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AI-Driven Smart Complaint Management System With Integrated Sentiment Analysis

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Abstract

Educational institutions receive a large volume of student complaints related to academics, infrastructure, administration, and campus services. Traditional complaint management systems are often manual, time-consuming, and inefficient, resulting in delayed resolutions, improper categorization, and limited transparency. Additionally, language barriers and the lack of complaint prioritization further reduce the effectiveness of existing systems.

To overcome these challenges, this paper proposes an AI-driven Smart Complaint Management System that integrates sentiment analysis and natural language processing (NLP). The system allows students to securely register, authenticate, and submit complaints along with supporting evidence in multiple languages. NLP techniques are employed for multilingual translation, sentiment detection, and automated complaint classification. Administrators are provided with the original complaint, its English translation, sentiment score, priority level, and AI-generated recommendations, including relevant departmental contact details.

The system is implemented using React, Next.js, Node.js, Express.js, Python, MongoDB, Cloudinary, and machine learning techniques. Experimental results indicate that the proposed approach significantly enhances complaint handling efficiency, accuracy, and transparency, making it a practical solution for modern educational institutions.

Keywords
Smart Complaint System, Artificial Intelligence, Sentiment Analysis, NLP, Multilingual Support, Machine Learning

1. Introduction

The rapid digital transformation of educational institutions has significantly increased dependence on online platforms for academic, administrative, and student support services. Among these, grievance redressal systems are essential for maintaining transparency, accountability, and overall student satisfaction. Higher education institutions routinely receive a wide range of complaints concerning academics, examinations, infrastructure, hostel facilities, administrative inefficiencies, and campus safety. Such grievances are typically submitted as unstructured textual data, which poses considerable challenges for automated processing and systematic analysis.

Conventional complaint management systems primarily rely on manual inspection and decision-making by administrative personnel. These systems are often time-consuming, susceptible to subjective bias, and prone to

misclassification, leading to delayed or ineffective grievance resolution. Furthermore, students may be reluctant to report sensitive issues due to concerns about identity disclosure or possible retaliation, thereby reducing participation and limiting the effectiveness of traditional redressal mechanisms.

Recent advancements in artificial intelligence (AI), machine learning (ML), and natural language processing (NLP) have introduced effective techniques for addressing these limitations. Sentiment analysis, which focuses on identifying emotional polarity and intensity in textual data, has been widely studied and shown to improve understanding of user opinions and feedback [1], [2]. Surveys and systematic mapping studies highlight the growing adoption of sentiment analysis and opinion mining in educational data to support decision-making and service improvement [2], [3]. In addition, text classification techniques enable the automated categorization and routing of complaints to relevant departments, thereby reducing response time and administrative workload [4]. Multilingual sentiment analysis models further extend system accessibility by allowing users to submit grievances in regional or native languages without compromising analytical accuracy [5].

In this context, this paper proposes a Smart Complaint Management System that integrates AI-driven sentiment analysis, multilingual text processing, and intelligent prioritization for student grievance redressal. The system supports secure student-only registration, anonymous complaint submission, automated categorization, and real-time communication between students and administrators. The primary contribution of this research lies in the design of a scalable, privacy-aware, and intelligent grievance management platform specifically tailored to the needs of educational institutions, leveraging state-of-the-art NLP techniques to enhance efficiency, fairness, and responsiveness.

1.1 Problem Statement

Educational institutions handle numerous student complaints related to academics, infrastructure, and administration. Existing systems rely heavily on manual processing, leading to delays, misclassification, and poor prioritization. Language barriers and the lack of sentiment-based urgency detection further reduce the effectiveness of grievance resolution.

1.2 Significance

An intelligent complaint management system can greatly enhance institutional efficiency by automating complaint processing and enabling faster resolution. Integrating Artificial Intelligence and sentiment analysis helps administrators understand the urgency and nature of complaints more effectively. A multilingual system ensures inclusivity and accessibility for students from diverse linguistic backgrounds.

1.3 Proposed Solution

The proposed Smart Complaint Management System provides an AI-driven platform that automates complaint categorization, sentiment analysis, translation, and resolution assistance. The system ensures transparent communication between students and administrators while significantly reducing manual effort and response time.

2. Literature Review

Sentiment analysis has emerged as a significant research area within natural language processing due to its ability to automatically identify opinions, emotions, and attitudes expressed in textual data. Early studies focused on comparing different sentiment analysis techniques and highlighting their applicability across multiple domains.

