

**GENERATIVE AI-BASED CHATBOT FOR
EMPLOYEE AND CUSTOMER SUPPORT
AUTOMATION IN LOLC COMPANY**

Project Id: RP25 – 036



Project Proposal Report

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**Bsc.(Hons) Degree In Information Technology Specialization in
Software Engineering.**

**Department of Information Technology
Sri Lankan Institute of Information Technology**

January 2025

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Declaration of the Candidate & Supervisor

I declare at this moment that the proposal I am presenting is entirely my work, and I have not incorporate, without paper acknowledgement, any materials previously submitted for a degree or diploma at any other university or institute of higher learning. This proposal does not contain any material previously published or written by another person, except where the appropriate acknowledgement has been made in the text.


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The Supervisor should certify the proposal report with the following declaration.

The candidate mentioned above are currently conducting research fo their undergraduate dissertation, under my supervision, As their supervisor, I certify this propsal report.


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List of Abbreviations

TTS – Text-To-Speech

STT – Speech-To-Text

NLP – Natural Language Processing

AI – Artificial Intelligence

CNN – Convolutional Neural Networks

RNN – Recurrent Neural Networks

Abstract

The advancement of artificial intelligence (AI) and natural language processing (NLP) has significantly transformed the way humans interact with technology, with chatbots emerging as a vital tool across various domains. This research focuses on the development of a cutting-edge 3D avatar chatbot that incorporates Text-to-Speech (TTS) and Speech-to-Text (STT) modules to deliver seamless, real-time interactions. The chatbot is designed to dynamically generate prompts based on user input, process the data through a knowledge base, and provide contextually relevant responses to the user.

A key innovation in this project is the integration of sentiment analysis and real-time emotion sensing, which enables the chatbot to adapt its responses and visual expressions to the emotional state of the user. Through the use of advanced emotion detection algorithms, the system will analyze vocal tone, facial expressions, and textual cues to adjust the avatar's gestures, expressions, and voice modulation, creating a highly engaging and empathetic interaction.

The 3D avatar will serve as a visual and interactive interface, enhancing user experience by offering human-like communication that bridges the gap between traditional conversational agents and immersive digital interactions. This research aims to explore and implement these capabilities with a focus on user-centric design, leveraging state-of-the-art technologies in AI, 3D modeling, and natural language understanding.

The proposed system is designed specifically for LOLC Financial Company, enhancing customer interactions through advanced AI and sentiment analysis. By integrating real-time emotional intelligence and supporting English with a Sri Lankan accent, the chatbot aims to improve user engagement and accessibility. This project redefines chatbot usability in the financial sector, creating an intelligent and emotionally responsive platform tailored to customer needs.

Key Terms: 3D Avatar, Text-to-Speech, Speech-to-Text, Sentiment Analysis, Emotion Sensing, Natural Language Processing, Human-Computer Interaction.

1. Introduction

1.1. Background

The rapid evolution of Artificial Intelligence (AI) and Natural Language Processing (NLP) has significantly transformed human-computer interactions, making chatbots integral to various industries. These conversational agents have moved beyond simple scripted responses to advanced systems capable of handling complex queries, providing personalized experiences, and improving efficiency in domains such as customer service, education, and healthcare. However, despite these advancements, traditional chatbot systems face several limitations in delivering meaningful, human-like interactions.

A key challenge lies in the lack of emotional intelligence in existing chatbot technologies. While modern chatbots excel at understanding and generating text-based responses, they often fail to recognize and adapt to the emotional states of users. This absence of empathy limits their ability to address sensitive situations, such as mental health support, personalized customer service, or adaptive learning environments. For example, a user seeking comfort during a stressful situation may find a generic or poorly timed response disengaging, further amplifying their frustration.

Another challenge is the absence of engaging visual interaction in most chatbot systems. Text-based or voice-only chatbots lack the human-like touch needed for immersive communication. Introducing 3D avatars capable of expressing emotions through facial expressions, gestures, and body language can bridge this gap by simulating real-world interactions. Such avatars can significantly enhance the user experience, making conversations more relatable, especially in applications requiring high user engagement, such as virtual therapy, online education, or interactive customer service.

Additionally, accessibility remains a pressing issue. Many chatbot systems are designed for text-based communication, excluding users with visual or literacy impairments. Incorporating Text-to-Speech (TTS) and Speech-to-Text (STT) modules enables voice-based interactions, ensuring inclusivity for users with diverse needs.

The integration of real-time sentiment analysis and emotion sensing represents a promising solution to these challenges. By analyzing user inputs—including facial expressions, vocal tones, and text sentiment—a chatbot can adapt its responses dynamically, creating a more empathetic and context-aware interaction. For instance, a chatbot in a healthcare setting could detect stress or frustration and adjust its tone and behavior to provide calm and reassuring guidance. Similarly, an educational chatbot could identify confusion and offer additional explanations to improve understanding.

In the context of these challenges, this research proposes the development of a 3D avatar chatbot equipped with TTS, STT, sentiment analysis, and emotion sensing. By merging visual interactivity, voice communication, and emotional intelligence, this system aims to redefine the boundaries of conversational AI. The ultimate goal is to address current limitations, enhance user satisfaction, and open new avenues for applications in healthcare, education, and customer service, where personalized and empathetic interactions are paramount.

