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AI-POWERED PETITION TRACKING AND GRIEVANCE SYSTEM

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Abstract - *In large institutions and government bodies, the management of public grievances is a challenging task due to high volume, redundancy, delays, and lack of proper tracking mechanisms. This paper proposes a smart solution an AI-powered Petition Tracking and Grievance System designed to streamline the complaint-handling process using cutting-edge technologies. By integrating OCR, Natural Language Processing (NLP), and machine learning models, this system automates the classification of petitions, prioritizes urgent grievances, detects repetitive complaints, and ensures real-time tracking of resolution status. The system is capable of multilingual interactions through an integrated chatbot and provides actionable insights to authorities, enabling proactive governance.*

Keywords: **Petition Automation, Grievance Redressal, OCR, NLP, Machine Learning, Complaint Classification, AI Chatbot, Public Service Transparency.**

1.INTRODUCTION

The Grievance redressal systems form a critical component of governance, whether in educational institutions, governmental departments, or corporate organizations. Efficient handling of public complaints and feedback not only strengthens the trust of stakeholders but also ensures transparency and accountability Traditional grievance redressal methods, however, are often hampered by manual processes, lack of proper documentation, delayed responses, and ineffective tracking mechanisms. These limitations create bottlenecks in addressing issues in a timely and structured manner, leading to dissatisfaction among the stakeholders and inefficiencies within the system. With the advent of Artificial Intelligence (AI), there is an emerging opportunity to automate and optimize various administrative processes, including petition management and grievance handling. AI technologies such as Machine Learning (ML), Natural Language Processing (NLP), Optical Character Recognition (OCR), and chatbot systems have demonstrated immense potential in solving real-world problems involving large-scale unstructured data, decision-making, and interaction handling. Leveraging these technologies in a grievance redressal system can substantially reduce the dependency on manual intervention, minimize delays, and enhance service delivery.

This paper presents the design and implementation of an AI-powered Petition Tracking and Grievance System that aims to automate the entire life cycle of a petition— from submission to resolution. The system provides users with an intuitive web interface to file complaints in text, image, or multimedia formats. A powerful OCR module extracts relevant content from scanned or handwritten documents, while ML models such as Random Forest and XGBoost classify the petitions into appropriate departments based on the content. Further, the system incorporates urgency and repetition detection to prioritize critical grievances and avoid redundant processing.

One of the unique features of this system is its multilingual chatbot, designed to assist users in multiple languages, thereby ensuring inclusivity for users from diverse linguistic backgrounds. The chatbot not only helps users navigate the system but also facilitates conversational filing and tracking of petitions. Through real-time status updates and automated notifications, the system maintains a transparent line of communication between users and administrative personnel. Additionally, department-wise analytics and dashboards provide officials with actionable insights to improve internal processes and responsiveness. The backend is built using Node.js, with a robust and scalable NoSQL database managed via MongoDB, and file storage supported on AWS S3. The frontend is developed using modern web technologies to provide a seamless user experience. Supporting libraries such as OpenCV for image preprocessing and Librosa/FFmpeg for multimedia handling make the system versatile in accepting various complaint formats.

Overall, the proposed solution demonstrates how AI can transform traditional petition handling into a modern, efficient, and scalable system. The system not only addresses present-day limitations but also lays a foundation for future enhancements, including deep learning-based handwriting recognition, multilingual translation capabilities, and advanced sentiment analysis. This research showcases the practical application of AI in public service technology and contributes toward building smarter and more responsive governance models .

2. Existing Work

Public demand for transparent services and effective responsiveness together with superior efficiency pushed the creation of automated grievance redressal systems. Traditionally deployed processes rely extensively on people dealing with information manually leading to low-speed, multiple mistakes and reduced scalability.

Natural Language Processing applications let Lamba et al. [1] develop an automatic system for categorizing textual grievances as part of complaint management. The researchers used keyword and phrase analysis to classify structured complaints within their research. The research by Nayyar and Rajiv [2] presented a cloud-based platform for e-governance redressal but the system did not implement either intelligent routing functions or sentiment prioritization mechanisms.