Chidananda *et al.* [1] presented a comparative survey of sentiment analysis approaches, discussing lexicon-based and machine learning techniques along with their advantages and limitations. This work provides a foundational understanding of sentiment classification methods.

With the increasing adoption of digital platforms in education, sentiment analysis has been widely applied to analyze student feedback. Kastrati *et al.* [2] conducted a systematic mapping study on sentiment analysis of students' feedback using natural language processing and deep learning techniques. Their study categorizes existing research based on models, datasets, and evaluation metrics, emphasizing the growing role of deep learning in educational sentiment analysis.

Recent surveys have further explored sentiment analysis and opinion mining specifically within educational data. Shaik *et al.* [3] reviewed modern techniques used to analyze educational feedback, highlighting challenges such as data imbalance, contextual ambiguity, and domain dependency. Their findings underline the importance of intelligent sentiment analysis systems for improving decision-making in educational institutions.

In addition to domain-specific studies, comprehensive reviews of sentiment analysis methodologies have been conducted. Gunasekaran [4] analyzed a wide range of sentiment analysis techniques, including rule-based, machine learning, and deep learning approaches. This review provides insights into model selection and performance considerations, which are useful for designing effective sentiment-based systems.

Another important challenge in sentiment analysis is multilingual text processing. Can *et al.* [5] addressed this issue by proposing a recurrent neural network-based framework for multilingual sentiment analysis in low-resource settings. Their work is particularly relevant for systems that need to process feedback or complaints submitted in multiple languages.

Overall, the existing literature demonstrates that sentiment analysis plays a vital role in extracting meaningful insights from textual feedback. However, challenges such as multilingual support, real-time processing, and accurate sentiment classification remain open research areas, motivating the development of advanced and application-specific sentiment analysis systems.

3. Methodology (Development Process)

3.1 Research Design

This research adopts a **design and development methodology** focused on building an intelligent web-based complaint management system. The system is designed by integrating AI models, NLP techniques, and modern web technologies to automate complaint handling and improve decision-making for administrators.

3.2 Information Gathering

- **Secondary Data:**

Research papers, IEEE journals, and articles related to sentiment analysis, NLP, and grievance management systems were reviewed to understand existing approaches and limitations.

- **Technical Research:**

A detailed study of MERN stack applications, AI-based text processing, and multilingual systems was conducted to select suitable technologies and ensure system scalability and security.

3.3 System Architecture

The system is developed using a layered architecture to ensure modularity and efficient data flow. AI services are integrated with backend APIs to provide real-time complaint analysis and recommendations.

Figure 1: System Flow Diagram of the Smart Complaint Management System

4. Desig

4.1 User

The syste

- **Frontend Layer:**

Developed using React and Next.js, providing separate interfaces for students and administrators.

- **Backend Layer:**

Implemented using Node.js and Express.js, handling authentication, complaint management, messaging, and notifications.

- **AI & NLP Services:**

Python-based services perform sentiment analysis, language translation, and complaint classification.

- **Data & Media Storage:**

MongoDB stores complaint data, while Cloudinary manages uploaded proof files.

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4.2 Technologies Used

Component	Technology Used
Frontend	React.js, Next.js
Backend	Node.js, Express.js
Database	MongoDB
AI & NLP	Python, ML, NLP

File Storage	Cloudinary
Authentication	RBAC (Role-Based Access Control)
Notifications	Discord Webhooks

4.3 User Interface (UI) Screenshots

The Smart Complaint Management System is designed with a user-centric and role-based interface to ensure ease of use, accessibility, and efficient interaction for both students and administrators. The user interface is developed using React and Next.js, enabling a responsive and dynamic experience across desktop, tablet, and mobile devices.

The system follows consistent design principles such as simplicity, clarity, and intuitive navigation. Role-based access control ensures that users can only access features relevant to their roles, thereby enhancing security and usability.

4.3.1 Student Interface

The student interface allows authenticated students to perform all complaint-related activities through a simple and structured dashboard. Key features include:

- Registration and Login Pages: Students can register using valid institutional credentials and log in securely using a unique student ID.
- Complaint Submission Page: Students can file complaints by selecting a category, entering complaint details in any language, and uploading supporting evidence such as images or documents.
- Complaint Tracking Dashboard: Displays submitted complaints along with their current status (Received, In Progress, or Resolved), enabling students to track progress in real time.
- Messaging Interface: Allows students to communicate directly with administrators regarding their complaints and receive updates or clarifications.