1.2. Literature Review

The advancement of conversational AI has led to the development of various chatbot systems, each designed to address specific interaction challenges. However, the integration of 3D avatars, emotion sensing, and sentiment analysis remains underexplored, particularly in applications requiring human-like communication and empathetic interaction. This literature review examines relevant advancements in Text-to-Speech (TTS) and Speech-to-Text (STT) systems, sentiment analysis, emotion sensing, and 3D avatars to establish the foundation for this research.

1.2.1 Text-to-Speech (TTS) and Speech-to-Text (STT) Systems

TTS and STT technologies are cornerstones of voice-based interaction, enabling seamless communication between humans and machines. Text-to-Speech (TTS) systems convert textual data into synthesized speech, offering accessibility and convenience, especially for users with visual impairments or literacy challenges. Over time, TTS systems have evolved to produce more natural-sounding speech by incorporating advancements in prosody, intonation, and contextual understanding. Modern TTS solutions, such as Google's WaveNet and Amazon Polly, leverage deep learning models to improve the naturalness and expressiveness of synthesized voices, including support for multiple languages and accents. However, these systems often struggle to convey emotional nuance, limiting their ability to reflect or adapt to user sentiment effectively. This shortcoming reduces the perceived empathy and engagement in human-computer interactions.

Conversely, Speech-to-Text (STT) systems transcribe spoken words into text, enabling real-time processing of user input. Advanced STT models, such as Whisper by OpenAI and IBM Watson Speech to Text, utilize neural networks to achieve high transcription accuracy even in noisy environments or with diverse accents. These systems are particularly useful in scenarios requiring hands-free interaction or accessibility support. Despite their progress, STT systems still face challenges in recognizing speech accurately in the presence of background noise, handling overlapping speech, and understanding idiomatic expressions or colloquial phrases. Furthermore, their inability to capture the emotional tone of speech diminishes their effectiveness in applications requiring empathetic interaction.

The integration of TTS and STT systems into conversational agents has been transformative, yet these systems often operate in isolation without a seamless connection to emotion recognition. For instance, while TTS excels in generating speech, it cannot dynamically adjust its tone or cadence to match the emotional context of the interaction. Similarly, STT transcribes words but lacks the ability to analyze vocal tones that may indicate emotions such as frustration, joy, or sadness. Emerging research highlights the potential of combining these technologies with sentiment analysis to create emotionally aware systems that respond dynamically to user needs.

Moreover, tools like Google's TTS API and IBM Watson STT service have introduced features such as speaker diarization, voice activity detection, and real-time transcription, making them robust solutions for diverse environments. These platforms have also expanded their capabilities to include multilingual support and domain-specific customizations. However, for

emotionally intelligent applications, there is a need for further refinement to enhance their ability to recognize and convey emotions, particularly in real-time settings.

The proposed research seeks to address these gaps by embedding TTS and STT modules with sentiment analysis and emotion sensing capabilities. By leveraging advanced AI models, the system will enable dynamic modulation of voice output to reflect emotional context, while also improving speech recognition in complex, real-world environments. This integration aims to provide an empathetic and engaging experience for users, setting a new benchmark for conversational AI.

