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EduTech Portal: An AI-Powered Student Assistant Chatbot

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Abstract: The increasing number of queries concerning admissions in engineering and polytechnic institutions under the Department of Technical Education has highlighted the limitations of traditional response methods. To ensure smoother communication and timely dissemination of information, deploying a centralized AI-powered chatbot emerges as an efficient and scalable solution. Functioning as a virtual assistant, this intelligent system can autonomously manage frequently asked questions about eligibility, available programs, fee details, scholarship opportunities, hostel facilities, and placement timelines. Operating 24/7, the chatbot alleviates the pressure on administrative staff, improves user satisfaction, and provides valuable data for continuous service optimization. Through machine learning, it evolves by learning from interactions, enhancing the precision and contextual relevance of its responses. The system not only expedites query resolution but also reduces the dependency on manual efforts for routine tasks. Additionally, its integration within the academic framework ensures consistent and fair information delivery. With built-in Natural Language Processing (NLP) capabilities, the chatbot supports multilingual communication, expanding access and enabling students and their families to make well-informed decisions.

Keywords: *AI-Powered Chatbot, Virtual Assistant for Education, Admission Support System, Automated Query Handling, NLP, Machine Learning, 24/7 Student Support, Centralized Communication, Digital Education Assistant, Smart Education Technology*.

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I. INTRODUCTION

The admission process for engineering and polytechnic institutions governed by the Department of Technical Education is a pivotal phase for students, parents, and educational stakeholders. This period typically experiences a significant influx of inquiries related to admission procedures, eligibility requirements, tuition fees, scholarships, hostel facilities, course offerings, and placement opportunities. Traditionally, these queries are managed through conventional methods such as telephone conversations, email communication, or in-person visits to campuses. However, these approaches are often time-consuming, inefficient, and inconsistent, leading to delays and a poor user experience. Educational institutions frequently encounter difficulties in coping with the high volume of queries, resulting in the diversion of valuable administrative resources toward handling repetitive questions. Consequently, both institutions and stakeholders face challenges—universities struggle with operational inefficiencies, while students and guardians are left seeking timely and reliable information. To mitigate these issues and enhance the efficiency of communication, the adoption of AI-powered chatbots presents a viable and innovative solution. These intelligent systems act as virtual assistants, capable of delivering instant, accurate, and automated responses to frequently asked questions around the clock. By leveraging cutting-edge technologies such as Artificial Intelligence (AI), Machine Learning (ML), and Natural Language Processing (NLP), the proposed chatbot system offers a scalable, user-friendly, and accessible platform that transforms how information is disseminated in academic environments. This integration not only reduces the burden on institutional staff but also ensures consistent and equitable information access, thereby empowering stakeholders to make informed decisions during the admission process.

II. PROBLEM STATEMENT

During admission seasons, engineering and polytechnic institutes experience a sharp increase in queries related to eligibility criteria, fee structures, placements, and other concerns. Traditional methods such as phone calls, emails, or face-to-face interactions consume significant time and effort for both administrative staff and prospective applicants. Implementing an AI-powered chatbot offers an effective

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solution by delivering round-the-clock support, automating responses to frequently asked questions, easing the burden on staff, and ensuring that students and their families can conveniently access accurate information.

III. PROPOSED SYSTEM

The proposed system introduces a centralized AI-based chatbot designed to streamline admission-related queries for engineering and polytechnic institutes under the Department of Technical Education. It delivers real-time, accurate responses to frequently asked questions about eligibility, admission timelines, fees, scholarships, hostel availability, course options, and placements.

Integrated into the official admission portal, the system ensures 24/7 accessibility. It employs Artificial Intelligence (AI) for smart replies, Machine Learning (ML) to adapt through user interactions, and Natural Language Processing (NLP) to handle multilingual input effectively.

The platform includes secure Sign In/Sign Up features, allowing personalized access and data privacy. A key addition is the College Recommendation System, which uses user inputs—like academic scores and preferences—to suggest suitable colleges. Users can also generate downloadable PDF reports of recommended colleges for offline review and informed decision-making.

A. *Key Features:*

- Automated Chatbot: Instantly resolves admission-related queries without human intervention.
- 24/7 Availability: Offers continuous access, including outside working hours.
- Multilingual Support: Supports English, Hindi, and other regional languages.
- AI & ML Integration: Uses AI for smart responses and ML to learn from user behavior.
- User Authentication: Secure Sign In/Sign Up for personalized services.
- College Recommendation Engine: Recommends colleges based on scores, preferences, and other criteria.
- PDF Report Generation: Allows users to download customized college recommendation reports.
- Interactive Interface: User-friendly design for smooth engagement.
- Data Insights: Gathers analytics to support institutional decisions.
- This system reduces manual effort, improves user experience, and provides institutions with valuable insights for better planning.

