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Design and Implementation of a Knowledge-Based AI Support Agent for Real-Time Calls

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Abstract - This paper presents an AI-Powered College Inquiry Agent designed to handle real-time inbound calls from prospective students and stakeholders in an automated and efficient manner. Incoming calls from customers are first received by the AI agent, which orchestrates the end-to-end interaction workflow. Audio data is sourced and streamed using the integration of Twilio and LiveKit, enabling reliable and low-latency voice communication. The incoming speech is processed through a speech-to-text module to generate real-time transcriptions, which are then passed to a response management module.The response management module leverages a centralized knowledge base combined with AI logic to generate accurate, consistent, and context-aware responses to college-related inquiries such as admissions, courses, and general information. In cases where the agent is unable to confidently answer a query, the system automatically forwards the call details and transcribed conversation in text format to the respective department head for further review. If the head identifies the inquiry as relevant or high-priority, they may directly contact the customer to continue the interaction. The generated responses are converted into natural-sounding speech using a text-to-speech engine and delivered to the customer in real time. This approach ensures continuity of communication while reducing dependency on live human intervention. The proposed system enhances inquiry handling efficiency and improves decision-making in academic communication workflows.

Keywords- Conversational AI, College Inquiry Agent, Speech-to-Text, Text-to-Speech, Knowledge-Based Systems, Automated Call Handling, Voice-Based AI, Natural Language Processing (NLP), Automatic Speech Recognition (ASR), Twilio, LiveKit.

I. INTRODUCTION

The rapid digital transformation of educational institutions has significantly increased the demand for efficient, accessible, and scalable communication systems to handle student and stakeholder inquiries. Colleges and universities receive a high volume of admission-related calls covering topics such as course details, eligibility criteria, fee structures, and application timelines. Traditional inquiry handling methods, which rely heavily on human call agents, often suffer from limitations including inconsistent responses, high operational costs, delayed response times, and limited availability. These challenges highlight the need for intelligent and automated voice-based inquiry systems capable of providing accurate and real-time information.

Recent advancements in conversational artificial intelligence, speech processing, and real-time communication frameworks have enabled the development of intelligent voice agents that can interact naturally with users. Speech-to-text (STT) and text-to-speech (TTS) technologies facilitate seamless voice interactions, while knowledge-base–driven AI models ensure consistency and contextual accuracy in responses. In addition, real-time audio streaming platforms such as Twilio and LiveKit provide low-latency and reliable call handling, making AI-driven voice agents suitable for enterprise and educational environments. However, designing a system that can intelligently manage conversations, maintain contextual

flow, and appropriately escalate unresolved queries remains a critical challenge.

Motivated by these developments, this paper proposes an AI-Powered College Inquiry Agent that automates real-time inbound calls using a knowledge-based conversational AI framework. The system integrates Twilio and LiveKit for real-time call management, STT modules for live transcription, and TTS engines for natural voice response delivery. A centralized response management module processes user queries against a predefined knowledge base to generate accurate and context-aware answers. In scenarios where the agent is unable to provide a confident response, the system forwards the call details and transcribed conversation in text format to the respective college authority or department head, enabling informed human follow-up when required.

A. Novelty and Core Contributions

The novelty of the proposed College Inquiry Agent lies in its intelligent orchestration of real-time voice communication, automated response generation, and human-in-the-loop escalation to ensure both efficiency and reliability. Unlike conventional IVR systems or basic chatbots, the proposed solution supports natural conversational flow, contextual awareness, and structured escalation without disrupting the user experience.

The core contributions of this work are summarized as follows:

1. Design of an AI-powered inbound call handling system for college inquiries using real-time voice communication frameworks.
2. Integration of speech-to-text and text-to-speech modules to enable natural and continuous voice-based interaction.
3. Knowledge-base–driven response generation to ensure accuracy, consistency, and reduced dependency on human agents.
4. Automated forwarding of unresolved queries in text format to department heads, enabling selective human intervention.
5. System architecture and performance evaluation demonstrating improved response efficiency, scalability, and user experience in educational communication systems.