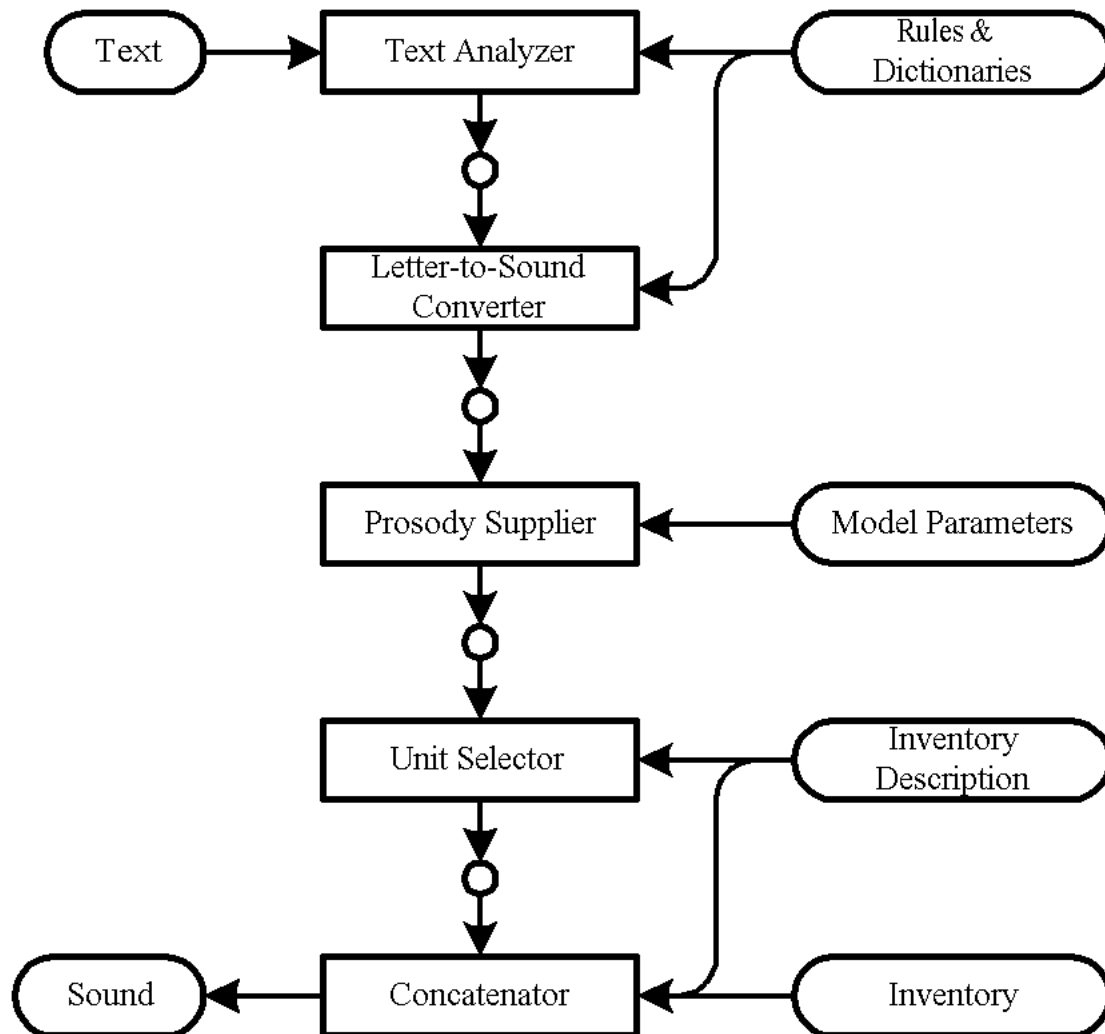


Figure 1 : TTS and STT System

1.2.2 Sentiment Analysis and Emotion Sensing

Sentiment analysis, a subset of NLP, determines the emotional tone of textual or spoken data. Techniques include rule-based approaches, machine learning models, and deep learning architectures such as BERT and GPT. Emotion sensing extends this by analyzing multimodal inputs, such as facial expressions, vocal tone to identify complex emotional states. Research in this area highlights the effectiveness of integrating voice analysis and facial recognition for emotion detection. For instance, studies using convolutional neural networks (CNNs) and recurrent neural networks (RNNs) have demonstrated high accuracy in detecting emotions from audio-visual inputs. Despite these advancements, real-time processing and the fusion of multimodal data remain key challenges, especially in dynamic conversational environments.

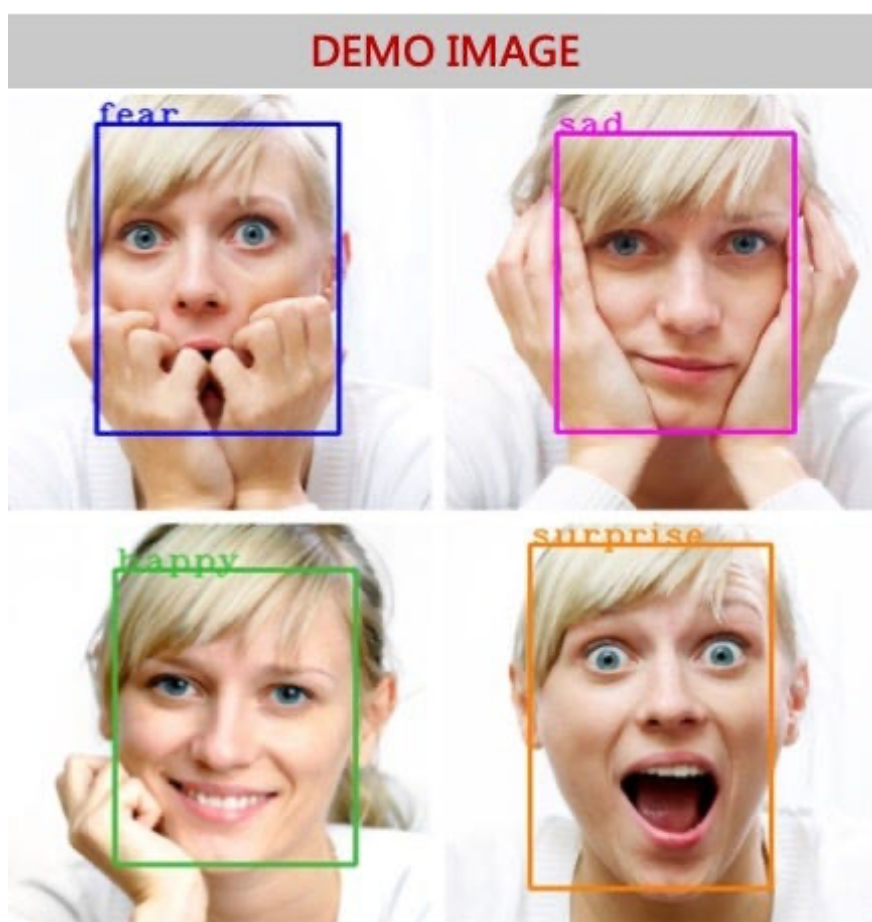


Figure 2 : Face emotion Detection

1.2.3 3D Avatar Integration in Chatbots

3D avatars add a visual and interactive dimension to chatbot systems, enabling human-like expressions and gestures. Research indicates that avatars with synchronized facial expressions and lip movements significantly enhance user engagement and trust. Technologies such as Unity 3D and Blender have been utilized to design realistic avatars, while frameworks like NVIDIA Omniverse offer tools for real-time animation. However, most existing systems lack the capability to adapt avatar behavior dynamically based on user emotions. Integrating sentiment analysis with 3D avatars can bridge this gap, creating emotionally intelligent virtual assistants capable of context-aware communication.