IV. SYSTEM ARCHITECHTURE

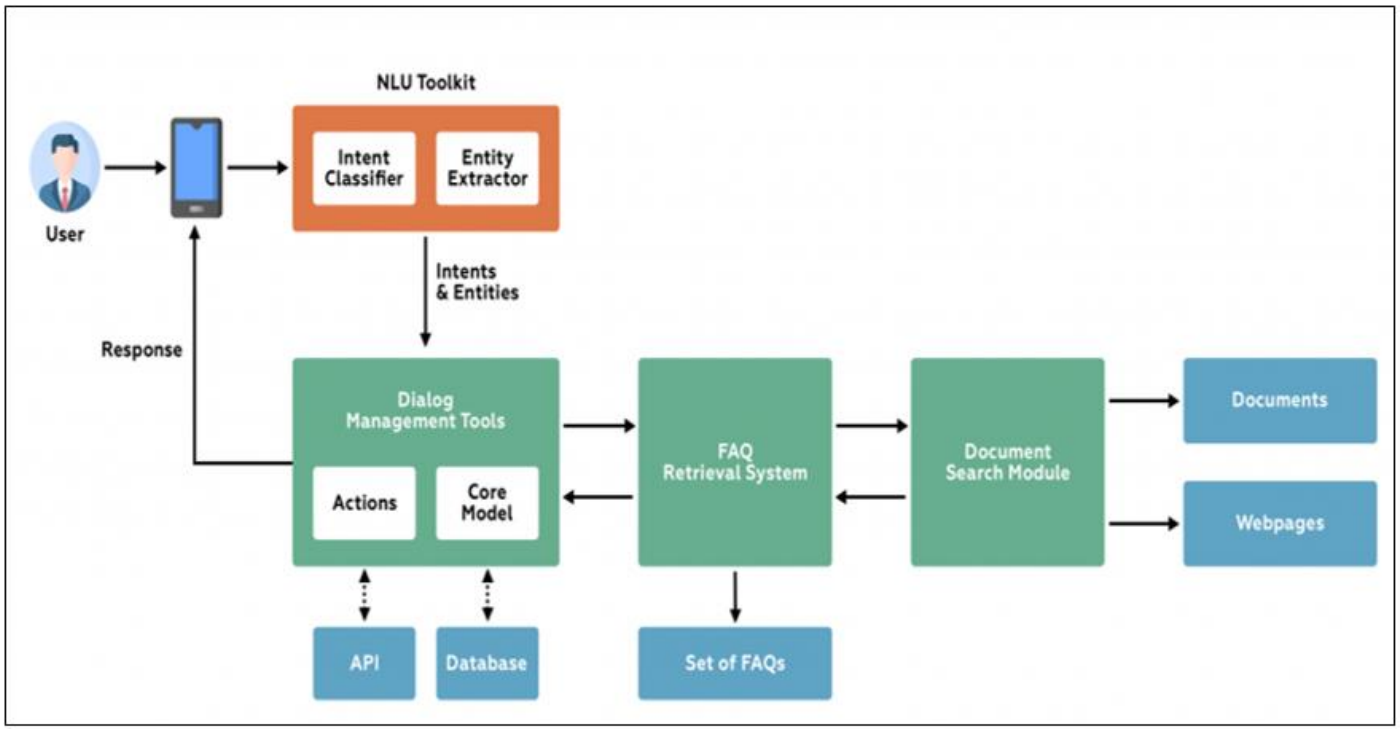

Fig 1 System Architechture of AI-Powered Student Assistant Chatbot

- *User Interaction:*

- The process starts when a user submits a query through the chatbot interface.

- *NLU Toolkit Processing:*

- The input is analyzed by the Natural Language Understanding (NLU) toolkit, which includes:

- Intent Classifier: Determines the purpose of the query.

- *Entity Extractor:*

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- Identifies key information such as names, dates, or categories.

➢ *Intent and Entity Flow:*
- The detected intents and entities are sent to the Dialog Management Tools for decision-making.

➢ *Dialog Management System:*

- Chooses suitable actions based on the core model and past interactions.

- Uses predefined logic and learning models to generate relevant responses.

➢ *Data Integration:*

- Pulls necessary data from APIs and Databases to enrich the response.
- Ensures dynamic, real-time information like admission deadlines, fee updates, or placement stats.

➢ *FAQ Retrieval System:*

- For straightforward queries, the dialog system accesses a Set of FAQs to provide quick, relevant answers.

➢ *Document Search Module:*

- For complex queries, the system uses a search module to retrieve information from structured Documents or Webpages.

➢ *Response Generation and Delivery:*

- The system formulates the final response and delivers it back to the user via the chat interface.

V. PROPOSED ALGORITHMS

A. BERT for Natural Language Processing (NLP) :

➢ *Steps:*

- Preprocess the input query (tokenization, cleaning).
- Fine-tune BERT on domain-specific datasets related to college admissions.
- Feed the query into the BERT model to generate contextual embeddings.
- Use embeddings to detect user intent and extract relevant information.
- Generate a context-aware response based on detected intent.

➢ *Explanation:*

BERT is a powerful NLP model that captures deep contextual relationships within a sentence by considering both preceding and succeeding words. Fine-tuning it on admission-specific data allows it to understand complex, domain-specific queries with high accuracy.

➢ *Model Capabilities:*

BERT captures bidirectional context in text, allowing it to understand complex queries by considering both the previous and following words in a sentence. It provides high precision in understanding the semantic meaning of queries.

➢ *Impact on the System:*

BERT enhances the chatbot's ability to handle ambiguous and complex queries. It ensures accurate responses by leveraging deep context, improving overall user satisfaction and engagement.

B. K-Nearest Neighbors (KNN) for Query Suggestion :

➢ *Steps:*

- Extract feature vectors from incoming user queries.
- Store feature vectors and corresponding responses from past queries.
- Calculate the similarity between the new query and stored vectors.
- Retrieve the K most similar queries based on similarity calculation.
- Return the best matching response from the retrieved queries.

➢ *Explanation:*

KNN is a memory-based algorithm that identifies the most similar past queries to suggest responses. By comparing feature vectors, it retrieves the most contextually similar queries and their responses, ensuring relevant suggestions for the user.

➢ *Model Capabilities:*

KNN is a simple, instance-based learning algorithm that identifies similar queries by calculating the distance between feature vectors. It is flexible and requires minimal training, making it suitable for real-time query suggestions.

➢ *Impact on the System:*

KNN improves response efficiency and accuracy by suggesting relevant past queries, reducing ambiguity and speeding up response time. It enhances the chatbot's ability to provide quick, relevant suggestions based on historical data.

C. Text-to-Speech (TTS) for Voice Responses :

➢ *Steps:*

- Generate a text-based response to the user query.
- Convert the text response into phonetic units.
- Synthesize the speech from the phonetic units using a TTS engine.
- Output the synthesized speech as an audio response.

➢ *Explanation:*

The TTS system converts the text-based response into spoken language, enhancing accessibility and interactivity. By using natural-sounding speech synthesis, it ensures that

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25may390

users can interact with the chatbot in a more intuitive and engaging manner.

➢ *Model Capabilities:*

TTS systems can generate natural-sounding speech by converting text into audio, supporting a range of languages and accents. Advanced TTS models focus on realistic pronunciation, tone, and prosody to improve the user experience.

➢ *Impact on the System:*

TTS improves accessibility and user engagement, offering voice-based interaction that is especially beneficial for users who prefer auditory responses or have visual impairments. It makes the chatbot more interactive and inclusive.

VI. COMPARISON WITH EXISTING SYSTEMS

AI-powered chatbots outperform traditional methods by offering superior availability, faster response times, and enhanced user convenience, supported by multilingual capabilities, voice interaction, and advanced data analytics. Unlike static conventional systems, AI chatbots leverage machine learning and natural language processing to continuously improve accuracy and adaptability while enabling real-time analytics and personalized interactions. These features ensure seamless scalability, reduced manpower requirements, and a more intuitive UI with intelligent query suggestions and centralized data management.