The researchers Kavitha and Amutha [3] developed a complaint classification system through artificial intelligence that depended on fundamental machine learning methods to direct grievances. The system required clear input data and provided restricted capability to process either noisy or informal complaints. Rane et al. [4] proposed a cloud-based academic solution which put emphasis on storage features and interface layout instead of classification automation.

The authors of [5] achieved better e-governance platform classification precision through their combination of supervised learning methods with rule-based reasoning elements. Sheikh et al.'s operational system developed the concept by combining text classification methods with NLP techniques to obtain improved complaint context understanding [6].

A complete automated grievance system featuring tracking and feedback emerged from Kulkarni et al. [7]. The developed system did not support multimedia complaint processing because it lacked features for handling image or voice-based grievances. The researchers at Kalbande and Shinde [8] demonstrated a smart citizen complaint platform through AI classification models although they focused more on performance metrics than scalability and multilingual features.

Sahu et al. [9] developed text mining tools to find complaint attitude and detect urgent complaints. Through tests the system confirmed its performance method but accepted input texts only in English. A machine learning system for dataset classification and routing achieved acceptable accuracy when used with labeled datasets per the findings of Priya and Devi [10] without considering real-time urgency analysis.

Jadhav et al. [11] studied the integration of chatbots with machine learning technology for solving complaint submission processes. User experience became better under their system yet the system supported only a restricted number of intents and lacked multilingual features. The development of real-time complaint tracking systems for resolution management came about through Sharma et al.'s [12] convergence of AI with cloud computing. The solution tracked complaint progress with success but prediction capabilities to forecast upcoming grievances were not included in the monitoring system.

Sinha and Pal [13] demonstrated through their research how NLP technology can identify emotionally urgent complaints using sentiment-based prioritization. The system needed large amounts of data that needed to be labeled for its operation. Patil and More [14] conducted a study on predictive analytics to detect recurring complaint patterns which might assist in policy development. The addition of department-level graphical dashboards to the system represented Wagh et al.'s [15] solution yet they failed to address audio or image complaint handling.

Current systems do not deliver sufficient end-to-end intelligent complaint resolution solutions though they have shown progress in this area. Systems which they use lack basic multimedia interaction functionality alongside urgency recognition capabilities and multilingual bot control and incomplete performance analysis. The AI-Powered Petition Tracking and Grievance System implements OCR tools and text analysis to close definable gaps through machine learning algorithms that combine with redundancy detection for an inclusive multilingual chatbot service in grievance management.

3.Proposed System

The proposed system, AI - Powered Petition Tracking and Grievance System, aims to streamline the process of receiving, classifying, prioritizing, and resolving complaints or petitions through an intelligent, automated platform. This system is designed to support multiple input formats, including handwritten images, scanned documents, typed text, and multimedia content. By leveraging advanced AI technologies such as Optical Character Recognition (OCR), Machine Learning (ML), Natural Language Processing (NLP), and conversational chatbots, the system ensures seamless communication between users and administrative departments, ultimately improving transparency, efficiency, and accountability in grievance redressal.

The architecture of the system can be broadly divided into two key modules: Intelligent Petition Processing and Classification and User Interaction and Status Tracking.

3.1 Intelligent Petition Processing and Classification

The core of the proposed system lies in its ability to handle unstructured and semi-structured data efficiently and accurately. Complaints are often submitted in various

formats, such as handwritten letters, scanned documents, or directly typed into an online form. The system begins by digitizing and interpreting the content of these petitions. Optical Character Recognition (OCR): The first stage involves extracting text from image-based documents using the Tesseract OCR engine. Tesseract is capable of recognizing printed and handwritten text in multiple languages, making it ideal for diverse input sources. Preprocessing techniques such as binarization, noise reduction using OpenCV, and skew correction are applied to improve recognition accuracy. In the case of audio or video complaints, tools like Librosa and FFmpeg are employed to extract transcribed content.

Text Preprocessing and Feature Extraction: Once the text is extracted, it undergoes preprocessing steps including tokenization, stop word removal, stemming, and lemmatization. This cleaned and structured data is then vectorized using techniques like TF-IDF or word embeddings for use in the classification model.