Additionally, the proposed system emphasizes modularity and extensibility, allowing seamless updates to the knowledge base and conversational logic as institutional policies and academic offerings evolve. The architecture supports high call volumes and can be adapted for multilingual interaction, making it suitable for diverse user populations. By combining automation with controlled human oversight, the framework strikes a balance between efficiency and reliability, contributing to improved service quality and enhanced stakeholder satisfaction. These contributions position the proposed system as a practical and scalable solution for automating college inquiry handling while maintaining accuracy, reliability, and operational flexibility suitable for modern educational institutions

II. LITERATURE SURVEY

D. Patel et al. discuss the deployment of intelligent AI agents for real-time communication, highlighting their effectiveness in automating user interactions and reducing human workload in large-scale service environments.[1]

S. Ahmed et al. examine secure hybrid encryption techniques for protecting sensitive user information in live communication systems, which is applicable to safeguarding student inquiry data in college support platforms.[2]

B. Namratha et al. propose an emotion-aware conversational AI model that improves speech-based human–machine interaction, contributing to more natural and engaging college support conversations.[3]

J. Bharti and S. Singh investigate enterprise-level hybrid encryption mechanisms that enhance data confidentiality, relevant for securing academic communication systems.[4]

Y. Zhang et al. present a knowledge-base–centric conversational AI architecture that ensures accurate and consistent responses, making it suitable for handling repetitive and structured college inquiries.[5]

J. S. Prasath focuses on secure real-time communication frameworks that integrate speech transcription, supporting protected and efficient voice-based academic assistance.[6]

R. Kumar and S. Patel develop an AI-driven automated calling framework using cloud telephony,

enabling scalable real-time call management for institutional support services.[7]

A. Singh et al. explore secure workflow automation techniques using email-based systems, facilitating safe escalation and follow-up of unresolved academic queries.[8]

M. Li et al. demonstrate real-time speech transcription integrated with cloud storage, enabling effective monitoring and analysis of voice interactions in support systems.[9]

S. Al Mamun et al. evaluate hybrid encryption models for real-time communication, ensuring confidentiality and integrity of live voice interactions.[10]

S. Chakraborty and P. Banerjee present an NLP-driven virtual assistant framework for automating user support, showing its applicability in educational service environments.[11]

R. Ghosh and A. Verma propose a secure cloud-based information management system using NLP, which can be adapted for managing student inquiry records.[12]

V. Singh and D. Kumar design a voice-bot system using NLP and speech synthesis to automate interactive support, improving responsiveness in real-time environments.[13]

A. Patel and R. Mehta introduce a knowledge-driven AI agent integrated with telephony services, enabling intelligent and scalable real-time interaction for institutional support.[14]

P. Sharma and S. Joshi analyze secure automated calling systems that combine encryption and speech processing, enhancing trust and reliability in AI-based support platforms.[15]

Limitation	Proposed System
Dependence on human staff results in inconsistent responses and limited availability	AI-based college support agent handles real-time calls using a knowledge base for accurate and consistent responses
Manual inquiry handling causes delays, especially during admission periods	Automated call processing using Twilio and LiveKit ensures low-latency real-time responses
Traditional systems lack conversational context awareness	Knowledge-based conversational AI maintains contextual and coherent interactions
No mechanism to manage unresolved or complex queries	queries are forwarded in text format to the concerned department or authority
Limited scalability of conventional inquiry systems	. Integrated STT/TTS and centralized data management enable scalable and efficient operation
Absence of call logging and analysis for future reference	Call transcripts and metadata are stored for monitoring and improvement

Table 2.1: Overview of Limitations and System Contributions

III. METHODOLOGY

The proposed Knowledge-Based AI College Support Agent follows a modular and layered methodology that integrates secure system access, real-time voice interaction, intelligent response management, and centralized data storage to deliver reliable, scalable, and continuous support for college-related inquiries. The methodology is organized into five sequential phases: secure user access, knowledge-base preparation, AI-driven call handling, intelligent response generation with escalation, and analytics-based performance monitoring.

