritization, and inadequate transparency. These challenges lead to dissatisfaction among citizens, reduced trust in public institutions, and an overall decline in service quality.

Historically, grievance redressal systems were managed through physical complaint desks, telephone helplines, and email-based submissions, which required human intervention at every stage. While these methods allowed citizens to report issues, they lacked automation and real-time tracking, making it difficult to process complaints efficiently. Many existing semi-automated systems use

basic ticketing mechanisms, but they fail to incorporate intelligent classification, prioritization, and analytics.

With advancements in Artificial Intelligence (AI), Natural Language Processing (NLP), and Machine Learning (ML), modern AI-powered grievance redressal systems can revolutionize the way complaints are handled. AI enables automated text analysis, sentiment detection, voice recognition, and image/video processing, allowing for faster resolution, better categorization, and improved service delivery.

The AI-powered Grievance Redressal System (AIGRS) builds on these technological advancements to eliminate inefficiencies, reduce manual workload, and enhance the overall complaint resolution experience. By integrating AI-driven chatbots, speech-to-text conversion, real-time complaint tracking, and secure authentication mechanisms, AIGRS ensures a seamless, transparent, and effective grievance-handling process.

With cloud hosting (AWS), secure authentication (2FA, PBKDF2:SHA-256), and automated email notifications (NodeMailer), this system is designed to be scalable, secure, and accessible to both public service sectors and corporate grievance management platforms. It marks a significant transformation in complaint resolution, moving from outdated manual methods to an intelligent, automated, and highly responsive system.

3.MOTIVATION

The motivation behind this AI-driven Grievance Redressal System is rooted in the inefficiencies of traditional complaint management methods in urban areas. Citizens frequently face difficulties in reporting issues related to public infrastructure, such as broken streetlights, potholes, water supply disruptions, and waste management failures. Conventional systems often suffer from delayed responses, lack of transparency, and improper tracking, leading to frustration and dissatisfaction among the public.

This project aims to develop an intelligent, automated grievance redressal system that leverages Natural Language Processing (NLP) and Machine Learning (ML) to categorize complaints, prioritize them based on urgency, and route them to the appropriate authorities. By integrating geolocation tagging, the system ensures accurate reporting and effective resolution of issues. Additionally, real-time status updates allow users to track the progress of their complaints, fostering transparency and accountability.

Ultimately, this project seeks to streamline the grievance-handling process, enhance citizen-government communication, and improve service efficiency. By reducing manual intervention and optimizing resource allocation, the system will contribute to more responsive governance, better urban infrastructure management, and increased public trust in municipal services.

4. OBJECTIVES

The aim of this report regarding the AI-enabled Grievance Resolution System is to chronicle the architecture, creation, and assessment of an automated complaint-handling solution. The main goals of the project are as follows:

1. Create and implement an AI-enabled grievance resolution system that effectively manages citizen complaints concerning public infrastructure.

2. Utilize Natural Language Processing (NLP) methods to proficiently understand, classify, and prioritize grievances.

3. Streamline the complaint escalation process to channel issues to the relevant municipal departments for quicker resolution.

4. Incorporate geolocation features to enable users to pinpoint the exact locations of reported issues, ensuring accurate identification and effective resolution.

5. Deliver real-time updates on complaint progress, bolstering transparency and enhancing citizen confidence in the system.

6. Assess the system's effectiveness in terms of precision, response duration, and user satisfaction.

7. Examine data trends using Machine Learning (ML) to uncover recurring problems and facilitate data-informed decision-making for infrastructure enhancements.

8. Reduce manual involvement and operational inefficiencies in the conventional grievance management process.

9. Review the outcomes, efficacy, and constraints of the implemented system.

10. Identify potential future upgrades, such as expanding the system's functionalities with voice recognition, multilingual capabilities, and integration with intelligent city frameworks.

In summary, the purpose of this report is to provide a thorough overview of the design, execution, and assessment of the AI-powered grievance resolution system, delivering valuable insights into its operation, effectiveness, and potential improvements for smarter urban management.

5. OUTLINES

This paper will be structured into six main sections: Introduction, Literature Review, Methodology, Results and Discussion, Conclusion, and References.