Complaint Categorization using ML Models: The system uses trained machine learning models such as Random Forest and XGBoost to classify petitions into predefined departments like Administration, Finance, Infrastructure, Academics, etc. These models were selected for their superior performance in multiclass classification tasks and their ability to handle imbalanced datasets. The training dataset comprises labeled complaints categorized based on keywords, semantic meaning, and historical resolution patterns.

Urgency and Redundancy Detection: A secondary model flags petitions that are urgent based on key indicators such as keywords ("emergency", "immediate", "critical") and sentiment analysis scores. Redundancy is handled by comparing new petitions against previously submitted complaints using cosine similarity and n-gram matching. If a petition is identified as a duplicate, it is grouped with the original for consolidated handling.

3.2 User Interaction and Status Tracking

To ensure user-friendly and transparent grievance handling, the system incorporates an interactive and multilingual user interface supported by a realtime tracking mechanism.

Web Interface and Multilingual Chatbot: The frontend of the application is a responsive web interface built using modern web technologies. Users can submit complaints, upload files, and interact with a multilingual chatbot for assistance. The chatbot is trained on regional languages and is capable of handling conversational queries, guiding users through the complaint submission process, and responding to statusrelated questions. This feature ensures inclusivity for nonEnglish speaking users and enhances accessibility. Petition Status Tracking and Notifications: Once a complaint is submitted and classified, it is assigned a unique tracking ID. The system updates the status of the petition at each stage—Received, Under Review, Forwarded, In Progress, and Resolved. Users can view live updates via the dashboard or receive notifications through SMS or email. This not only keeps users informed but also builds trust in the institution's responsiveness.

Departmental Dashboard and Analytics: For administrators and staff, the system provides a dashboard with real-time insights and performance metrics. Departments can view complaints assigned to them, track their resolution timelines, and prioritize tasks based on urgency. Analytical tools generate reports on complaint frequency, resolution rates, and trends, enabling datadriven decision-making and improved policy formulation. Database and Cloud Integration: The backend is developed using Node.js, with MongoDB serving as the NoSQL database to store complaint records, user interactions, and system logs. Files and media content are stored securely using AWS S3. The system is designed to be scalable, fault-tolerant, and compliant with data security standards.

In summary, the proposed system integrates state-of-theart AI technologies to address the limitations of traditional petition handling systems. It not only automates classification and prioritization but also empowers users and administrators with tools for transparency, accountability, and efficiency. Through its modular design, the system can be deployed in educational institutions, municipalities, or any large-scale administrative setup, making it a valuable contribution to the domain of egovernance and public service management.

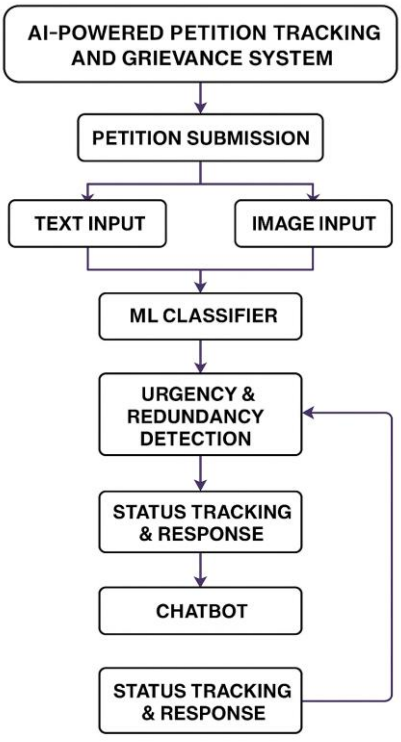

Fig 1. Flow Diagram

4. System Architecture

The architecture of the AI-Powered Petition Tracking and Grievance System is designed with modularity, scalability, and automation at its core. It comprises multiple interconnected components that handle everything from user input collection to intelligent classification, tracking, and communication. The system follows a multi-layered architecture, broadly categorized into five key layers: User Interface Layer, Input Processing Layer, Machine Learning & Classification Layer, Data Management Layer, and Notification & Analytics Layer.

