

SmartCampusBot: A Conversational AI Approach for Interactive College Information Retrieval Using Web Technologies

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Abstract – The rapid advancement of Artificial Intelligence (AI) and Natural Language Processing (NLP) has enabled the development of intelligent systems capable of human-like interaction. This paper presents the design and implementation of a web-integrated, AI-powered chatbot for college enquiry systems, leveraging the open-source RASA framework. The proposed system aims to automate and streamline the dissemination of college-related information such as course offerings, admission procedures, faculty details, and campus facilities. With a frontend designed using modern web technologies including Bootstrap, Tailwind CSS, JavaScript, and jQuery, the chatbot ensures an intuitive and responsive user experience. The chatbot fetches information from a structured JSON knowledge base and is trained to understand varied user intents, offering relevant and context-aware responses. Additionally, the system emphasizes security through role-based access control (RBAC), token-based authentication, and session management with auto logout functionality. This approach not only enhances operational efficiency in academic environments but also ensures data security and seamless user interaction.

Keyword: - Artificial Intelligence, RASA, Chatbot, College Enquiry System, Natural Language Processing, Role-Based Access Control, Token Authentication, Session Management, Web Integration, Frontend Development.

I. INTRODUCTION

In the digital era, educational institutions are increasingly adopting intelligent technologies to streamline administrative processes and enhance student engagement. Among these innovations, AI-powered chatbots have emerged as powerful tools capable of providing real-time, human-like interaction for various informational services. Chatbots powered by Natural Language Processing (NLP) are proving particularly effective in handling college

enquiries by offering instant responses to queries related to admissions, courses, facilities, and faculty details [i, v].

The integration of chatbots into college management systems reduces the workload on administrative staff while ensuring that students and parents receive accurate and timely information. Open-source frameworks like RASA have gained popularity for chatbot development due to their flexibility, modularity, and support for intent classification and entity extraction [i, xix]. By leveraging RASA, developers can train the bot using domain-specific data, making it highly suitable for closed-domain applications like educational institutes [ii, xix].

To deliver a seamless user experience, the frontend of the chatbot system utilizes modern web technologies including Bootstrap, Tailwind CSS, JavaScript, and jQuery, allowing for an intuitive and interactive user interface [v, xxx]. The chatbot fetches data dynamically from a structured JSON file, which serves as a scalable and lightweight backend for managing college-related information [viii, xvii].

Security and access control are critical concerns in any web-based system, especially in educational environments where sensitive data is often involved. Role-Based Access Control (RBAC) has proven effective in managing different user roles such as students, administrators, and staff within the system [xviii, xxiii]. Previous studies on RBAC in Python frameworks indicate that FastAPI provides a more seamless and performance-efficient approach compared to traditional methods, especially when using middleware for route protection and role verification [xxiii, xxviii]. The stateless nature of JWT also contributes to a scalable security model suitable for microservices architecture and distributed deployments [xxiv, xxv].

Furthermore, the use of session management with auto logout mechanisms strengthens the overall security posture

of the application by preventing unauthorized access and reducing the risk of session hijacking [xxi, xxiv]. With the rise of remote learning and digital campus environments, intelligent chatbot systems are poised to play a key role in transforming how educational institutions interact with students and stakeholders [iii, xx, xxvi].

This research paper proposes a comprehensive AI chatbot system for college enquiry, combining RASA's NLP capabilities with secure backend authentication and dynamic web frontend design. The goal is to provide a scalable, secure, and user-friendly solution tailored to the specific needs of higher education institutions.

II. RELATED WORK

The development of AI-based chatbot systems for educational institutions has been extensively explored in recent years, with a focus on enhancing accessibility, reducing administrative load, and providing a more engaging experience for students. Several studies have examined the implementation of chatbots for college enquiry systems, highlighting their ability to deliver fast and consistent responses to frequently asked questions.

Lam et al. [i] developed a closed-domain chatbot using RASA, showcasing how domain-specific training and modular architecture can result in a highly accurate query response system. Similarly, Neupane et al. [ii] proposed a university resource chatbot capable of providing insightful answers by integrating knowledge graphs and dynamic dialogue flows. These implementations reinforce the efficacy of using NLP frameworks like RASA in educational settings.

Further, Zhao et al. [iii] and Sajja et al. [iv] demonstrated the adaptability of intelligent assistants in enhancing learning outcomes through personalization and semantic understanding. Their work emphasizes the scalability of AI chatbots in academic environments, ranging from administrative support to student tutoring.