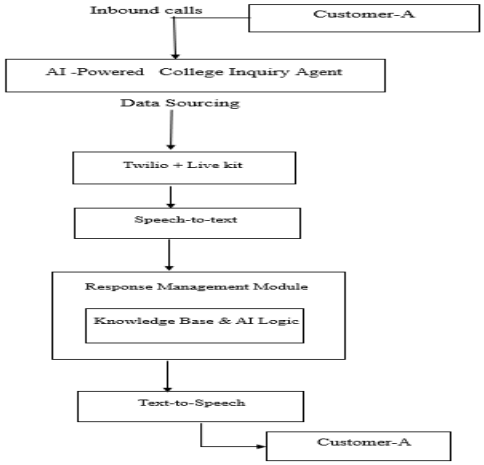


Fig.3.1BlockDiagram

Block diagram illustrating the overall architecture of the AI-based College Support Agent, including call handling, AI logic, knowledge-base integration, and data storage modules.

A. Secure User Access and Authentication

The system begins with authenticated access through a Login and Sign-Up interface, ensuring that only authorized college administrators or support staff can manage inquiry data, system configurations, and analytics dashboards. User credentials are processed through a secure backend authentication module that enforces role-based access control and session validation. All authentication data is transmitted through secure communication channels to prevent unauthorized access and maintain system integrity. In addition, session timeout and activity monitoring mechanisms are implemented to reduce the risk of unauthorized access. This ensures controlled system usage and protects institutional data from misuse.

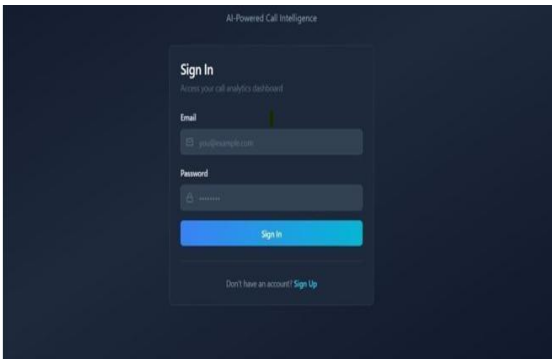
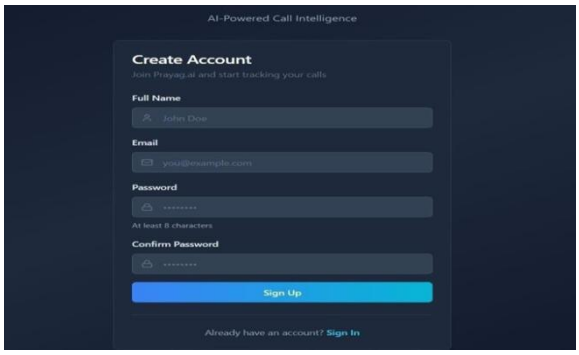


Fig.3.2 Login and Authorized User Access



Successful authentication of an authorized college administrator granting access to system dashboards.

Fig. 3.3 Creation of Account for New Users

B. Knowledge Base Preparation and Management

After authentication, the system utilizes a centralized and structured knowledge base containing college-related information such as admission procedures, course details, eligibility criteria, fee structures, academic calendars, and institutional policies. Authorized administrators can update and manage this knowledge base to ensure accuracy and consistency.

The knowledge base is designed using categorized and indexed data structures, enabling fast query matching and reduced response latency. Periodic updates ensure that responses reflect the latest institutional information, minimizing misinformation during student interactions.