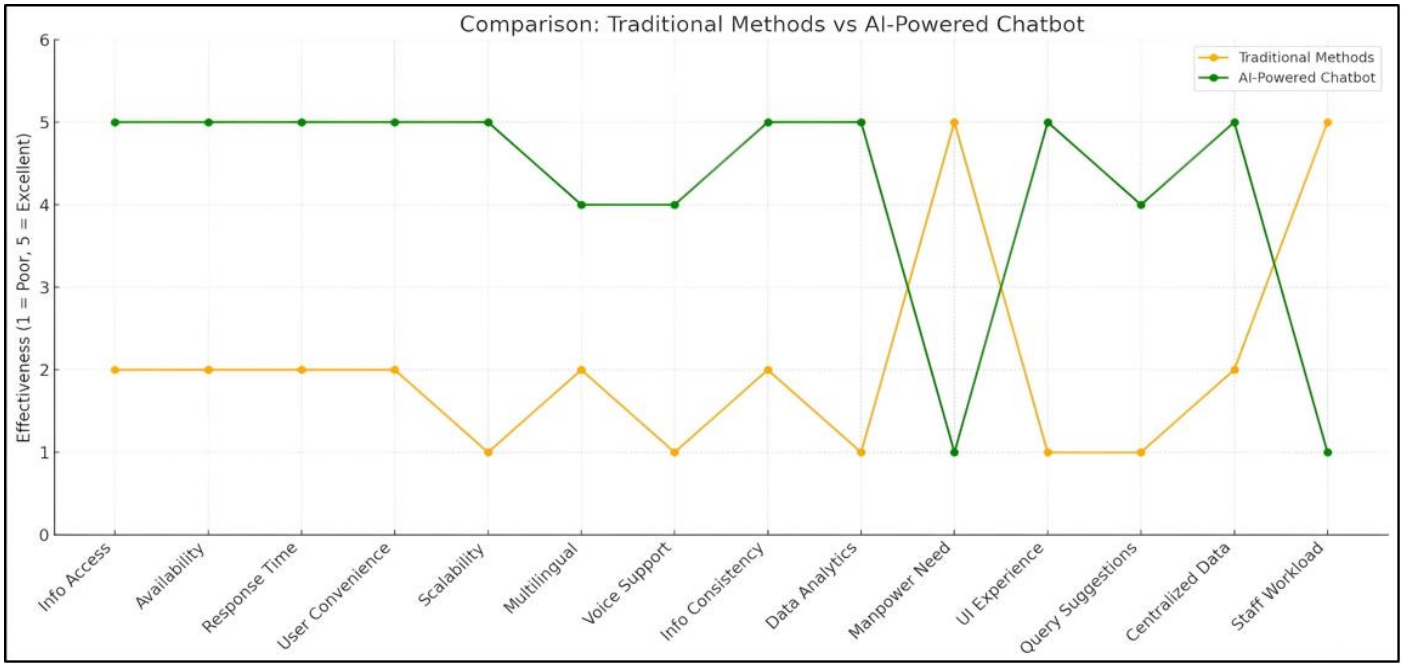

Fig 2 Traditional Methods vs AI-Powered Chatbot

In addition, these chatbots are capable of handling large volumes of simultaneous queries, making them ideal for high-demand environments like educational institutions during admission seasons. Their ability to learn from interactions ensures they evolve with user expectations, providing increasingly accurate and context-aware responses. Through centralized dashboards, administrators can monitor trends, identify common issues, and continuously improve services. The integration of smart filters, predictive search, and instant document delivery further simplifies the user journey. Overall, AI chatbots represent a shift toward intelligent automation that empowers both users and institutions alike.

VII. MATHEMATICAL MODEL

The AI-powered Student Assistant Chatbot for engineering and polytechnic institutions is modeled as a multi-component system that delivers intelligent, real-time support for admission-related queries. The system is defined as a tuple representing its various functional modules, each addressing a specific aspect of the student assistance process. These components work collaboratively to ensure seamless authentication, personalized recommendations, scholarship guidance, and responsive query handling. By leveraging natural language understanding and structured data processing, the model ensures both accuracy and accessibility for diverse user needs. Each module is designed to operate autonomously while contributing to the system's overall decision-making process. The modular architecture also facilitates future integration of additional educational services, making the platform extensible and adaptable to evolving institutional requirements.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25may390

➢ *The System is Defined as a Tuple:*

$$\mathcal{M} = \{\mathcal{U}, \mathcal{A}, \mathcal{L}, \mathcal{R}, \mathcal{D}, \mathcal{S}, \mathcal{F}, \mathcal{C}, \mathcal{B}, \mathcal{P}\}$$

Where each component is defined as:

- $\mathcal{U}$: Set of Users, $U = \{u_1, u_2, ..., u_n\}$
- $\mathcal{A}$: Authentication Module
- $\mathcal{L}$: Language Processing Unit (NLP)
- $\mathcal{R}$: Recommendation Engine
- $\mathcal{D}$: College Database
- $\mathcal{S}$: Scholarship Eligibility Engine
- $\mathcal{F}$: FAQ Knowledge Base
- $\mathcal{C}$: Contact and Manual Query Escalation
- $\mathcal{B}$: Chatbot Interface
- $\mathcal{P}$: PDF Generator for College Recommendation

1. Authentication Module ($\mathcal{A}$)

Each user u_i must pass the authentication check:

$$\text{Auth}(u_i) = \begin{cases} 1 & \text{if hash}(pwd_i + salt_i) = \text{stored}(u_i) \\ 0 & \text{otherwise} \end{cases}$$

2. Profile Definition

A user profile is defined as:

$$P(u_i) = (\text{percentile}_i, \text{category}_i, \text{income}_i, \text{preferences}_i)$$

3. College Database ($\mathcal{D}$)

Each college c_j is represented as:

$$c_j = (\text{name}, \text{location}, \text{fee}, \text{rating}, \text{placement\%}, \{\text{cutoff}_b^r\}, \text{hostel})$$

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25may390

4. Recommendation Engine ($\mathcal{R}$)

Eligible colleges for a user u_i:

$$\mathcal{R}(u_i) = \{c_j \in \mathcal{D} \mid \text{percentile}_i \geq \text{cutoff}_b^{\tau}(c_j)\}$$

College ranking is computed as:

$$\text{Score}(c_j) = \sum_{k=1}^{4} w_k f_k(c_j)$$

Where:

- f_1 = Placement Score
- f_2 = Fee Affordability
- f_3 = NAAC Grade
- f_4 = Hostel Availability

5. Scholarship Module ($\mathcal{S}$)

Scholarship eligibility for user u_i and college c_j:

$$\text{Eligible}(u_i, c_j) = \begin{cases} 1 & \text{if income}_i \leq \theta \wedge \text{percentile}_i \geq \phi \\ 0 & \text{otherwise} \end{cases}$$