The Introduction section will provide an overview of the project, introducing the concept of an AI-driven Grievance Redressal System and discussing the growing need for efficient public complaint management. It will outline the objectives of the study and the significance of implementing an automated grievance redressal mechanism to enhance governance and citizen satisfaction.

The Literature Review section will summarize existing research and technologies related to grievance redressal systems, highlighting traditional methods, their limitations, and how AI-based solutions can improve efficiency, accuracy, and transparency in complaint handling.

The Methodology section will describe the system architecture, including the integration of Natural Language Processing (NLP) for complaint analysis, Machine Learning (ML) for prioritization, and a chatbot interface for user interactions. It will also explain the implementation of geolocation tagging and database management for effective complaint tracking and resolution.

The Results and Discussion section will present the system's performance, evaluating the accuracy of complaint categorization, response time, and overall efficiency. It will compare the AI-driven approach to conventional manual grievance redressal methods, discuss challenges encountered during implementation, and propose potential improvements.

The Conclusion will summarize the key findings and contributions of the study, highlighting the impact of the AI-driven grievance redressal system on urban governance. It will also provide suggestions for future enhancements, such as voice recognition, multilingual support, and smart city integrations.

Finally, the References section will list all sources cited throughout the paper. This structure ensures a comprehensive understanding of the project and its potential for revolutionizing grievance redressal in public administration.

6. LITERATURE REVIEW

The literature review provides an overview of existing research and advancements in AI-driven grievance redressal systems, focusing on automated complaint management and natural language processing (NLP) techniques. It begins by discussing the challenges of traditional grievance-handling methods, including inefficiencies, delays, and lack of transparency, which often lead to citizen dissatisfaction.

The review explores various AI-based grievance redressal approaches, emphasizing the role of NLP in analyzing and categorizing complaints. Studies highlight the effectiveness of machine learning models in prioritizing issues based on urgency, sentiment analysis, and predefined classification rules. These technologies enable real-time complaint processing, reducing human intervention and response time.

Furthermore, the review examines the integration of chatbots and voice assistants in automated grievance systems. AI-powered virtual assistants have been widely adopted in e-governance for handling citizen complaints, offering a more interactive and efficient experience. Research also highlights the role of geolocation-based tracking in pinpointing issue locations, and improving resource allocation for quicker resolutions.

Finally, the literature review identifies gaps in existing research, such as the need for multilingual support, improved AI accuracy, and enhanced security in complaint handling. This study aims to address these limitations by proposing an advanced AI-driven grievance redressal system, ensuring a more effective and user-friendly complaint management process.

7. METHODOLOGY

The methodology for implementing the AI-Powered Grievance Redressal System involves several key steps, focusing on the integration of advanced Artificial Intelligence (AI), Natural Language Processing (NLP), and secure cloud-based services. This structured approach ensures efficient complaint handling, real-time tracking, and automated resolution.

A. Working Principle of the Proposed Project

The working principle of the AI Grievance Redressal System is based on multiple technologies working together to automate grievance submission, classification, and resolution. The key components and their interactions are as follows:

1. User Grievance Submission: Users can submit complaints through text, voice input (converted via speech-to-text), or multimedia uploads. An AI-powered chatbot assists users in structuring complaints, ensuring all necessary details are included.
2. Complaint Categorization & Prioritization: NLP-based analysis extracts key information and classifies complaints into categories like public service or infrastructure. Sentiment analysis determines urgency, prioritizing critical grievances for faster resolution.

3. Automated Communication & Complaint Tracking: Users receive real-time SMS and email updates via NodeMailer after complaint submission. A unique tracking ID allows them to monitor progress, and the system routes complaints to the appropriate department.
4. AI-Driven Response & Resolution: A Generative AI chatbot provides automated responses and guidance for common grievances. If a complaint requires manual intervention, it is escalated to the relevant personnel for further processing.
5. Cloud-Based Hosting & Scalability: The system is hosted on AWS Cloud for scalability and real-time access. It integrates with government portals to ensure seamless complaint handling and faster grievance redressal.