4.3.2 Administrator Interface

The administrator interface is designed to support efficient complaint management and decision-making. It provides a centralized dashboard with the following functionalities:

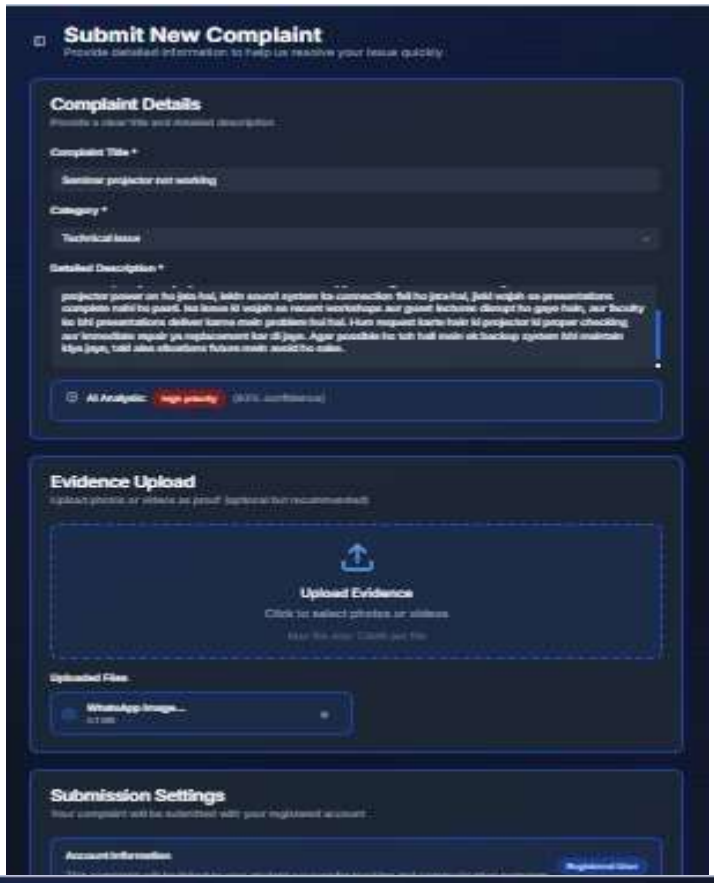
- Complaint Management Panel: Displays all submitted complaints along with translated content, sentiment score, priority level, and assigned category.
- Complaint Categorization and Prioritization: Administrators can modify complaint categories if incorrectly selected and assign priority levels based on sentiment analysis results.
- Smart Solution View: Presents AI-generated recommendations, including responsible department details, contact numbers, and email addresses for quick resolution.

- Status Update and Messaging Module: Enables administrators to update complaint status and send real-time notifications or messages to students.