6. FAQ Knowledge Base ($\mathcal{F}$)

Let $Q = \{q_1, \ldots, q_m\}$ and $A = \{a_1, \ldots, a_m\}$

Response retrieval:

$$\text{Retrieve}(q) = \arg\max_{q_k \in Q} \text{BERTScore}(q, q_k)$$

7. Contact System ($\mathcal{C}$)

For low-similarity queries:

$$\text{Response}(msg) = \begin{cases} \text{FAQ Answer} & \text{if } \text{sim}(msg, q_k) > 0.8 \\ \text{Manual Escalation} & \text{otherwise} \end{cases}$$

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25may390

8. Chatbot System ($\mathcal{B}$)

For user query q_a:

Step 1: Embedding

$$E(q_a) = \text{BERT}(q_a), \quad E(Q) = \{\text{BERT}(q_k)\}$$

Step 2: Match using KNN

$$k^* = \arg\min_k \|E(q_a) - E(q_k)\|$$

Step 3: Response Generation

$$R = \begin{cases} a_{k^*} & \text{if similarity} > \delta \\ \text{ChatGPT}(q_a) & \text{otherwise} \end{cases}$$

Step 4: Text-to-Speech

$$S = \text{TTS}(R)$$

9. PDF Generator for College Recommendation ($\mathcal{P}$)

The final downloadable pdf is structured as:

$$\mathcal{P}_u = \begin{bmatrix} \text{User Info} & & P(u_i) & & \\ \text{Recommendations} & \text{College} & \text{Branch} & \text{Fee} & \text{Score} \end{bmatrix}$$

10. Performance Metrics

Module	Metric	Formula
$\mathcal{A}$	Authentication Success Rate	$\frac{\#\text{success}}{\#\text{attempts}}$
$\mathcal{R}$	Precision@5	$\frac{\#\text{relevant colleges in Top 5}}{5}$
$\mathcal{F}$	FAQ Resolution Rate	$\frac{\#\text{resolved FAQs}}{\#\text{queries}}$
$\mathcal{B}$	Chatbot Accuracy	$\frac{\#\text{correct matches}}{\#\text{interactions}}$
$\mathcal{C}$	Avg. Response Time	$\mathbb{E}[t_{\text{response}}]$

Table 1: Performance Metrics for System Modules

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25may390

VIII. RESULTS

The AI-powered student assistant chatbot website boasts an intuitive and user-centric interface, ensuring seamless navigation through essential features such as secure login, a customized dashboard, and an up-to-date college listing. Additionally, it includes a tailored recommendation system, comprehensive scholarship details, and a responsive chatbot to offer real-time assistance throughout the admission journey. Designed to streamline the decision-making process, the platform leverages natural language processing and data-driven insights to enhance accessibility and student engagement.