Figure 3 : Avatar Designing and facial expressions changing

2. Research Gap

Several chatbot systems have incorporated advanced NLP and AI features but fall short in combining emotional intelligence with 3D avatar technology. For instance, Microsoft Azure and Google Dialogflow provide robust NLP tools but do not natively support emotion sensing or avatar integration. Similarly, customer service bots and virtual assistants like Siri and Alexa focus on task completion rather than empathetic interaction. Research in healthcare and education has explored emotion-aware chatbots, but these are often limited to text or voice-based systems, lacking visual interaction through avatars.

Features	Research [1]	Research [2]	Research [3]	Proposed Solution
Real-Time Emotion Detection	✓	✗	✓	✓
Sentiment Analysis Integration	✓	✓	✗	✓
3D Avatar with Facial Expressions	✗	✓	✗	✓
Speech-to-Text (STT) & Text-to-Speech (TTS)	✗	✗	✓	✓
Lip-Syncing & Gesture Synchronization	✗	✗	✓	✓
Adaptive Responses Based on Emotion	✗	✗	✗	✓

Table 1 Research Gaps

Existing chatbot systems have limitations in delivering emotionally responsive, engaging, and immersive interactions. While previous studies have explored real-time emotion detection, sentiment analysis, and 3D avatars individually, they have not fully integrated these technologies into a unified system.

Table 1 highlights the research gaps addressed in this study. Prior research has implemented emotion recognition and sentiment analysis but lacks a fully synchronized 3D avatar capable of lifelike facial expressions, gestures, and real-time lip-syncing. Additionally, while Speech-to-Text (STT) and Text-to-Speech (TTS) technologies exist, they have not been effectively combined with emotion-adaptive responses in a chatbot system. Most significantly, no previous studies have developed such an advanced chatbot specifically for financial institutions like LOLC, where user engagement and intelligent interactions are crucial.

To bridge these gaps, the proposed system integrates real-time emotion detection, sentiment analysis, and synchronized 3D avatar animations with expressive facial and gestural responses. By merging these elements, the system enhances chatbot usability and effectiveness, making it particularly valuable for customer service, education, and financial assistance.

3. Research Problem

The development of emotionally intelligent 3D avatar chatbot systems presents multiple complex challenges that need to be addressed systematically. Current chatbot implementations, despite their advancement in natural language processing, still struggle with creating truly engaging and emotionally aware interactions. The primary research problem centers on developing a system that can seamlessly integrate real-time emotion detection, 3D avatar animation, and contextual response generation while maintaining natural conversation flow.

The first critical challenge lies in achieving accurate real-time emotion detection from multiple input streams. While existing systems can process individual emotional cues, combining facial expressions, voice tonality, and textual sentiment in real-time presents significant technical challenges. The system must process these inputs simultaneously while maintaining low latency and high accuracy, particularly challenging when dealing with subtle emotional nuances or mixed emotions.

Another fundamental problem is the creation of natural and appropriate avatar responses. The system must not only detect emotions but also translate them into realistic facial expressions and body language in the 3D avatar. This involves complex mapping between detected emotions and avatar animations, ensuring that the transitions between expressions appear smooth and natural rather than abrupt or mechanical. Furthermore, the avatar's voice modulation must align with both the emotional context and facial expressions, requiring sophisticated coordination between different system components.

The integration with knowledge base systems presents another significant challenge. The system must generate contextually appropriate responses while considering the emotional state of the user, requiring complex decision-making algorithms that balance factual accuracy with emotional appropriateness. This becomes particularly challenging when dealing with sensitive topics or emotional situations where the wrong response could negatively impact the user experience.

Additionally, the system faces the challenge of maintaining consistent performance across different user demographics, environmental conditions, and technical constraints. Factors such as varying lighting conditions, accents, cultural differences in emotional expression, and internet bandwidth limitations can significantly impact system performance. The research must address how to create a robust system that can adapt to these variables while maintaining reliable emotion detection and response generation.

Finally, the system must address privacy concerns and ethical considerations regarding emotion detection and data storage, particularly in applications involving sensitive user interactions or personal information. This includes developing appropriate data handling protocols and ensuring transparent user consent mechanisms while maintaining system effectiveness.

4. Objectives

4.1. Main Objective

The primary objective of this project is to develop an advanced 3D avatar-based conversational system that seamlessly integrates real-time sentiment analysis and emotion sensing capabilities to create more natural and empathetic human-computer interactions. The system will combine multiple technologies, including facial expression analysis and voice tone detection analysis, to accurately detect user emotions while simultaneously generating appropriate emotional responses through a realistic 3D avatar interface. This integration will incorporate a sophisticated combination of Text-to-Speech (TTS) and Speech-to-Text (STT) modules with support for South Asian English accents, emotion detection systems, and knowledge base integration. This will enable the avatar to engage in contextually relevant conversations while displaying appropriate facial expressions, gestures, and voice modulations that align with the emotional and cultural context of the interaction. The success of this system will be measured through its ability to accurately detect and respond to emotions in real-time, maintain natural conversation flow, and enhance overall user engagement, particularly for South Asian users.

4.2. Sub Objective

4.2.1. TTS and STT integration

Seamlessly integrate Text-to-Speech (TTS) and Speech-to-Text (STT) modules to enable natural, voice-driven interactions. This integration will allow the chatbot to deliver human-like speech and understand spoken commands or inquiries effectively. By employing advanced speech synthesis and recognition techniques, the system will ensure accurate and context-aware communication. The TTS module will generate clear and natural-sounding speech to improve user engagement, while the STT module will process user speech inputs in real-time, enabling a seamless conversational flow. This integration will also support multi-language capabilities, adaptive learning for accents or dialects, and customizable voice profiles, further enhancing accessibility and personalization. Together, these modules will create an intuitive and immersive user experience that mimics natural human communication.