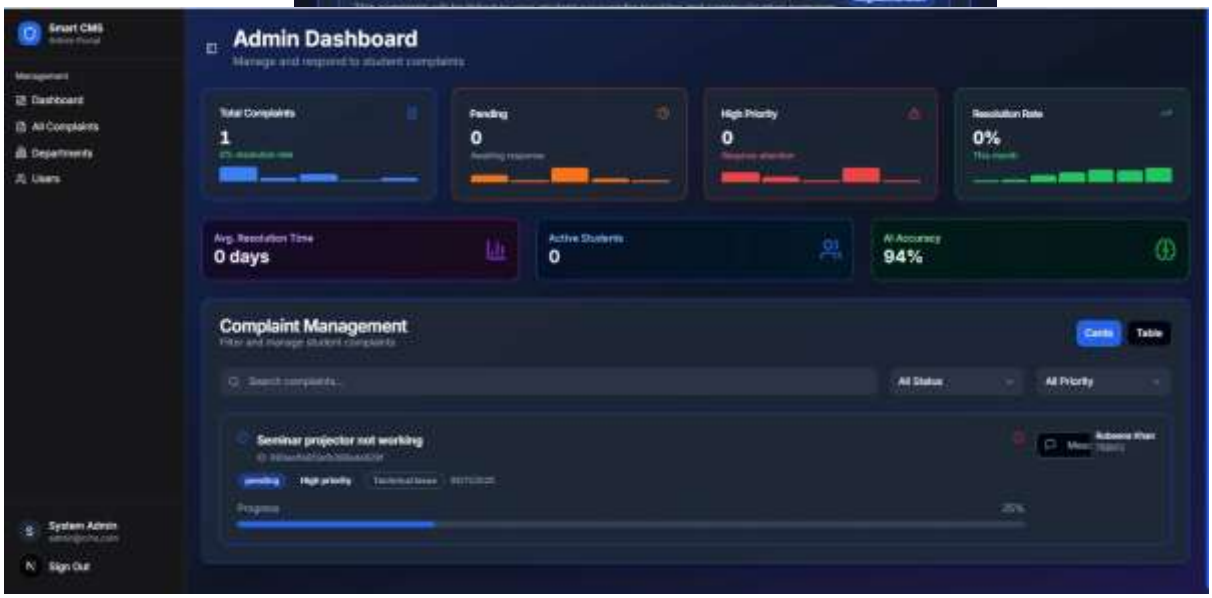
- Systems Home Page

- Student Dashboard

- Complaint Submission Page



- Admin Dashboard



5. Test Case Description

To validate the functionality and effectiveness of the proposed Smart Complaint Management System, several test cases were designed to evaluate core system features such as authentication, complaint submission, categorization, sentiment analysis, and response handling.

Test Case 1: Student Registration and Login
This test case verifies that only authorized students can register and access the system using valid credentials. The system successfully allows authenticated users to log in while preventing unauthorized access.

Test Case 2: Complaint Submission
This test evaluates the ability of students to submit complaints in free-text format. The system correctly accepts complaints, stores them securely, and allows optional anonymous submission without revealing student identity.

Test Case 3: Automated Complaint Categorization
In this case, submitted complaints are processed using NLP-based classification. The system accurately assigns complaints to appropriate categories such as academics, infrastructure, or administration without manual intervention.

Test Case 4: Sentiment and Priority Detection
This test checks the sentiment analysis module. The system successfully identifies the emotional intensity of complaints and assigns higher priority to critical or negative grievances.

Test Case 5: Multilingual Complaint Processing
Complaints submitted in regional or native languages are tested. The system correctly processes and analyzes multilingual inputs, ensuring consistent categorization and sentiment detection.

Test Case 6: Administrator Response and Communication
This test validates real-time interaction between administrators and students. The system allows administrators to respond to complaints, update status, and maintain transparent communication.

6. Functional Workflow

1. A student registers and logs in using a unique student ID.
2. The student submits a complaint with supporting evidence in any language.
3. The system translates the complaint into English using NLP techniques.
4. Sentiment analysis and machine learning literacy models determine urgency and category.
5. The administrator receives the complaint with sentiment score, priority level, and smart solution suggestions.
6. The administrator updates the complaint status and communicates with the student.

7. Discussion

7.1 Strengths of the System

The proposed Smart Complaint Management System offers several notable strengths that enhance the efficiency of grievance redressal in educational institutions. The system automates complaint categorization and prioritization using AI techniques, ensuring that grievances are routed to the appropriate departments without manual intervention. Support for multilingual complaint submission allows students to express concerns in their native or regional languages, improving accessibility and inclusivity. Additionally, the system provides AI-generated smart solutions along with relevant contact details, enabling faster preliminary guidance. Real-time communication between students and administrators enhances transparency and trust, while the overall automation significantly reduces administrative workload and response time.

7.2 Challenges and Limitations

Despite its advantages, the system has certain challenges and limitations. Its functionality is dependent on stable internet connectivity, which may affect accessibility in regions with limited network infrastructure. Administrators may require initial training to effectively use and manage the system, particularly in understanding AI-driven insights. Furthermore, the accuracy of complaint classification, sentiment detection, and solution generation is highly dependent on the quality and robustness of the underlying AI models, which may require continuous refinement and updates.

7.3 Future Scope

There is significant scope for future enhancement of the proposed system. Developing a dedicated mobile application could further improve accessibility and user engagement. The integration of advanced AI-based recommendation models may enable more personalized and context-aware solutions for student grievances. Additionally, integrating the system with existing institutional Enterprise Resource Planning (ERP) systems would allow seamless data exchange, improved administrative coordination, and a more comprehensive approach to institutional management.

8. Conclusion

The Smart Complaint Management System using AI and Sentiment Analysis provides an effective and scalable solution for handling student grievances in educational institutions. By automating translation, sentiment analysis, prioritization, and resolution guidance, the system significantly improves efficiency and transparency. The integration of real-time messaging and smart solutions enables administrators to take quick and informed actions.

This system demonstrates the practical application of Artificial Intelligence in improving institutional service management.

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