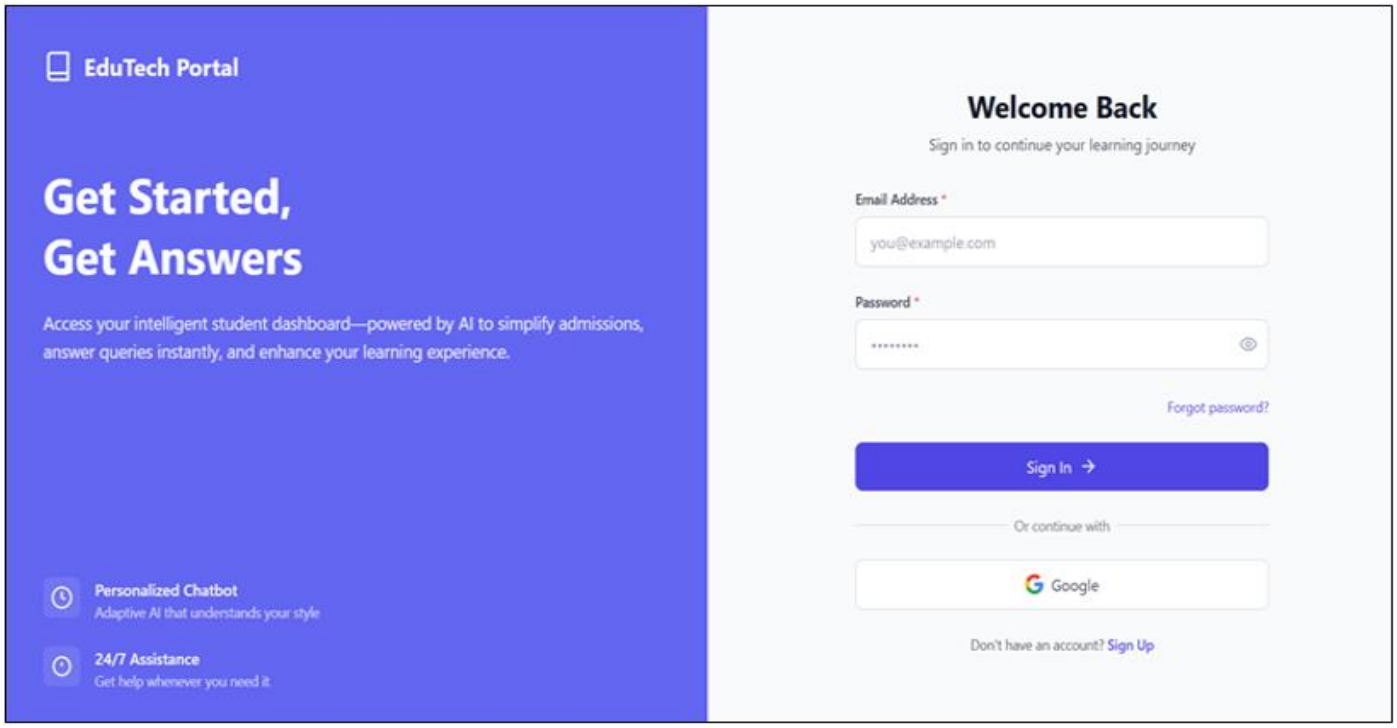

Fig 3 Login Page

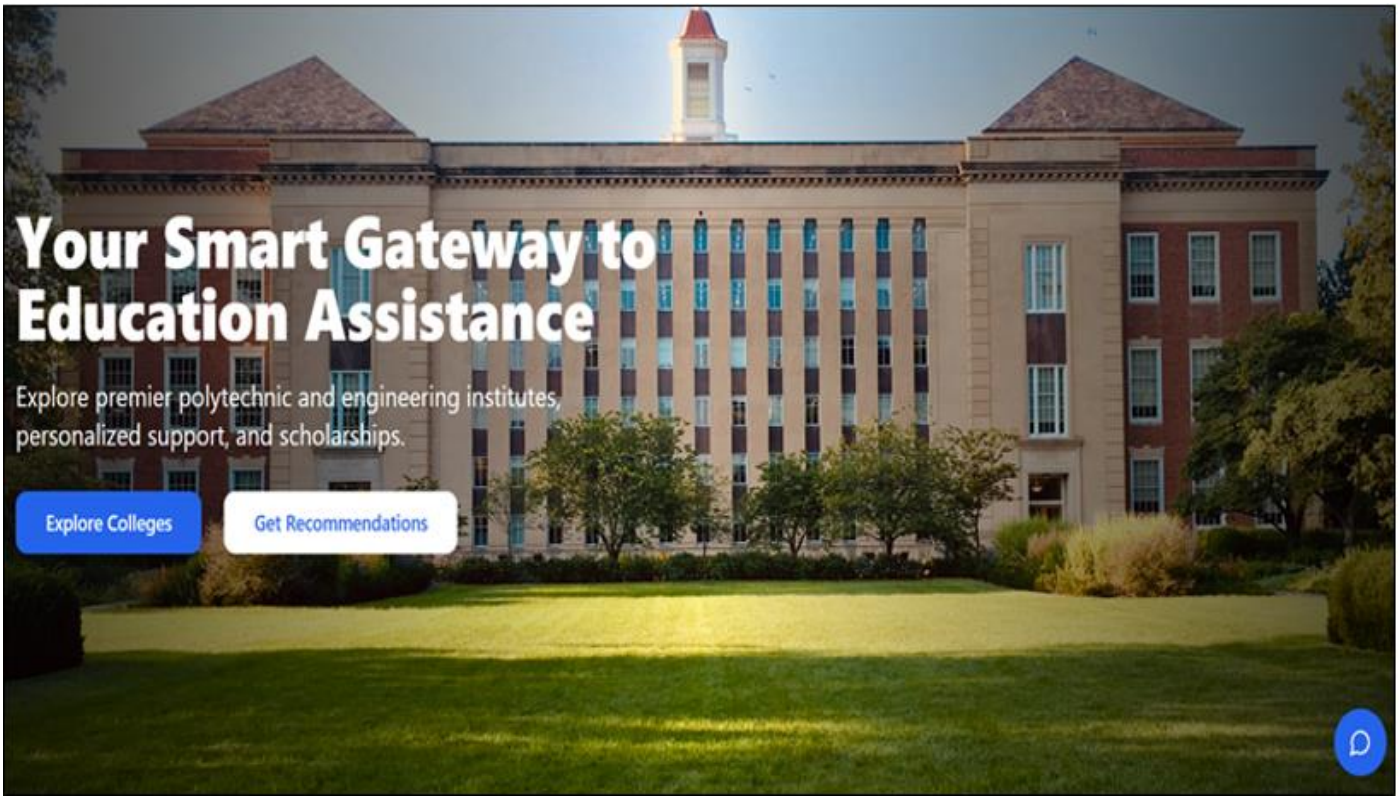

Fig 4 Dash Board

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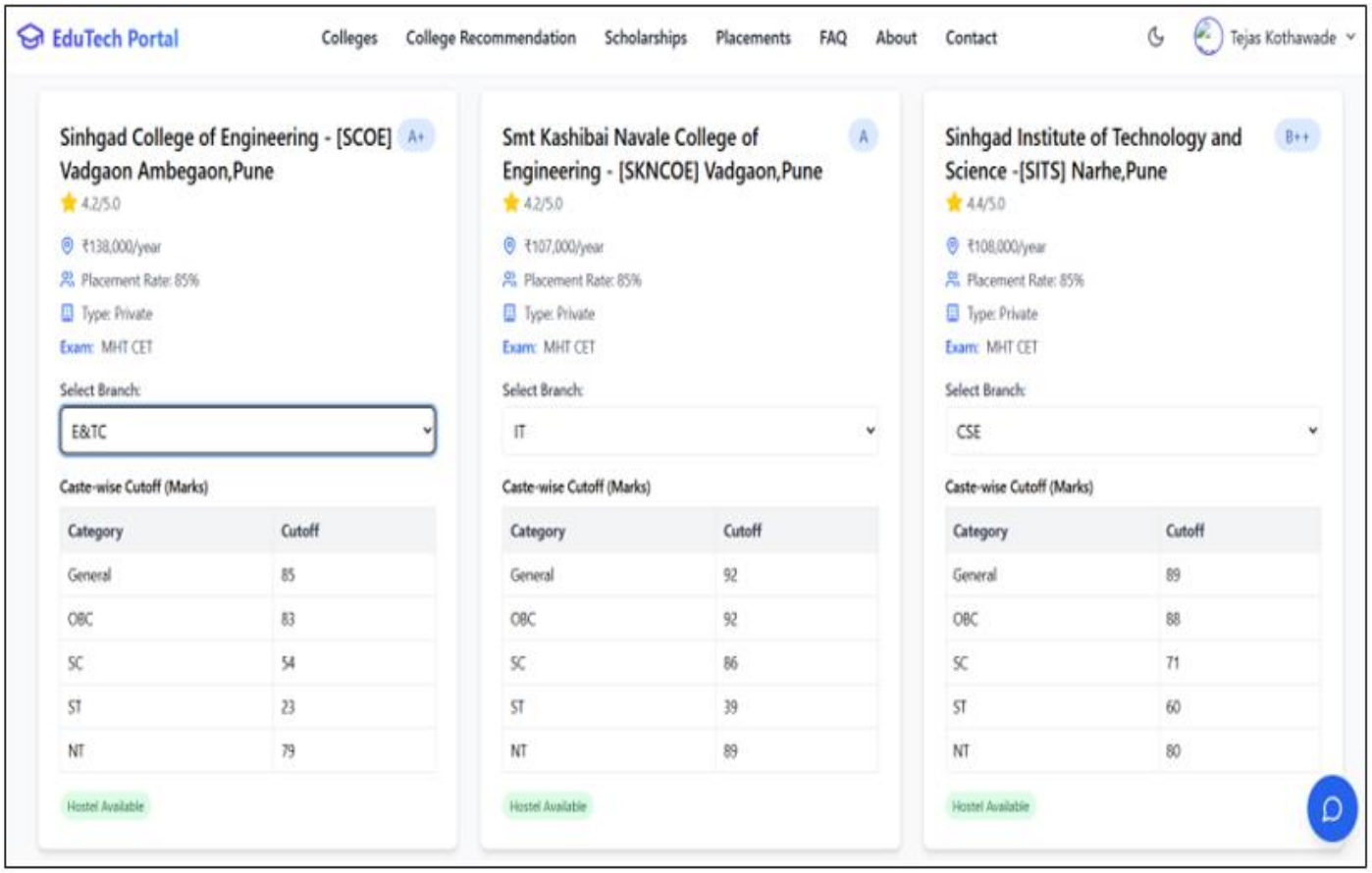