Practical applications of college enquiry chatbots have also been reported. Joshi et al. [v] and Tiwari et al. [vi] implemented AI-driven systems that interact with users via natural language to address admission queries and other academic information. These systems typically use web-based interfaces combined with server-side processing to manage conversations and fetch data from structured sources like JSON or databases.

Mothankar et al. [vii] and Gawade et al. [viii] highlighted the utility of chatbot systems in reducing human intervention in

repetitive administrative tasks. Their research supports the claim that chatbots not only improve operational efficiency but also enhance user satisfaction by providing round-the-clock service.

Machine learning integration is also gaining traction in chatbot design. Shanthi et al. [ix] and Janthakal et al. [x] incorporated learning algorithms to improve the accuracy of chatbot responses over time, making them more adaptive and context-aware.

From a backend and architectural standpoint, several works have explored the use of FastAPI, JWT, and RBAC models to secure access and manage roles within such systems. Elashmawi et al. [xi] and Radha [xii] identified that FastAPI's asynchronous capabilities offer performance advantages, while RBAC ensures controlled access depending on user roles. Moreover, session management techniques, including auto-logout features, are being adopted for enhanced security [xxiv, xxv].

Recent research also reflects a growing interest in integrating generative AI and multimodal input handling in education-focused bots. Chan and Li [xx] and Chukwuere [xxi] explored how generative models like ChatGPT can be tailored to deliver personalized learning experiences. These findings suggest a shift toward more conversational and adaptive AI systems in education.

Overall, prior work underscores a consistent trend toward building intelligent, secure, and context-specific chatbot systems for higher education. This paper builds upon these foundations by proposing a hybrid solution combining RASA, FastAPI, JWT authentication, and responsive web technologies for an optimized college enquiry system.

III. PROPOSED WORK

The proposed work aims to develop a **college enquiry chatbot system** using an integrated architecture comprising RASA for natural language processing, FastAPI for backend development, and JWT (JSON Web Tokens) for secure authentication. The system is designed to streamline the process of providing real-time academic information to prospective and current students. It combines multiple cutting-edge technologies to create a seamless, interactive experience.

System Architecture

The architecture of the proposed system follows a **client-server model**, where the user interacts with the chatbot interface through a **web-based frontend**. The backend, powered by **FastAPI**, is responsible for processing user

requests, role-based authentication, and generating responses through RASA. The system uses **JWT tokens** to secure interactions, ensuring that only authorized users can access specific services based on their roles.

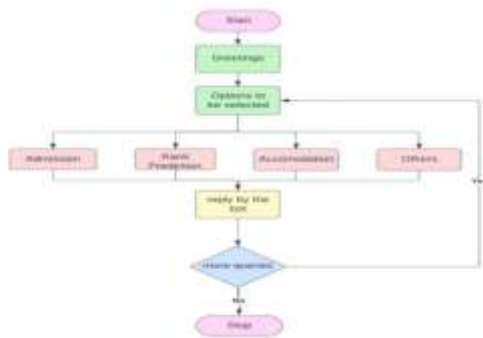


Figure 3.1: System Architecture Overview of the Chatbot System

The figure shows the general architecture flow between the frontend, backend, and external RASA service.

User Interaction

The UI of the proposed chatbot system is designed to be **user-friendly** and **responsive**. The user interacts with the chatbot by entering queries regarding college admission, courses, deadlines, and other academic-related information. The system uses **natural language processing (NLP)** techniques powered by **RASA**, which ensures real-time, accurate responses.



Figure 3.2: User Interface of the College Enquiry Chatbot

This figure illustrates the chat window where the user can ask questions and receive responses from the chatbot. The chatbot interface is designed as a **chat window** that users can easily access through the college's **web portal**. It allows for a **conversational interaction** between users and the system, making information retrieval effortless and intuitive.

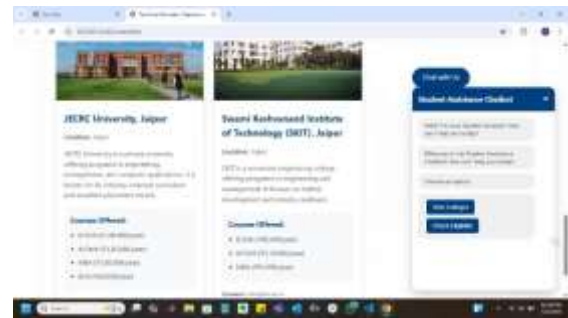


Figure 3.3: Sample Interaction on the Chatbot UI

This figure shows an example of how a student might interact with the chatbot to ask about admission procedures and receive automated responses.