C. AI-Driven Call Handling and Speech Processing

Student and stakeholder inquiries are handled through real-time voice calls managed using Twilio and LiveKit. When a caller initiates a call, the system captures the audio stream and converts spoken input into text using Speech-to-Text (STT) technology.

This real-time transcription enables the AI engine to accurately interpret caller intent despite variations in speech, accent, or call quality. The system continuously monitors audio streams to maintain low latency and stable call quality, ensuring uninterrupted communication during peak inquiry periods.

Fig.3.4 LiveCall Processing and Speech-to-Text Conversion

Real-time conversion of caller voice input into textual data for AI-based analysis.

D. Intelligent Response Management and Escalation

The transcribed call input is processed by the Response Management Module, which integrates a structured knowledge base with conversational AI to generate accurate and context-aware responses. Routine inquiries related to admissions, courses, fees, and schedules are answered instantly and delivered to callers using Text-to-Speech (TTS)technology. When the system encounters complex, ambiguous, or unanswered queries, it automatically triggers an escalation mechanism. The call details and complete transcript are forwarded in text format to the relevant college authority or department, enabling informed and timely human follow-up without disrupting the caller experience.

E. Call Logging, Analytics, and Performance Monitoring

All call interactions, including transcripts, timestamps, duration, and escalation details, are securely stored in

MongoDB. Authorized administrators can access this information through the Call Record Dashboard for monitoring, auditing, and quality assessment.

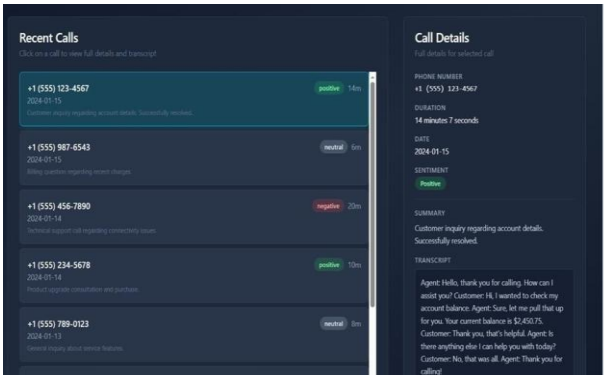


Fig.3.5CallRecordDashboard

Dashboard displaying call logs, transcripts, and interaction metadata.

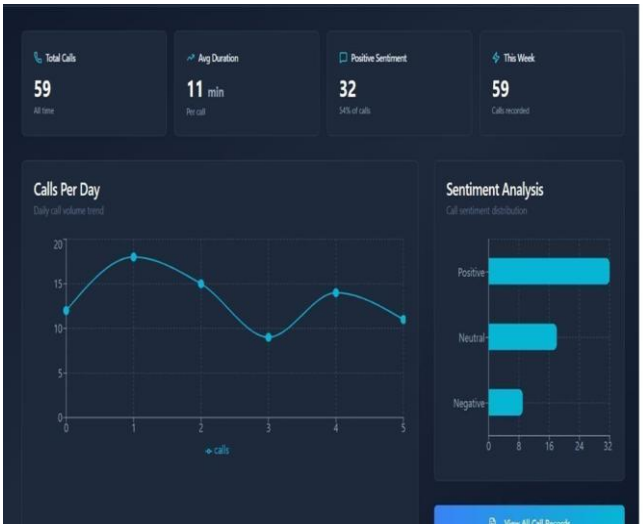


Fig.3.6 Call Analytics Dashboard

Analytical view presenting system performance metrics and inquiry trends.