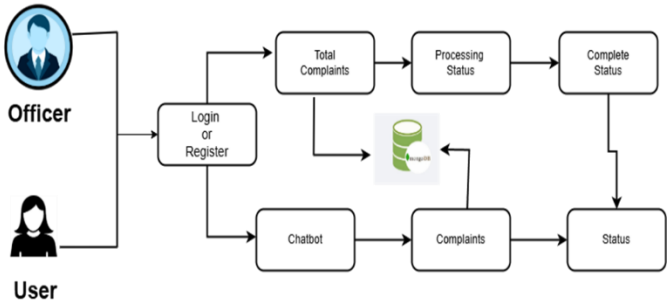

Fig -1: Figure

B. Proposed Approach

Fig 1 provides a structured observation of the complaint -travel system, which reflects the interaction between users, administrators and centralized databases. The process begins when users log on or register on the platform so that they can submit complaints related to different problems. When a complaint is submitted, it is stored in the database and classified for effective treatment. The system allows administrators to track the total number of complaints, monitor the ongoing cases and update the situation in the resolution. A chatbot is integrated into the system so that users can provide automatic reactions for frequent questions, reduce the response time and to improve the user's satisfaction.

The database acts as the origin of the system, which ensures spontaneous storage, recovery and control of complaints. Each complaint continues through several stages, including submission, treatment and resolution, users can track real time updates. Structured status updates - such as "treatment" and "complete" - to maintain openness and responsibility. In addition, the system provides analysis of the trends of complaints, supports administrators in identifying recurrent questions and adapting the dissolution strategies.

By taking advantage of automation and tracking of real -time, this improves the complaint -travel system The efficiency of addressing the user's concerns. The integration of a chatbot further streamlines communication, reduces delays and ensures the user - friendly experience. The system not only facilitates fast complaints, but also promotes a transparent and responsible mechanism for users and administrators.

D. Process of Working

The AI-driven grievance redressal system automates complaint handling through AI and machine learning. Data collection starts with users submitting complaints via text, speech, or multimedia through web portals, mobile apps, emails, and chatbots. Speech-to-text conversion processes voice complaints, while image/video analysis (YOLOv8, Faster R-CNN, SSD) verifies evidence.

Data preprocessing ensures clean and structured input using NLP techniques (tokenization, stop-word removal, lemmatization) and Named Entity Recognition (NER) to extract complaint details. Speech-based grievances are converted using MFCC feature extraction with CNN/RNN, while image noise reduction enhances clarity.

For classification, the system uses Naïve Bayes, BERT, and LSTM models to categorize complaints. Transformer-based models ensure real-time classification accuracy, and confidence thresholds reduce misclassification errors.

Sentiment analysis detects urgency, escalating critical complaints. Multimodal analysis integrates text, speech, and image sentiment for precise prioritization.

The AI-powered chatbot provides real-time responses, tracks complaint status, and guides users through resolution.

Authentication & Security is ensured using PBKDF2:SHA-256, BCRYPT encryption, SCRAM-SHA-256 authentication, and 2FA (TOTP, HMAC-OTP) for safe user access.

By integrating AI-powered automation, NLP, sentiment analysis, and secure authentication, the system ensures efficient, transparent, and scalable grievance redressal

D. Experimental Analysis

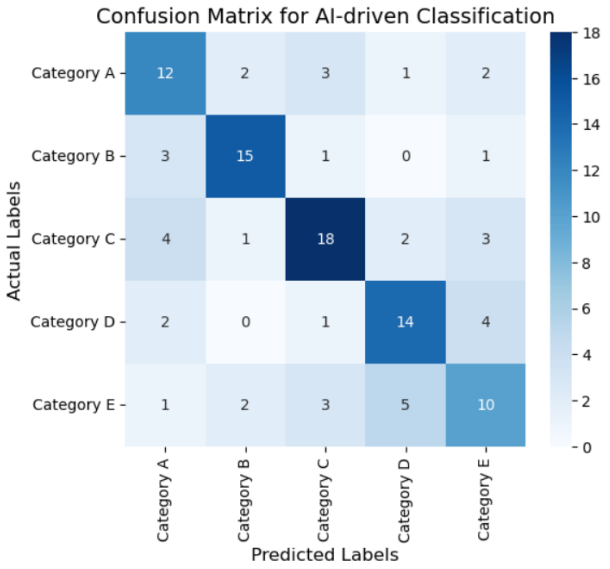

Fig -2: Figure

The evaluation metrics from the confusion matrix indicate that the AI-driven classification model performs effectively, achieving a strong accuracy rate. The model demonstrates its ability to distinguish between different categories, making it valuable for automated classification tasks. The confusion matrix provides a detailed breakdown of the model's predictions, where Category C was classified correctly in most cases, showing the highest classification accuracy. Category B also performed well, with minimal misclassifications. However, Category E exhibited some misclassification instances, particularly being predicted as Category D multiple times, suggesting areas for improvement. The color intensity in the matrix visually highlights classification success, emphasizing well-performing categories and areas needing optimization. These insights help refine the model, ensuring better accuracy and efficiency in future iterations.