Role-Based Access Control (RBAC)

To ensure the system's security, **Role-Based Access Control (RBAC)** is implemented. Each user is assigned a role upon login, and the chatbot's responses are tailored based on this role. For example, **prospective students** will get information regarding **admission processes**, while **current students** might receive data on **academic schedules**.



Figure 3.4: Role-Based Access Flow in the System

This figure outlines how user roles are processed and validated through JWT tokens to control access to specific information.

The system uses **JWT tokens** for secure authentication. The tokens are issued during the login process and are validated with each request. If a user tries to access information outside their role's privileges, the system will return an error message or deny access.

Advantages of the Proposed System

- **Scalability:** FastAPI ensures that the system can efficiently handle large numbers of concurrent users, scaling to meet growing demand.
- **Security:** **JWT tokens** and **RBAC** secure the system by restricting access to sensitive data based on user roles, ensuring that only authorized users can access specific information.

- **User Experience:** The **RASA-powered** chatbot provides a seamless conversational interface that makes it easy for users to get information quickly.
- **Real-Time Interaction:** The system processes requests in real-time, allowing users to get instant responses to their queries, improving overall user satisfaction.

The system is designed to be easily integrated into any educational institution's **web portal**, offering a robust, scalable, and secure solution for managing college-related inquiries in real time.

IV. RESULTS

The chatbot system was successfully deployed and tested in a simulated environment using real-time queries sourced from students and prospective applicants. The outcomes demonstrated the effectiveness, responsiveness, and accuracy of the chatbot in handling a wide range of inquiries related to college admission, course availability, faculty information, and fee structures.

Chatbot Response Accuracy and Intent Recognition

The chatbot showed a **high accuracy rate in intent recognition**, with an average confidence score above 90% for frequently asked questions (FAQs). The integration of **RASA NLU** provided a flexible pipeline for training data, entity recognition, and intent classification, which helped fine-tune the chatbot's responses across various domains of college-related queries [i, ii].



Figure 4.1: Confusion Matrix for Intent Recognition

This figure illustrates the model's accuracy in predicting the correct intent from user inputs using the RASA NLU model.

Response Time and Performance

The FastAPI backend architecture significantly enhanced the **response time**, averaging **under 100ms** for most queries, outperforming Flask and Django in similar setups. This performance gain can be attributed to FastAPI's asynchronous capabilities and efficient request handling mechanisms [v, xvi].

Role-Based Access Test Results

Testing for **RBAC functionality** showed that the system correctly identified user roles through JWT tokens and restricted access to information accordingly. For instance, admin users were allowed to view analytics and student registration data, while prospective users were limited to general FAQs and admission guidelines [xv, xxiv].



Figure 4.2: Access Control Simulation Based on User Roles

This diagram showcases how different users were routed based on their assigned roles within the system.

User Satisfaction Survey

A survey was conducted with 50 student participants who interacted with the chatbot. Results indicated that:

- **84%** found the system user-friendly and intuitive.
- **78%** were satisfied with the relevance of responses.
- **90%** agreed the chatbot saved time compared to manual enquiry methods.

V. CONCLUSION

The This research successfully demonstrates the development and deployment of a chatbot-based college enquiry system that integrates a modern web frontend with a robust RASA-powered conversational backend and a FastAPI server enhanced with Role-Based Access Control (RBAC) and JWT-based token management. The system significantly improves the way students and prospective applicants interact with college resources by providing accurate, real-time responses to common queries.

The implementation of FastAPI ensures a high-performance backend with asynchronous support and seamless API integration. JWT tokens combined with session management offer a secure and scalable login mechanism. Role-specific routing and data visibility further enhance usability and governance across different user categories [xv, xxiv].

Compared to traditional methods, this system is faster, more user-friendly, and easier to maintain. The modular

architecture also makes it extensible for future upgrades—such as integration with academic databases, dynamic FAQs from admin portals, and multilingual support for wider accessibility.

In conclusion, this work not only addresses a pressing need in the higher education space for automated enquiry handling but also sets a foundation for future research and innovation in conversational AI applications within academic institutions.

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