4.2.2. 3D Avatar Design

The development of a visually engaging 3D avatar aims to revolutionize user interaction by integrating advanced technologies for dynamic facial expressions, gestures, and animations. This avatar will act as the visual representation of the chatbot, enhancing relatability and immersiveness in user experiences. Leveraging cutting-edge 3D modeling tools such as Blender, Maya, or Unity3D, the avatar will feature lifelike designs with customizable options to accommodate cultural and demographic diversity. Real-time rendering engines, like Unreal Engine or WebGL, will ensure seamless animations and fluid movements.

To synchronize facial expressions and gestures with chatbot responses, emotion detection and sentiment analysis algorithms will be integrated. These will utilize Natural Language

Processing (NLP) frameworks like Google's Dialogflow, Microsoft Bot Framework, or OpenAI's GPT to interpret the user's input and generate emotionally aware outputs. Facial expressions, such as smiles or frowns, and gestures, like nodding, will be dynamically rendered using tools like ARKit or DeepMotion.

Additionally, voice synthesis technologies like Amazon Polly or Google Text-to-Speech will provide realistic speech, while phoneme-based animation will ensure accurate lip-syncing. By bridging virtual communication and human interaction, this project fosters personalization and trust, making chatbot interactions feel natural, human-like, and empathetic. This innovative approach will redefine virtual assistance and elevate user engagement.

4.2.3. Emotion Sensing and Sentiment Analysis

Develop and implement algorithms that enable the chatbot to detect and analyze user emotions and sentiments in real-time. This involves using advanced Natural Language Processing (NLP) techniques and machine learning models to assess voice tone, facial expressions, and textual input. By analyzing the user's emotional state, the chatbot can dynamically adjust its responses to enhance user interaction and engagement.

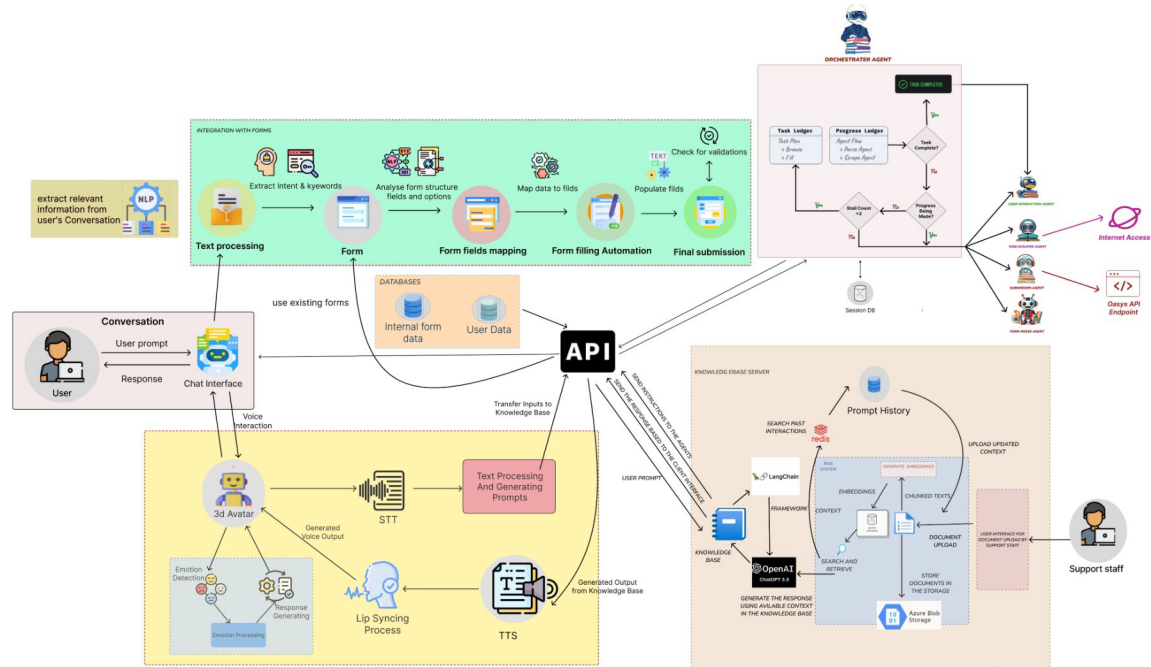
Voice tone analysis will identify cues such as pitch, volume, and cadence to infer emotional states like happiness, anger, or sadness. Facial expression detection will leverage computer vision technologies to recognize visual emotional indicators, such as smiles or furrowed brows. Textual sentiment analysis will process the user's language to identify positive, negative, or neutral tones within the conversation.

By integrating these modalities, the chatbot can respond empathetically and contextually, creating a more natural and personalized interaction. For instance, if frustration is detected, the chatbot might adopt a more patient tone and offer clear, step-by-step assistance. Conversely, detecting enthusiasm could lead to an equally energetic and engaging response.

This holistic approach ensures that the chatbot is not only reactive but also proactive in understanding and addressing the emotional and communicative nuances of the user, resulting in a more human-centric experience.

5. Methodology

5.1. Overall System Diagram



The development of the 3D avatar chatbot follows a systematic approach, ensuring seamless integration of Text-to-Speech (TTS), Speech-to-Text (STT), sentiment analysis, and real-time emotion sensing. The project begins with designing the system's overall architecture, comprising several interconnected components. These include a 3D avatar interface, TTS and STT modules for voice interaction, a sentiment analysis engine for text-based emotion detection, and an emotion-sensing module that processes multimodal inputs. A centralized backend, built using technologies such as Node.js or Python (e.g., Flask or FastAPI), will manage the data flow, coordinate components, and ensure efficient user interaction.