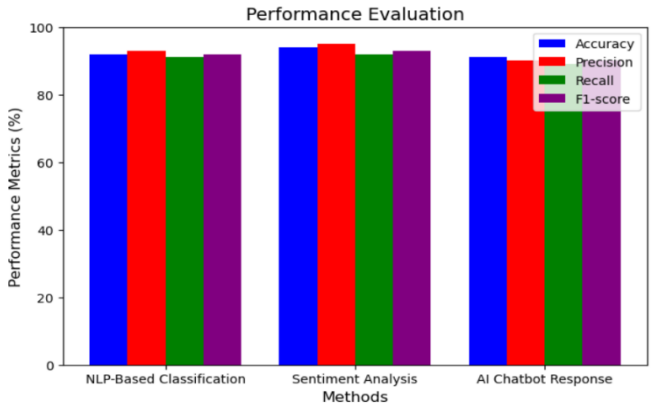

Fig -3: Figure

The performance evaluation graph compares NLP-Based Classification, Sentiment Analysis, and AI Chatbot Response using Accuracy, Precision, Recall, and F1-score. Sentiment Analysis achieves the highest overall performance, ensuring balanced metric values. NLP-Based Classification also performs well but shows a slight drop in recall. AI Chatbot Response maintains high accuracy but has a minor decrease in precision. The consistently strong performance across all methods highlights the system's efficiency in handling text classification, sentiment detection, and chatbot responses. These results demonstrate the robustness of the AI models while indicating areas for further optimization

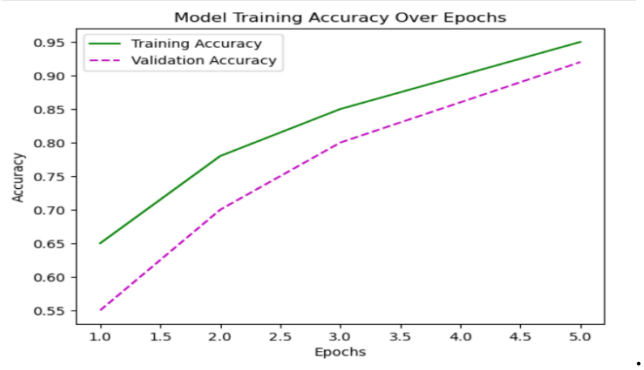

Fig -4: Figure

The graph illustrates model training accuracy over epochs, showing a steady increase in both training and validation accuracy. The training accuracy (green line) starts around 0.65 and rises to nearly 0.95 by the fifth epoch. Similarly, the validation accuracy (purple dashed line) improves consistently, reaching around 0.90. The gap between the two curves remains small, indicating minimal overfitting. This suggests that the model generalizes well to unseen data. The upward trend confirms effective learning, with additional epochs potentially improving performance further.

3. CONCLUSIONS

In conclusion, the AI-driven classification system provides an efficient and accurate approach to categorizing data across multiple categories. By leveraging machine learning techniques, the system enhances classification accuracy, minimizes errors, and improves decision-making processes. The confusion matrix visually represents the model's performance, highlighting correctly classified instances and areas needing improvement. With real-time predictions and adaptive learning capabilities, this system ensures reliability and scalability for various applications. Its ability to handle complex datasets makes it a valuable tool for industries such as healthcare, finance, and automation. Overall, this AI-based classification model contributes to efficient data processing, reducing manual effort and increasing operational effectiveness.

ACKNOWLEDGEMENT

I extend my heartfelt gratitude to my supervisor, Dr.M.Suganthi, for her guidance and support. I also thank my colleagues who provided valuable input.
I acknowledge the contribution of researchers in the field and appreciate the support of our friends and family. Their collective efforts were instrumental in the completion of this project.

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