Fig 5 Exploring Colleges

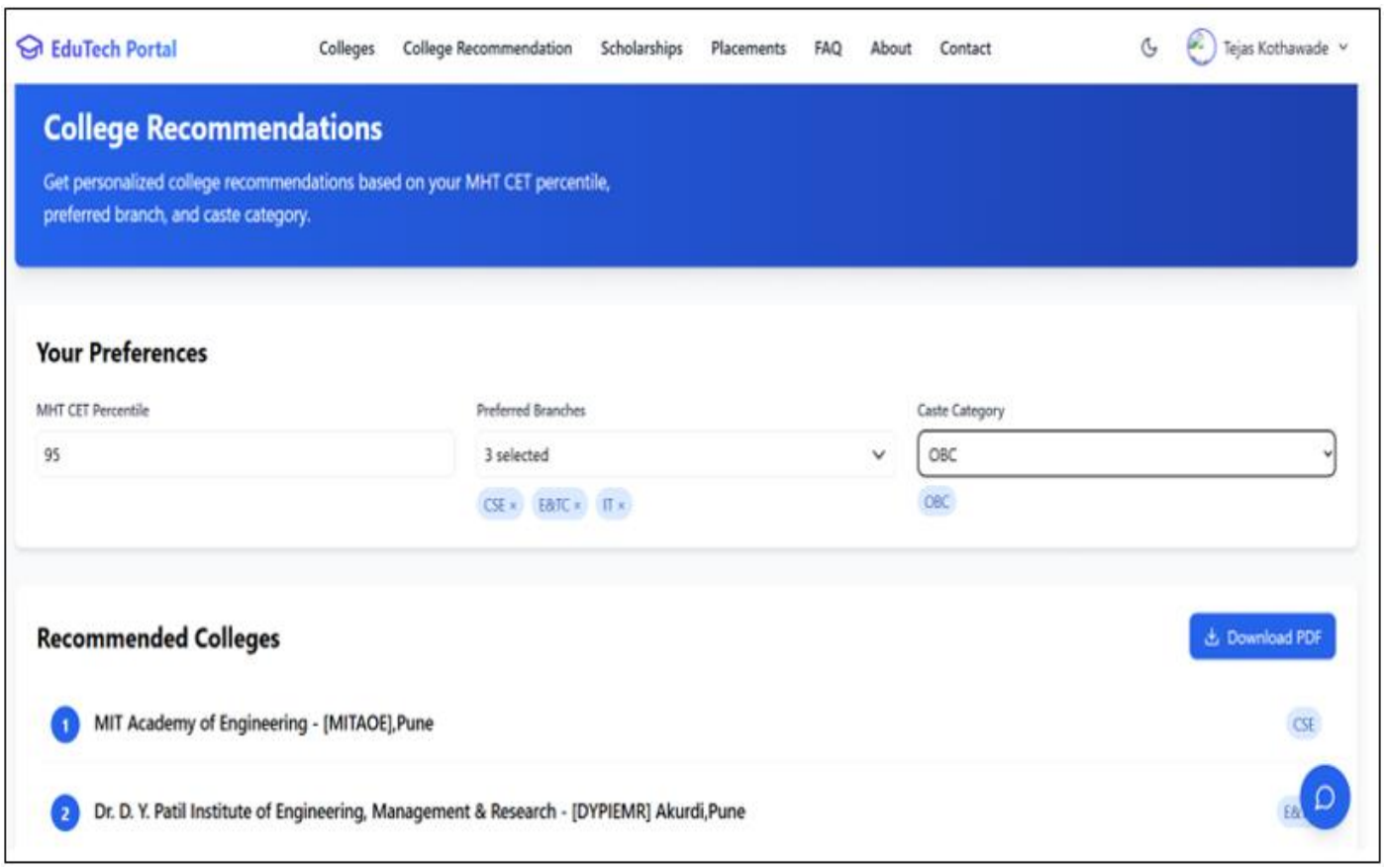

Fig 6 Working of College Recommendation

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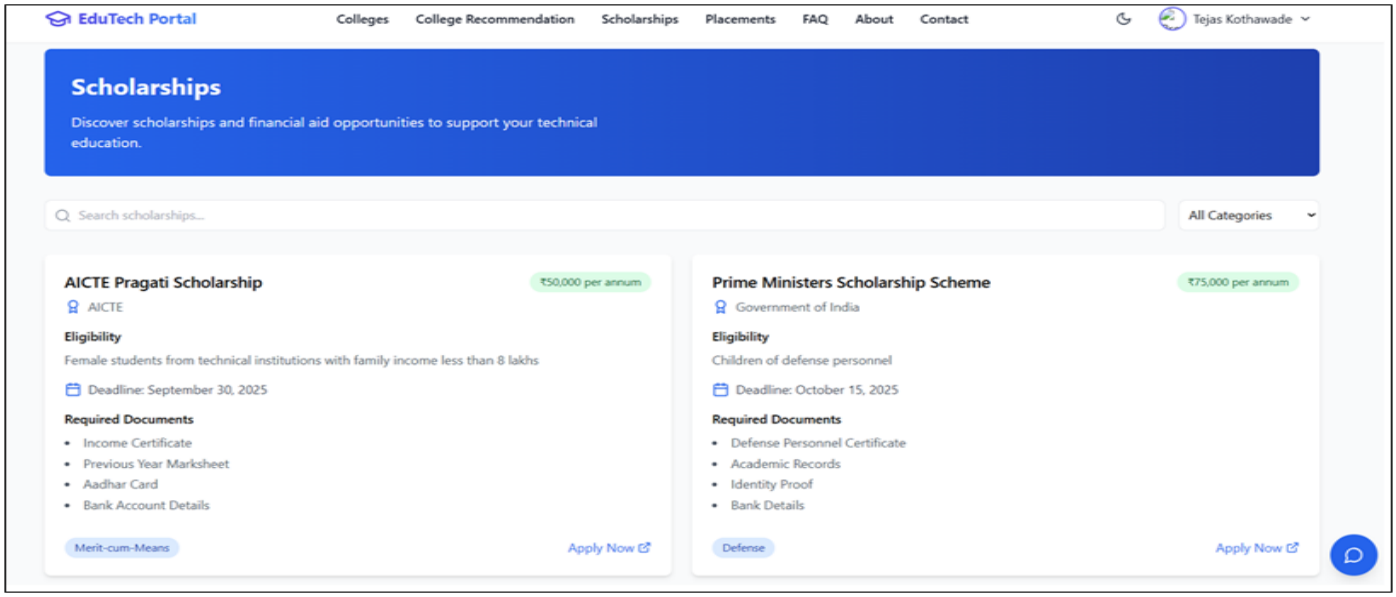