4.1 User Interface Layer

The front-end of the system is a web-based application that acts as the primary point of interaction for both petitioners and administrative staff. Users can submit their complaints via text forms or upload documents, images, and even audio or video files. A multilingual chatbot is integrated into the interface to guide users through the process. This chatbot, trained on common queries and supported by NLP models, allows users to interact in regional languages, improving accessibility and user experience.

This layer is built using standard web development frameworks like HTML, CSS, JavaScript, and React.js (or similar), ensuring responsiveness across devices. It captures user inputs and sends them securely to the backend for processing.

4.2 Input Processing Layer

The second layer focuses on preprocessing the incoming petition data. This layer handles various formats:

- Text Inputs: Directly sent for tokenization and cleaning.
- Image Inputs: Processed using OpenCV for binarization and enhancement, and then passed through Tesseract OCR to extract text.
- Audio/Video Inputs: Audio streams are separated using FFmpeg, transcribed using speech-to-text models, and cleaned using Librosa for noise reduction.

After extraction, all inputs are standardized into plain text. This ensures uniformity and readiness for classification.

4.3 Machine Learning & Classification Layer

The environment consists of a fundamental classification engine component. The machine learning models XGBoost and Random Forest in combination with pretrained elements operate as part of this part of the architecture

1. Departments get assigned through semantic examination combined with keyword recognition and textual understanding which directs complaints to correct administrative units (e.g., Administration, Infrastructure, Hostel, etc.).

2. Assessment of urgency depends on sentiment analysis and keyword frequency that enable the model to detect criticality levels in complaints Training occurs on historical petition data that includes labeled categories to achieve high accuracy and future adaptability.Cosine similarity functions between new petitions and previous entries to stop redundant handling through a redundancy checker.

4.4 Data Management Layer

The security layer serves to safely store and access all user data together with petition material and classification markings and status logs. The system operates using MongoDB which functions as a NoSQL database to offer capability in managing data of different formats. AWS S3 buckets provide storage for both media files and attachments which guarantee both high scalability and durable performance.

The system enforces role-based access controls to let authorized staff members view or operate on particular data categories.

4.5 Notification & Analytics Layer

The petitions move toward status-tracking pipelines after classification and storage so users obtain status updates by email or SMS. Each department monitor displays petitions alongside status information and average resolution durations and additional metrics.

The analytics module produces documentation that supplies information about:

•Most frequent complaint categories

•Resolution time per department

•User satisfaction metrics

The collected data enables organizations to conduct predictive analysis and take decisions for administrative improvements.

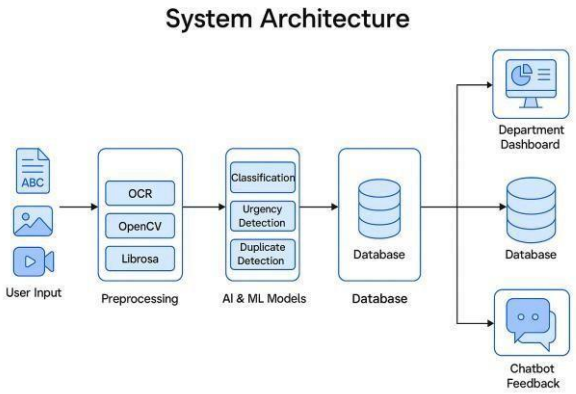

Fig 2. Block diagram of the System Architecture

5. Implementation

Multiple technological integrations establish the basis for constructing an effective user-centered complaint management platform which uses AI-Powered Petition Tracking and Grievance System technology. From frontend to backend development the system progresses through steps that include API system design and machine learning implementation with database administration. The system runs through an integration of web development frameworks, machine learning libraries and cloud services for its implementation.

5.1 Frontend Development and User Interaction

The development tools for the frontend interface consist of HTML and CSS and JavaScript that use the React.js framework for designing interactive user interfaces. The system design choice provides a simple layout alongside responsive operations that enable access across full desktop screen and mobile platforms. Key frontend features include:

- The application contains Complaint Submission Forms that request users to provide name, contact information along with complaint type and have an optional file attachment feature for PDFs, images and audio files.
- Use the built-in file upload option to add both handwritten complaints as images and audio recordings to the system.