The core development phase focuses on building each component. The 3D avatar will be designed using tools like Unity 3D or Blender, offering lifelike facial expressions, synchronized lip movements, and dynamic gestures. The avatar's behavior will adapt in real time based on the user's emotional state. For voice interaction, TTS and STT modules will leverage robust APIs like Google Cloud TTS/STT or custom-trained models in TensorFlow or PyTorch to ensure natural and accurate voice conversion. Sentiment analysis will use advanced NLP models, such as BERT or GPT, fine-tuned to understand user emotions in textual inputs. Additionally, real-time emotion sensing will analyze voice tone using tools like Librosa and facial expressions with libraries like OpenCV or DeepFace, combining these modalities for an accurate emotional profile.

The chatbot's intelligence will be driven by a knowledge base, such as Rasa or Dialogflow, designed to process user queries and generate responses. These responses will be dynamically

adapted based on the user's detected emotions, creating a personalized and empathetic interaction. The knowledge base will be updated continuously to improve conversational accuracy and relevance.

Testing and optimization are critical phases, focusing on validating the system's accuracy and emotional responsiveness. Real-world scenarios will be simulated to measure performance metrics, including emotion detection accuracy, conversation flow, and user satisfaction. Feedback loops will refine system components to enhance overall functionality. Finally, the chatbot will be deployed on a cloud platform, ensuring accessibility and scalability for diverse applications. User evaluations will provide insights for further iterations, ensuring the system meets its goal of delivering an empathetic, visually engaging, and context-aware conversational experience.

5.2. Individual System Diagram

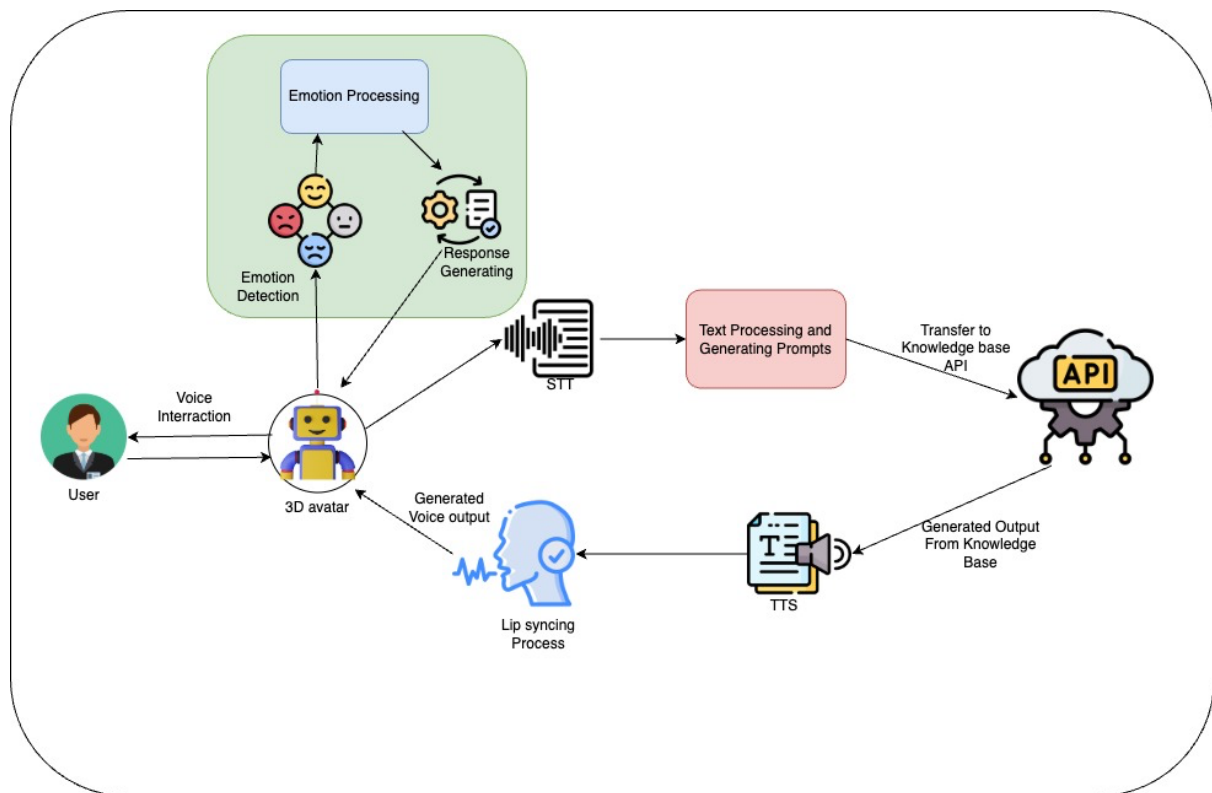


Figure 4: Individual System design

The system architecture of the 3D avatar chatbot represents an advanced conversational framework designed for natural and engaging interactions. The process begins with the user providing input, primarily through voice interaction. This interaction is captured by the 3D avatar, which serves as the visual interface of the system. The avatar offers a human-like representation, incorporating synchronized lip movements, gestures, and emotional expressions to create a realistic conversational experience.