Fig 7 Scholarships

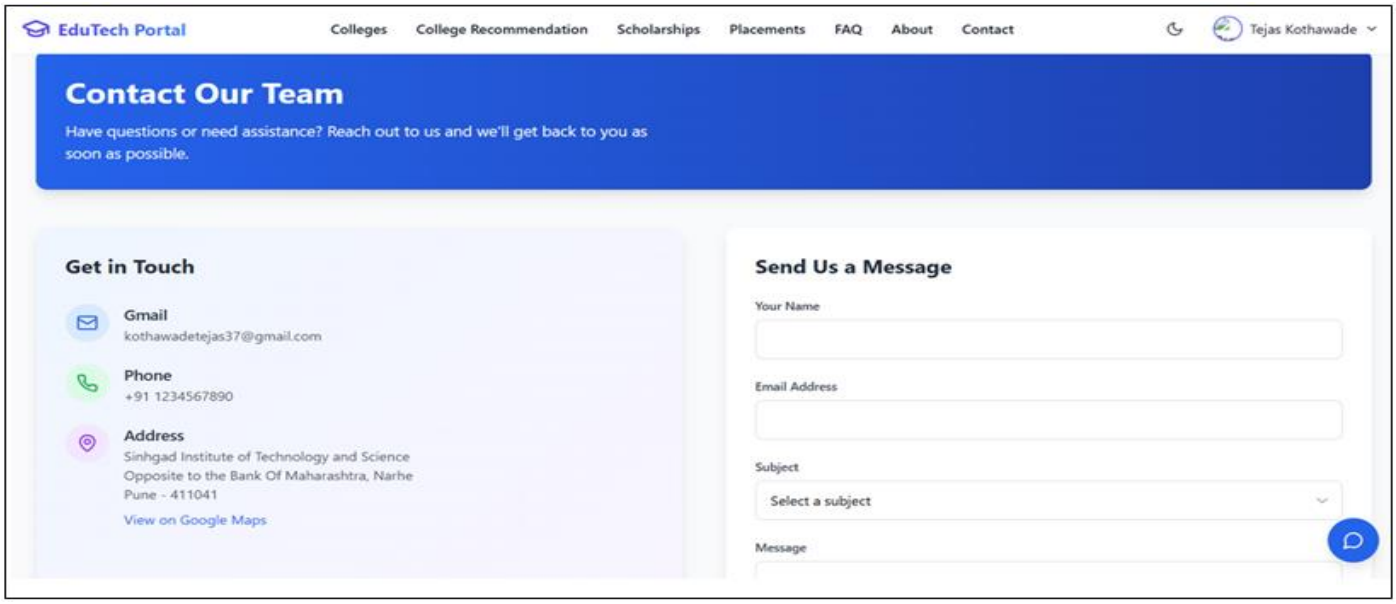

Fig 8 Contact

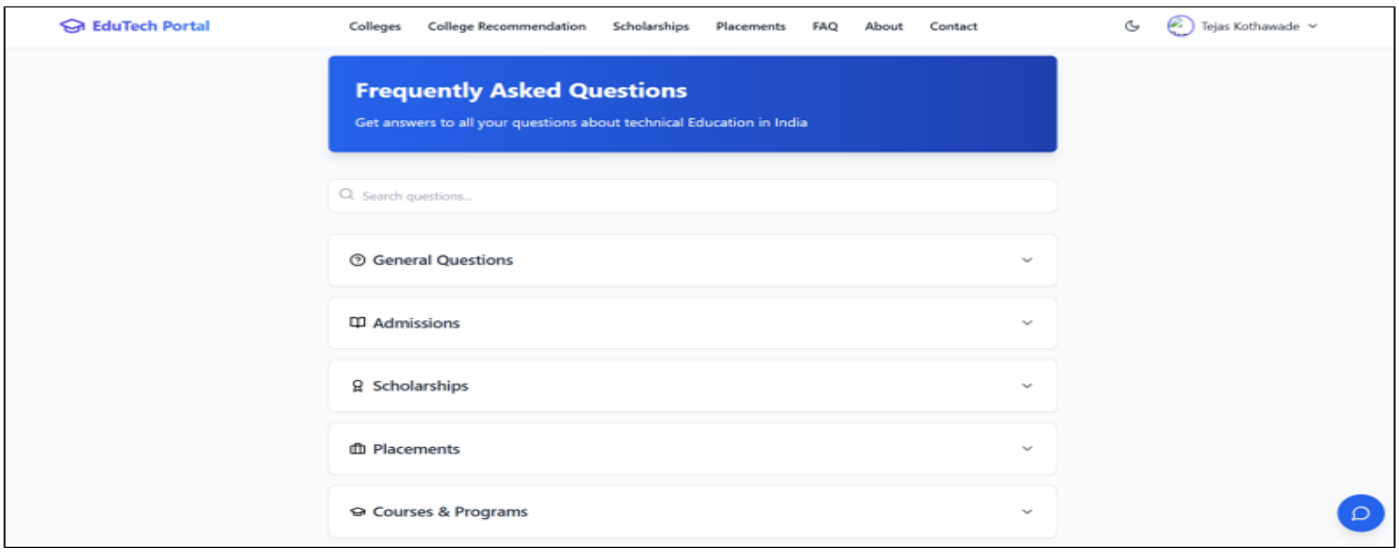

Fig 9 FAQ

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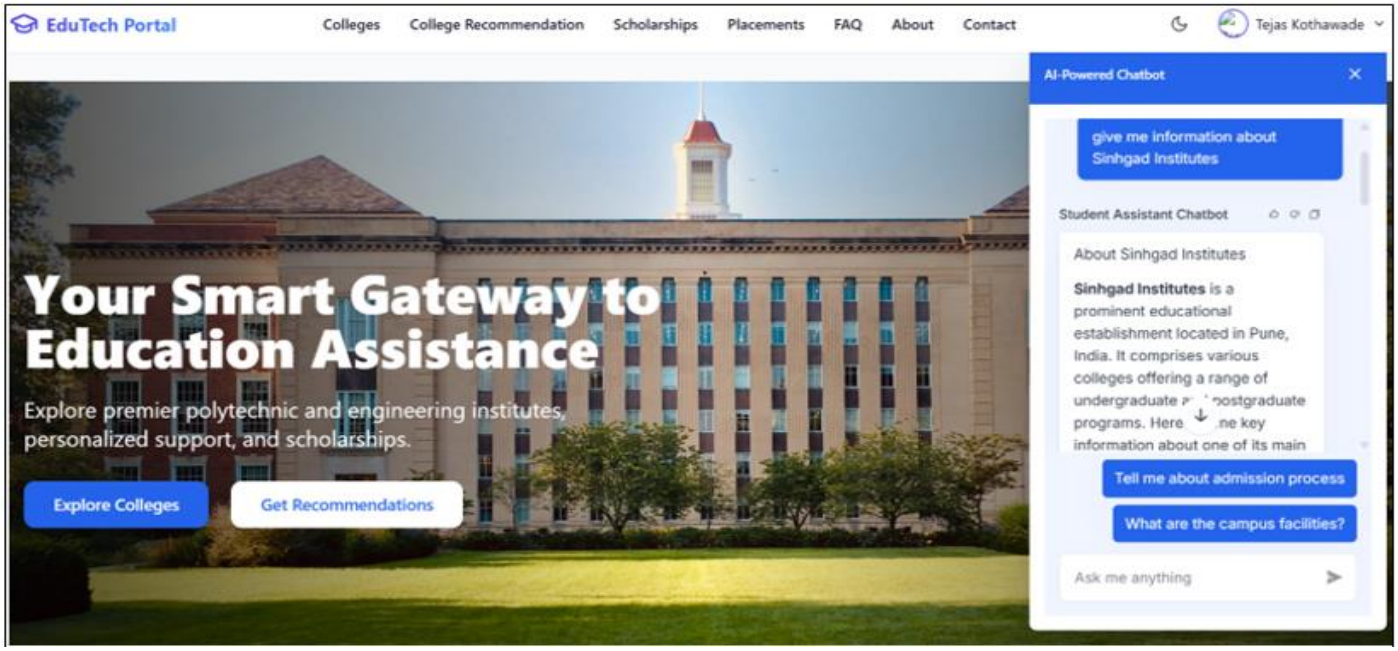

Fig 9 Working of Chatbot

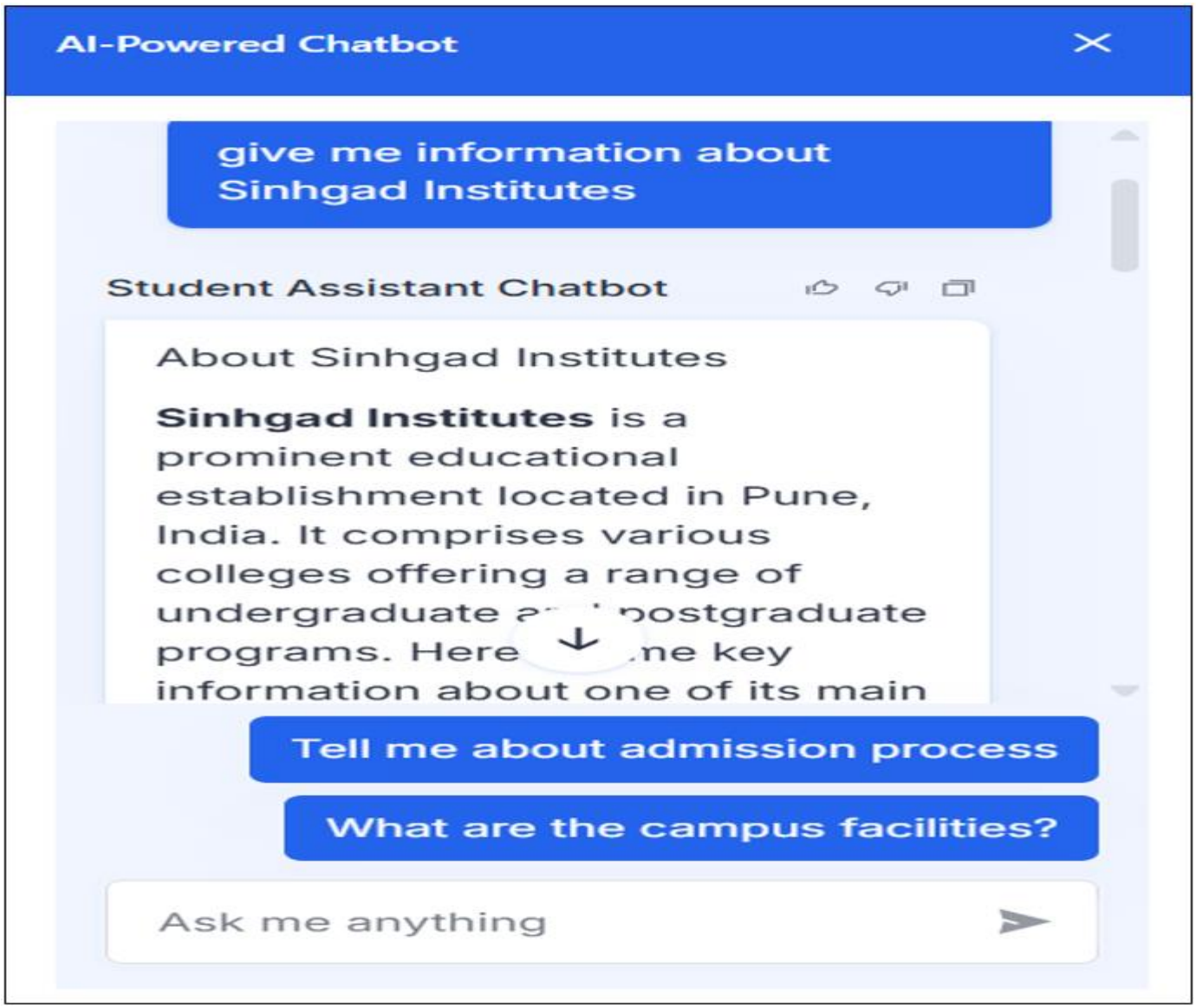

Fig 10 Chatbot Preview

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25may390

IX. CONCLUSION

The AI-based student assistant chatbot provides a unified platform for addressing admission-related queries in engineering and polytechnic institutes. It automates responses to FAQs on admissions, fees, scholarships, and placements, making information more accessible and reducing staff workload. With support for multiple languages and devices, its NLP-driven interface ensures smooth, user-friendly communication. Additionally, it offers valuable data insights to the Department of Technical Education for ongoing service improvement.

FUTURE WORK

The AI-based student assistant chatbot can be expanded to offer academic support like exam updates, internships, and career guidance. Real-time integration with institutional systems enables alerts on seat availability, deadlines, and admission status. Voice and multilingual support increase accessibility for diverse users. Personalized responses based on student profiles improve relevance. It can also predict trends, manage post-admission queries, and engage alumni through events or mentorship. Multi-platform deployment, including apps and messaging services, ensures broader reach and ease of use.

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