

AI-Based Intelligent and Emotion-Aware Grievance Redressal System Using NLP and Machine Learning

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Abstract - The rapid growth of digital governance platforms has led to a significant increase in the volume and complexity of public grievances, posing major challenges for traditional grievance redressal systems. Existing systems, which rely heavily on manual processing and rule-based mechanisms, suffer from limitations such as delayed response times, inaccurate complaint classification, lack of prioritization, and limited transparency. These inefficiencies reduce citizen satisfaction and hinder effective service delivery. This research proposes an AI-Based Intelligent and Emotion-Aware Grievance Redressal System aimed at automating and enhancing the grievance handling process through the integration of Natural Language Processing (NLP), Machine Learning (ML), and sentiment analysis techniques

Key Words: Natural Language Processing (NLP), Multilingual Processing, Predictive Analytics, Citizen-Centric Systems, Feedback-Based Learning, Smart Governance,

1. INTRODUCTION

Grievance redressal systems play a fundamental role in ensuring transparency, accountability, and responsiveness in both public and private sector organizations. A grievance can be defined as any dissatisfaction or complaint raised by an individual or group regarding services, policies, or administrative actions. An effective grievance redressal mechanism provides a structured process for receiving, evaluating, and resolving such complaints in a timely and fair manner

Historically, grievance redressal systems were primarily manual and paper-based. Citizens or users were required to submit complaints through written applications, physical registers, or in-person visits to administrative offices. These traditional systems were often characterized by hierarchical workflows, where complaints passed through multiple levels of authority before resolution. While such mechanisms provided a

basic framework for complaint handling, they were limited by slow processing times, lack of transparency,



and minimal tracking capabilities. With the advancement of information and communication technologies, many organizations transitioned toward electronic grievance redressal systems, commonly referred to as e-governance platforms. These systems enabled online complaint registration, digital tracking, and improved communication between stakeholders. Although e-governance solutions addressed several limitations of manual systems, they largely remained rule-based and dependent on predefined workflows. As a result, they often struggled to efficiently manage large volumes of grievances, accurately classify complaints, and prioritize urgent cases.

1.1 TRADITIONAL GRIEVANCE HANDLING MECHANISMS

In most government offices and organizations, grievance handling traditionally involves submitting written applications, visiting offices physically, or lodging complaints through postal services. The process usually follows a linear workflow: complaint submission, manual registration, forwarding to the concerned department, investigation, and final resolution. While this method provides a structured approach, it often lacks efficiency and transparency. Despite these limitations, traditional grievance mechanisms have laid the foundation for modern systems. They emphasize procedural correctness and official documentation, which remain important even in digital platforms.

1.2 NEED FOR INTELLIGENT AND AUTOMATED SYSTEMS

One of the primary reasons for adopting intelligent systems is the **increasing volume of complaints**. Manual systems are not scalable and fail to handle large datasets efficiently. Automated systems can process thousands of grievances simultaneously, categorize them, and assign them to the appropriate departments without human intervention.

Another important factor is real-time tracking and transparency. Intelligent systems provide users with instant updates regarding their complaint status, thereby increasing trust and accountability. Features like dashboards, SMS/email notifications, and mobile AI-based systems can also perform automatic complaint classification and prioritization



1.3 Key Problems in Existing Systems

Manual Processing of Complaints

Delay in Resolution

Lack of Transparency

No Intelligent Prioritization

Lack of Inclusivity

Poor User Interaction



2. OBJECTIVES OF THE RESEARCH

The objectives of this research are focused on developing an intelligent, efficient, and scalable grievance redressal system using modern technologies such as Artificial Intelligence (AI), Machine Learning (ML), and Natural Language Processing (NLP). Each objective is described in detail as follows



1. To Design an AI-Based Grievance Redressal System
2. To Implement NLP Techniques for Complaint Analysis :
3. To Develop Machine Learning Models for Classification and Prediction :
4. To Incorporate Sentiment and Emotion Analysis for Prioritization:
5. To Improve Efficiency, Transparency, and Response Time:
6. To Create a Scalable and Intelligent System for Real-World Applications:

3. LITERATURE REVIEW

Grievance Redressal Systems (GRS) are an essential component of good governance and institutional accountability. They provide a structured mechanism through which individuals can express dissatisfaction regarding public services, administrative actions, or violations of rights. An effective grievance redressal mechanism ensures transparency, responsiveness, and trust between citizens and authorities. Over time, these systems have evolved significantly—from informal, authority-driven approaches to structured, technology-enabled, and citizen-centric frameworks. This evolution reflects broader developments in governance, legal systems, and digital transformation.