The user's voice is processed through an **Emotion Detection module**, which analyzes the tone and context to identify emotional states such as happiness, sadness, or frustration. This emotion

data is passed to the **Emotion Processing and Response Generation module**, where it is utilized to craft responses that are empathetic and contextually appropriate. For instance, if a user expresses frustration, the system generates calming and reassuring responses to maintain a positive interaction.

Simultaneously, the user's speech is converted into text using the **Speech-to-Text (STT) module**. The generated text is then processed by the **Text Processing and Generating Prompts module**, which uses natural language understanding to interpret the user's intent. Based on the processed input, the module creates a relevant prompt and sends it to the **Knowledge Base API**. This API acts as a bridge, allowing the system to retrieve appropriate responses from a repository of information, which could include predefined answers, dynamically generated AI responses, or data from external integrations.

Once the knowledge base provides the necessary information, the response is converted back into speech using the **Text-to-Speech (TTS) module**. This generated speech output is synchronized with the 3D avatar's lip movements through the **Lip-Syncing Process**, ensuring that the visual and auditory elements are seamlessly aligned. This synchronization enhances the realism of the interaction, making the user experience immersive and engaging.

Finally, the 3D avatar delivers the response to the user, combining natural voice output, emotional intelligence, and synchronized gestures. This holistic approach ensures that the chatbot not only provides accurate answers but also maintains an empathetic and human-like interaction. The system's ability to detect emotions, process voice and text, and deliver visually synchronized responses makes it a cutting-edge solution for real-time conversational applications.

6. Software Specification

6.1. Functional Requirements

- Real-time STT and TTS capabilities.
- Emotion sensing and sentiment analysis.
- Interactive 3D avatar with facial expressions and gestures.
- Integration with a dynamic knowledge base.

6.2. Non-Functional Requirements

- **High System Responsiveness:** The system must exhibit minimal latency to ensure smooth and real-time interactions. A responsive chatbot ensures users feel engaged and satisfied without interruptions. This requires optimizing the system architecture, algorithms, and resource utilization to handle audio, text, and animation processing seamlessly.
- **Scalability for Handling Multiple User Interactions:** The chatbot must be capable of scaling to support concurrent interactions from multiple users without compromising performance. This involves employing cloud-based infrastructure, load balancing, and efficient database management to ensure the system remains robust under high traffic.
- **Accessibility for Users with Disabilities:** The system should adhere to accessibility standards to cater to users with various disabilities. Features such as adjustable text sizes, high-contrast visual elements, multi-language support, and customizable voice speeds will ensure inclusivity and ease of use for a diverse user base.
- **Security for User Data and Interactions:** Ensuring the confidentiality and integrity of user data is paramount. The system must implement strong encryption protocols, secure authentication mechanisms, and data anonymization to protect user interactions and personal information from breaches or unauthorized access.

6.3. Tools and Technologies

- **Programming Languages:** Python, JavaScript
- **Frameworks:** TensorFlow, PyTorch
- **3D Modeling Tools:** Blender, Unity
- **APIs:** Google Speech-to-Text, Amazon Polly
- **Database:** Firebase, MongoDB