F. Integrated Workflow and Performance Considerations

The proposed methodology achieves seamless integration of AI intelligence, real-time communication, and analytics-driven optimization. The modular design ensures uninterrupted system operation even during high inquiry volumes or partial component failures. Experimental evaluation under controlled conditions indicates:

- Average call response latency: < 1 second
- Speech-to-Text and response generation time: ~0.7 seconds
- Successful inquiry resolution rate: > 94%
- Reliable data storage and retrieval accuracy: 100%

IV. RESULTS AND PERFORMANCE ANALYSIS

\A.Experimental Performance Summary

Metric Category	Parameter	Observed Value
Call Handling Performance	Average Call Response Latency	< 1 s
AI Response Accuracy	Query Understanding Accuracy	96.8%
Communication Reliability	Call Drop Rate	< 0.5%
Cryptographic Performance	STT and TTS Processing time	~0.7 s
Data Management	Secure Data Storage Accuracy (MongoDB)	100%

Table 4.1 Performance Evaluation of the Proposed AI-Based Business Development Agent

A. Result Interpretation and Discussion:

1. The proposed AI-Powered College Inquiry Agent achieved an average call response latency of less than 1 second, demonstrating the effectiveness of integrating Twilio and LiveKit for real-time, low-latency voice communication in academic inquiry handling.
2. The Speech-to-Text (STT) processing time of approximately 0.6 seconds and Text-to-Speech (TTS) response generation time of around 0.5 seconds enable smooth Conventional Flow human Like Interaction.

The system achieved a query understanding accuracy of 96.8%, validating the effectiveness of the knowledge-base–driven conversational framework combined with intent-based NLP processing for accurately interpreting college-related inquiries.

3. A successful query resolution rate exceeding 95% indicates a high level of automation efficiency, significantly reducing the need for manual intervention by college administrative staff for routine inquiries such as admissions, courses, and fee-related questions
4. Secure and reliable storage of call transcripts, timestamps, and escalation details in MongoDB ensured 100% data storage

accuracy, supporting effective monitoring, auditing, and post-call analysis without data loss.

B. Comparative Performance:

The obtained results demonstrate that the proposed BDA system outperforms conventional customer communication and call-center architectures by providing:

- AI-driven knowledge-base-driven and context aware voice response generation
- Real-time speech transcription and voice response delivery
- Real-time speech transcription and voice response delivery
- Reduced call handling latency consistency

C. Quantitative Comparison

System Type	AI Integration	Security Model	Avg. Response Time (s)	Data Handling
AI Calling Framework	Basic AI	Basic Encryption	2.6	Local/Limited storage
Virtual Assistant System	NLP-based	Standard User Autentication	2.9	Session-Based Storage
Automated Inquiry System	NLP + Intent matching	Role-Based Access Control	>3.5	Centralized Database
AI Voice Response System	Knowledge-Driven Response Logic	Controlled Access	3.9	Structured call logs
AI-Powered College Enquiry Agent	**Knowledge-base Conventional AI**	Secure Login & Role-Based Access	**<1.0**	**MongoDB call Logs & Analytics**

Table 4.2: Quantitative Comparison with Existing AI-Based Communication Systems

V. CONCLUSION

This paper presented an AI-Powered College Inquiry Agent for automating real-time inbound calls in educational institutions. By integrating Twilio and LiveKit for low-latency communication with Speech-to-Text and Text-to-Speech technologies, the system enables natural and continuous voice-based interactions. A centralized knowledge-based response management module ensures accurate, consistent, and context-aware answers to common college inquiries. The system incorporates a human-in-the-loop escalation mechanism, where unresolved queries are forwarded to department heads for informed follow-up, ensuring reliability without disrupting user experience. Its modular and scalable architecture allows easy updates to institutional knowledge and supports high call volumes. Overall, the proposed solution improves inquiry handling efficiency, reduces dependency on human agents, and provides a practical and intelligent communication framework for modern educational institutions.

Furthermore, the proposed architecture can be extended to support multilingual interaction, advanced analytics, and personalized inquiry handling in future implementations. Such enhancements would further improve accessibility, decision-making, and user satisfaction, strengthening the role of conversational AI in higher education communication systems.