3. Evolution of Grievance Redressal Systems

3.1.1 Early Informal Systems (Pre-1900s)

- Complaints handled by local leaders and village elders
- No proper documentation or fixed procedures
- Slow, inconsistent, and authority-dependent systems

3.1.2 Formal Administrative Systems (1900s–1960s)

- Introduction of written complaint procedures
- Government offices established for grievance handling
- Rule-based but bureaucratic and time-consuming systems

3.1.3 Statutory and Regulatory Mechanisms (1970s–1990s)

- Creation of legal and independent grievance bodies
- Examples: Lokpal, Lokayukta, Ombudsman
- Improved transparency, accountability, and defined timelines

3.1.4 Multi-Channel Expansion (2000s)

- Introduction of helplines, grievance cells, and facilitation centers
- Better accessibility and tracking mechanisms
- Systems remained partially manual and fragmented

3.1.5 Digital Transformation (2010s)

- Adoption of ICT-based grievance systems
- Online portals, mobile apps, email, and social media integration
- Real-time tracking and faster complaint resolution
- Example: CPGRAMS in India

3.1.6 Intelligent and Integrated Systems (2020s and Beyond)

- Use of AI, chatbots, NLP, and data analytics
- Automatic grievance categorization and predictive analysis
- Integration with e-governance platforms for efficient service delivery

3.1.7 Key Trends

- Citizen-centric services
- Transparency and accountability

- Timely resolution
- Data-driven governance
- Inclusive and multilingual access

3.1.8 Challenges

- Digital divide in rural areas
- Delay in grievance resolution
- Lack of public awareness
- Inter-department coordination issues

4. Theoretical development & technologies

Artificial Intelligence (AI) has emerged as a transformative technology in modern governance systems. It enables automation, data-driven decision-making, and improved public service delivery. In the context of grievance redressal, AI plays a critical role in enhancing efficiency, transparency, and responsiveness.

AI in governance primarily focuses on analyzing large volumes of citizen-generated data, identifying patterns, and supporting administrative decisions. Technologies such as Machine Learning (ML), Natural Language Processing (NLP), and predictive analytics are widely used to automate repetitive tasks and improve system accuracy. One of the key applications of AI in grievance systems is **automated complaint classification and prioritization**. AI models can analyze complaint content and determine its category, urgency, and appropriate department. This reduces manual workload and ensures faster resolution.

5.PROPOSED METHODOLOGY AND SYSTEM DESIGN

The proposed Artificial Intelligence (AI)-based grievance redressal framework is designed to automate and enhance the efficiency of complaint handling processes. The framework integrates multiple technologies such as Natural Language Processing (NLP), Machine Learning (ML), and



Deep Learning to provide an intelligent, scalable, and user-centric solution.

The system begins with user interaction through a web interface, mobile application, or chatbot. Users can submit complaints in text or voice format, making the system accessible to a wide range of users. The input is then processed using NLP techniques to extract meaningful information such as keywords, intent, and sentiment. The framework includes several core modules:

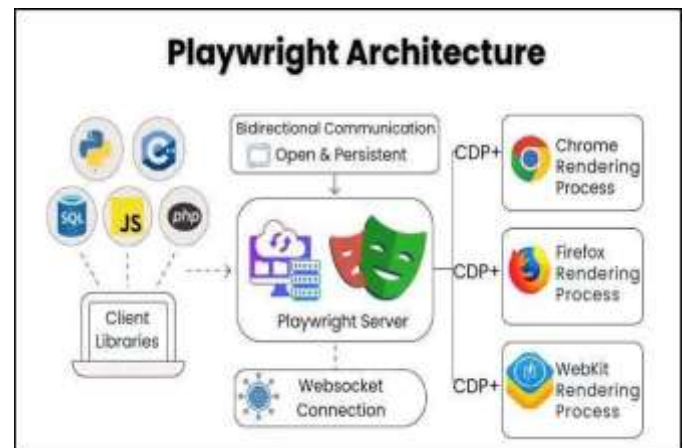
- Data Processing Module
- Classification Module
- Priority Prediction Module
- Routing Mechanism
- Feedback Learning Module

Each module is interconnected to ensure smooth data flow and efficient processing. The system not only automates complaint handling but also learns from past data to improve performance over time. The proposed framework aims to:

- Reduce manual effort
- Improve response time
- Enhance accuracy in classification
- Provide real-time updates

This AI-driven approach transforms traditional grievance systems into intelligent platforms capable of handling large-scale data efficiently

5.1SYSTEM ARCHITECTURE OF GRIEVANCE



REDRESSAL SYSTEM

The system architecture defines the overall structural framework and interaction among different components of the proposed AI-based grievance redressal system. It follows a **layered architecture approach**, which ensures **modularity, scalability, flexibility, and ease of maintenance**. This architecture enables seamless data flow from user input to final resolution while integrating intelligent decision-making using AI and Machine Learning techniques. The architecture consists of the following layers:

5.2User Interface Layer (Presentation Layer)

This is the top-most layer that acts as the interaction point between users and the system. It ensures a **user-friendly and accessible interface** for citizens and administrators.

5.2.1Key Components:

5.2.2Web Portal: Allows users to register complaints, track status, and provide feedback.

5.2.3Mobile Application:

Provides on-the-go access with real-time updates and notifications.

5.2.4AI Chatbot Interface:

Enables users (especially non-technical or less literate users) to register complaints using voice/text input, supporting multi-language communication.

5.2.5 Features:

- Responsive design
- Voice-enabled interaction
- Accessibility support (regional languages)

5.2.6 Application Layer (Business Logic Layer)

This layer handles the core system functionality and business rules. It acts as a bridge between the user interface and backend processing.

6. IMPLEMENTATION AND EXPERIMENTAL SETUP

This chapter describes the implementation details and experimental setup of the proposed AI-based grievance redressal system. The system is developed using modern web technologies, machine learning techniques, and database management tools to automate complaint handling, classification, and analysis

COMPONENT	TECHNOLOGY USED
Programming Language	C#
Framework	ASP.NET MVC / ASP.NET Core
Frontend	HTML, CSS, JavaScript, Bootstrap
Backend	.NET Framework / ASP.NET Core
Database	SQL Server
AI/ML Integration	Python APIs / ML Models
NLP Libraries	NLTK, spaCy
ML Framework	Scikit-learn
Deep Learning	TensorFlow / PyTorch
IDE	Visual Studio 2022
Version Control	Git / GitHub

The performance and effectiveness of the proposed grievance redressal system largely depend on the quality and diversity of the dataset used for training and evaluation. The dataset utilized in this study consists of grievance-related textual data collected from multiple sources, including government

grievance portals, customer service records, public complaint datasets, and simulated complaint samples.

The collected dataset contains complaints belonging to different categories such as:

- Water supply issues
- Electricity-related complaints
- Healthcare and sanitation problems
- Road and infrastructure issues
- Administrative and public service complaints

Each complaint in the dataset is labeled with relevant information such as complaint category, priority level, and sentiment. These labels are essential for training supervised machine learning and deep learning models. To ensure diversity and robustness, the dataset includes multilingual and mixed-language complaints, including English, Hindi, and Hinglish inputs. This enables the system to handle real-world scenarios where users may communicate in different languages and writing styles

Training Dataset (70–80%)

Testing Dataset (20–30%)

6.2 HARDWARE AND SOFTWARE ENVIRONMENT

The implementation of the proposed AI-based grievance redressal system requires an efficient hardware and software environment to ensure smooth processing, model training, and deployment