7. Work Breakdown Structure

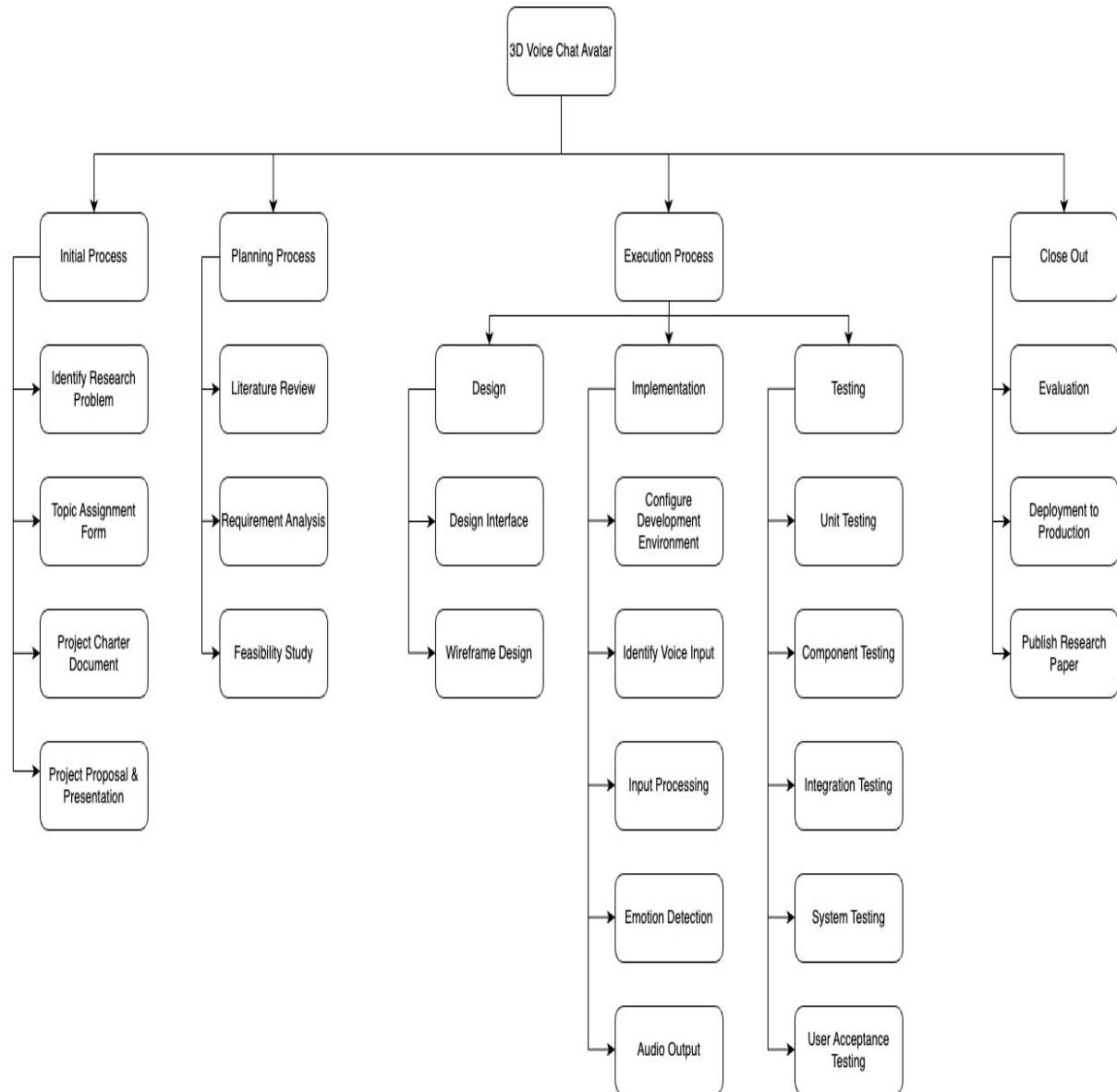


Figure 5: Work Breakdown Structure

8. Gantt Chart

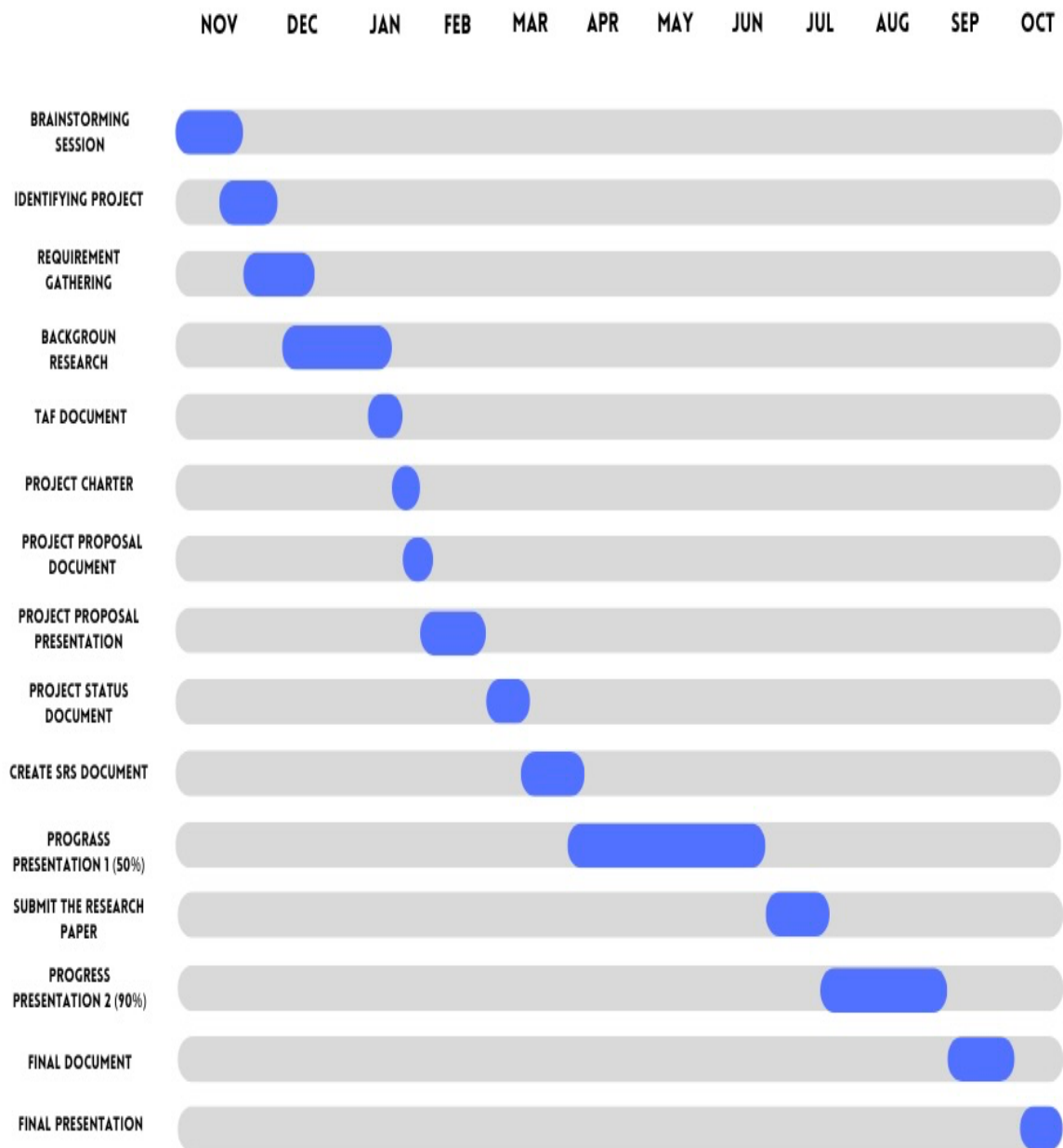


Figure 6: Gantt Chart

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