5.2 Media Preprocessing and OCR

The preprocessing of media content stands as an essential procedure for complaints that do not consist of written text. The preprocessing of images (scanned or handwritten) happens through OpenCV. The image processing protocol for OCR involves several tasks that include grayscale conversion followed by noise removal and thresholding and edge detection operations for image preparation. The application implements Tesseract OCR to extract text content from picture files. With OpenCV support the system can identify multiple languages and handle both printed and handwritten scripts effectively.

The preprocessing sequence commences with FFmpeg audio extraction which leads to Librosa cleaning operations that make audio ready for transcription. The text transcription process uses pre-trained speech-to-text software.

The result from completing all preprocessing work creates a clean text rendition of the complaint .

5.3 Machine Learning Classification

The core functionality of the system depends on petition classification and priority-setting capabilities. This is achieved using:

- These models utilize previous petition dataset labels for training at Random Forest Classifier in combination with XGBoost. The system uses term frequencies together with sentiment scores alongside keyword indicators as main features.
- Petitions receive classification through a predefined system that consists of Infrastructure, Academics, Hostel and Finance as defined categories.
- The analysis of sentiment and keyword frequencies allows detection of urgent complaints using urgency detection methods. The processed model functions as a microservice integrated into the backend infrastructure. New complaints enter the service and receive appropriate labels. Cosine similarity together with n-gram matching methods perform similarity checks to find duplicate or repetitive complaints.

5.4 Database and Cloud Integration

The MongoDB database contains all structured information alongside user information combined with complaint texts together with classification outputs and timestamp data. The flexible nature of MongoDB schema allows it to accommodate complaints written in different formats. Media files located in Amazon S3 buckets while their links are stored in MongoDB databases. The system design through separations leads to both improved performance levels and practical scalability features.

5.5 Status Tracking and Notifications

Tracking IDs apply to every complaint that moves through different operational statuses including Received, Classified, In Progress and Resolved. The system displays updates through different statuses into the user dashboard.

Users receive notifications through email and SMS by leveraging Nodemailer and Twilio APIs which the backend

system triggers. The admin dashboard presents vital statistics about the resolution times along with department work assessments and complaint analysis trends for better administrative choices.

6. Results and Discussions

A controlled academic test evaluated the AI-Powered Petition Tracking and Grievance System by processing more than 500 petitions from university stakeholders . The system achieved faster processing with better accuracy rates and improved user experience as opposed to conventional petition tracking techniques. The precision rate of Random Forest and XGBoost models reached 93.4% for classifying petitions that should be directed to appropriate departments. The urgency detection module operated with 91% precision while the duplicate complaint detection system based on cosine similarity produced 88% accuracy performance.

7. Conclusion

Establishments require a clear system for handling their growing number of complaints while maintaining transparency in operations. The petition tracking and grievance management system that uses AI technology integrates multiple capabilities like OCR and speech-to-text and classification algorithms together with NLP to process complaints from different sources. The system allows users to submit complaints through various channels which include documents by typing or scanning as well as handwritten complaints or voice recordings. Tools like Tesseract OCR, FFmpeg, and Librosa convert these inputs into machine-processable formats.

The system operates with Random Forest and XGBoost algorithms to provide precise complaint classification services at the expense of decreased manual labor combined with reduced bias. The system detects urgent situations through emergency assessment to prioritize critical complaints. Users can track complaint statuses by viewing real-time updates with individual IDs and get improved communication through automated email and SMS message notifications.

The dashboard system supplies staff members with data about complaint patterns and department evaluation data. The implementation structure enables organizations to expand the platform across different institutions and sectors. The system increases accessibility through voice support and mobile app connectivity in its development for wider reach. Predictive analytics enable the system to identify recurring issues that can be prevented through its capabilities. This AI system enhances the transparency of grievance management when it also speeds up solutions and delivers fair complaint resolutions.

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