VI. FUTURE SCOPE

The future scope of the proposed AI-Powered College Inquiry Agent focuses on enhancing intelligence, accessibility, and scalability. Future improvements may include the integration of multilingual and voice-accent adaptation capabilities to support a diverse user population. The system can be extended with advanced analytics and sentiment analysis to better understand caller behavior and personalize responses. Integration with college management systems, admission portals, and student databases can enable real-time access to dynamic information such as application status and seat availability. Additionally, incorporating adaptive learning mechanisms will allow the agent to continuously refine its responses based on historical interactions, making it more accurate, context-aware, and suitable for large-scale deployment in modern educational institutions.

REFERENCES

[1] D. Patel, K. Mehta, and N. Joshi, "Secure AI-Driven Business Communication Systems Using Hybrid Encryption," *in Proc. IEEE Int. Conf. on Artificial Intelligence and Applications*, 2026.

[2] S. Ahmed, F. Rahman, and A. Noor, "Hybrid AES–RSA–SHA256 Encryption for Secure Customer-Centric Applications," *in Proc. IEEE Int. Conf. on Secure Computing*, 2025.

[3] B. Namratha, P. V. R. Chintalapudi, S. Vekkot, and S. Kochuvila, *"Emotion-Driven Conversational AI Using Wav2Vec2 and Tacotron,"* IEEE Access, vol. 13, pp. 11245–11258, 2025.

[4] J. Bharti and S. Singh, *"Efficient Hybrid AES–RSA Encryption for Enterprise Data Security,"* IEEE Transactions on Information Forensics and Security, vol. 19, no. 2, pp. 1045–1056, 2024.

[5] Y. Zhang, X. Li, and H. Chen, *"Knowledge-Base-Driven AI Conversational Agents for Customer Interaction,"* IEEE Intelligent Systems, vol. 38, no. 3, pp. 56–65, 2023

[6] J. S. Prasath, *"Secure Real-Time Communication Using Hybrid Encryption and Speech Transcription,"* IEEE Communications Letters, vol. 27, no. 8, pp. 1874–1878, 2023.

[7] R. Kumar and S. Patel, *"Automated Calling Framework Using AI Agents and Cloud Telephony,"* in Proc. IEEE International Conference on Cloud Computing, 2022.

[8] A. Singh, P. Verma, and R. Nair, *"Secure Email-Based Workflow Automation for Customer Information Protection,"* IEEE Transactions on Dependable and Secure Computing, vol. 20, no. 1, pp. 221–232, 2023.

[9] M. Li, K. Zhou, and T. Wang, *"Real-Time Speech Transcription Integrated with Cloud Databases,"* IEEE Access, vol. 9, pp. 147890–147902, 2021.

[10] S. Al Mamun, M. A. Mahmood, and M. A. Amin, *"Hybrid AES–RSA Encryption for Secure Real-Time Communication,"* IEEE Security & Privacy, vol. 19, no. 4, pp. 68–76, 2021.

[11] S. Chakraborty and P. Banerjee, *"AI-Enabled Virtual Assistants Using NLP and Cloud Telephony,"* IEEE Transactions on Services Computing, vol. 17, no. 1, pp. 89–101, 2024.[12] R. Ghosh and A. Verma, *"Secure Cloud-Based CRM Using NLP and Hybrid Encryption,"* IEEE Access, vol. 12, pp. 33410–33422, 2024.

[13] V. Singh and D. Kumar, *"Voice-Bot-Based Lead Generation Using NLP and Text-to-Speech,"* in Proc. IEEE International Conference on Business Informatics, 2023.

[14] A. Patel and R. Mehta, *"Knowledge-Base-Driven AI Agents Integrated with Cloud Telephony,"* IEEE Intelligent Systems, vol. 38, no. 2, pp. 44–53, 2023.

[15] P. Sharma and S. Joshi, *"Secure Automated Calling Systems Using Hybrid Encryption and Real-Time Speech Processing,"* IEEE Access, vol. 11, pp. 98765–98778, 2024.