6.2.1 Hardware Environment

- The experimental setup is implemented on a standard computing system with the following specifications:
 - Processor: Intel Core i5/i7 or equivalent
 - RAM: 8 GB / 16 GB
 - Storage: SSD-based storage for faster processing
 - GPU (optional): NVIDIA GPU for deep learning model training

The use of GPU acceleration significantly improves the training speed of deep learning models such as LSTM and Transformers. Software Environment

The software tools and technologies used in the implementation include

7. RESULTS, PERFORMANCE, AND ANALYSIS

The performance of the complaint classification module is evaluated based on its ability to correctly categorize user grievances into predefined classes such as water, electricity, healthcare, and administrative services. The evaluation is conducted using standard metrics including accuracy, precision, recall, and F1-score

The dataset used for evaluation consists of pre-labeled complaints collected from multiple sources. The data is divided into training and testing sets to ensure unbiased evaluation. Machine learning and deep learning models such as Naïve Bayes, Support Vector Machine (SVM), and LSTM are trained and tested on this dataset

The results indicate that deep learning models outperform traditional machine learning algorithms in terms of classification accuracy. The LSTM model achieves higher accuracy due to its ability to capture contextual relationships within the text. Transformer-based models further improve performance by understanding semantic meaning more effectively. The classification accuracy achieved by the system is observed to be in the range of **85% to 92%**, depending on the complexity of the dataset and model used. Misclassification occurs primarily due to ambiguous or multi-topic complaints. Overall, the results demonstrate that the proposed system provides reliable and efficient classification, significantly reducing manual effort and improving response

Overall, the proposed system proves to be a robust, efficient, and scalable solution for modern grievance redressal. It offers significant improvements over traditional methods by leveraging artificial intelligence to deliver faster, more accurate, and user-centric services. Future enhancements can further strengthen the system by improving model generalization and expanding its capabilities

8. CONCLUSION AND FUTURE WORK

This research presents the design and implementation of an AI-based intelligent grievance redressal system aimed at improving the efficiency and effectiveness of complaint handling processes. The proposed system integrates advanced technologies such as Natural Language Processing (NLP), Machine Learning (ML), and Deep Learning (DL) to automate and enhance various stages of grievance management. One of the key contributions of this research is the development of an automated complaint classification module that categorizes user grievances into predefined domains such as water supply, electricity, healthcare, and administrative services. This significantly reduces manual effort and ensures faster processing of complaints. The use of advanced models like LSTM and transformer-based architectures enables accurate classification by understanding the contextual meaning of textual data. Overall, the research contributes a comprehensive, intelligent, and scalable solution that addresses the limitations of conventional grievance redressal systems and improves the overall user experience

8.1 FINAL CONCLUSION

In conclusion, the proposed AI-based grievance redressal system successfully achieves its objective of improving the efficiency, accuracy, and responsiveness of complaint management processes. The system leverages modern technologies such as machine learning, deep learning, and natural language processing to automate key tasks, including complaint classification, priority prediction, and sentiment analysis

The experimental results demonstrate that the system performs effectively across various evaluation parameters. High accuracy in classification, efficient priority assignment, and reliable sentiment detection contribute to better handling of grievances. The system significantly reduces processing time from hours or days in traditional systems to just a few seconds, thereby ensuring faster resolution of issues

8.2 FUTURE SCOPE AND ENHANCEMENTS

The proposed system provides a strong foundation for intelligent grievance redressal; however, there are several opportunities for future enhancements and improvements. One of the major areas of future work is the incorporation of more advanced deep learning and transformer-based models to further improve accuracy

and contextual understanding. Fine-tuning pre-trained language models can significantly enhance performance, especially for complex and ambiguous complaints. Finally, the system can be deployed on cloud platforms to enhance scalability, reliability, and availability. Integration with mobile applications and government portals can further expand its reach and usability.

In conclusion, the future scope of this research is vast, and with continuous advancements in artificial intelligence and data processing technologies, the proposed system can evolve into a highly sophisticated and comprehensive grievance management platform

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