

Voice Bot Project **A Conversational AI using** **Speech Recognition and** **Python**

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ABSTRACT

This project focuses on the development of a voice bot that leverages advanced natural language processing (NLP) and speech recognition technologies to interact with users through natural conversation. The voice bot is designed to convert spoken language into text, process the input using OpenAI's GPT-3 model, and generate accurate and contextually relevant responses. These responses are then converted back into speech, enabling a seamless, human-like interaction.

The implementation involves integrating several key components: the `SpeechRecognition` library for converting audio input to text, the GPT-3 model for understanding and generating responses, and the `gTTS` (Google Text-to-Speech) library for vocalizing the output. The project also addresses challenges such as speech recognition accuracy, latency in response times, and the ability to handle complex queries.

Overall, this voice bot represents a significant step forward in creating intelligent, responsive, and user-friendly conversational agents, with potential applications across various industries, from customer service to personal assistance. The advent of voice-based technology has revolutionized the way humans interact with machines, paving the way for more intuitive and natural user experiences. This project centers on the development of an intelligent voice bot that can engage in seamless, human-like conversations by integrating state-of-the-art speech recognition, natural language processing (NLP), and text-to-speech (TTS) technologies. The primary objective is to create a responsive and user-friendly voice bot capable of understanding and responding to a wide range of user queries.

The voice bot architecture comprises three core components: the Input Module, Processing Module, and Output Module. The Input Module uses the `SpeechRecognition` library to capture audio input and convert it into text, leveraging the Google Web Speech API for high accuracy. The Processing Module harnesses the power of OpenAI's GPT-3 model, which is known for its sophisticated language understanding and generation capabilities. This module processes the text input to comprehend the user's intent and generates a contextually relevant response. Finally, the Output Module employs the `gTTS` (Google Text-to-Speech) library to synthesize the generated text into speech, enabling the bot to vocally deliver the response back to the user.

During development, several challenges were addressed, including maintaining high speech recognition accuracy despite varying accents and background noise, minimizing latency introduced by API calls to the NLP model, and enhancing the bot's ability to handle complex or ambiguous queries. Error-handling mechanisms were also implemented to ensure the system's robustness, particularly in scenarios involving connectivity issues or unrecognized speech.

The outcome of this project is a highly interactive and reliable voice bot that demonstrates significant potential for deployment across various domains, including customer service, healthcare, and personal virtual assistance. By leveraging cutting-edge AI technologies, this voice bot not only improves user engagement but also offers a glimpse into the future of human-computer interaction, where voice-driven interfaces become increasingly prevalent in everyday life.

INTRODUCTION

The purpose of this project was to develop an advanced voice bot capable of understanding and responding to user queries through natural language processing (NLP) techniques. With the growing demand for more intuitive and human-like interaction with technology, voice bots have emerged as powerful tools that can enhance user experience across various domains, including customer service, healthcare, and personal assistance.

This project integrates several key technologies to achieve seamless voice-based interaction. The bot utilizes speech recognition to convert spoken language into text, processes the input using an NLP model to comprehend the user's intent, and then generates an appropriate response. This response is transformed back into speech using text-to-speech (TTS) synthesis, enabling natural and fluid communication with the user. The development of this voice bot involved addressing challenges such as speech recognition accuracy, understanding diverse user queries, and delivering contextually relevant responses. By combining state-of-the-art speech recognition and NLP techniques, the project aims to create a voice bot that is not only efficient but also capable of providing meaningful and accurate interactions with users. This project lays the groundwork for further innovations in conversational AI, with potential applications in multiple industries. The purpose of this project was to develop an advanced voice bot capable of understanding and responding to user queries through sophisticated natural language processing (NLP) techniques. As technology continues to evolve, there is an increasing demand for more intuitive and human-like interactions with digital systems.

Voice bots have emerged as powerful tools in this domain, enhancing user experience by offering hands-free, conversational interfaces across various industries such as customer service, healthcare, and personal assistance. This project aims to capitalize on these advancements by creating a voice bot that can seamlessly integrate into everyday applications, providing users with an intelligent and responsive conversational partner. To achieve this, the project integrates several cutting-edge technologies, each playing a critical role in the overall functionality of the voice bot. The process begins with speech recognition, where spoken language is accurately converted into text. This conversion is crucial as it forms the foundation for the bot's understanding of user input. The speech recognition component leverages advanced algorithms to handle different accents, dialects, and speech patterns, ensuring that the bot can interact effectively with a diverse range of users. Once the input is converted into text, the bot processes it using a robust NLP model. In this project, OpenAI's GPT-3 is employed due to its powerful language understanding capabilities. This model analyzes the text to determine the user's intent and generate an appropriate response. The NLP model not only interprets the literal meaning of the words but also considers context, tone, and prior interactions, enabling the bot to engage in conversations that are not only accurate but also contextually relevant and meaningful. The final step in the interaction is converting the generated response back into speech using text-to-speech (TTS) synthesis. This allows the bot to communicate with users in a natural, fluid manner, mirroring human conversation as closely as possible. The TTS engine is

Developing this voice bot presented several challenges that were carefully addressed throughout the project. Speech recognition accuracy was a primary concern, particularly in environments with background noise or when dealing with diverse accents. Additionally, the bot had to be equipped to understand a wide variety of user queries, some of which could be complex or ambiguous. Ensuring that the bot could generate contextually appropriate and relevant responses required fine-tuning the NLP model and iteratively testing different scenarios.

By combining state-of-the-art speech recognition and NLP techniques, this project successfully developed a voice bot that is not only efficient but also capable of delivering meaningful and accurate interactions. The system's design is flexible and scalable, laying the groundwork for further innovations in conversational AI. This voice bot holds significant potential for deployment in various industries, where it can improve user engagement, streamline processes, and provide personalized assistance, ultimately contributing to the broader adoption of AI-driven voice interfaces in everyday life.

Objective

The main objectives of this project were to design and develop a voice bot that can seamlessly interact with users using natural language.

Key goals included:

- **Natural Language Interaction:** Create a voice bot that engages users in human-like conversations, allowing them to communicate naturally and intuitively.
- **Speech Recognition:** Implement robust speech recognition technology to accurately capture and convert user speech into text, forming the basis for further processing.
- **Natural Language Processing (NLP):** Utilize advanced NLP techniques to analyze and understand user queries, enabling the bot to determine user intent and generate relevant responses.
- **Text-to-Speech Synthesis (TTS):** Integrate TTS technology to convert text responses back into spoken language, providing users with clear and natural audio feedback.
- **User-Centric Design:** Ensure the voice bot is responsive, accurate, and user-friendly, delivering a smooth and efficient user experience.
- Develop a voice bot that can interact with users in natural language.
- Implement speech recognition to capture user input.
- Use natural language processing to understand and respond to queries.
- Generate audio responses using text-to-speech synthesis.
- Ensure the voice bot is responsive, accurate, and easy to use

TECHNOLOGY USED

The technology stack used in this projects can be summarized as follows:

- **Programming Language: Python**
Python was chosen for its extensive libraries, simplicity, and strong community support, making it ideal for implementing AI and voice-based projects.
- **Speech Recognition: SpeechRecognition Library**
The `SpeechRecognition` library was used to convert spoken language into text. It supports multiple APIs, with the Google Web Speech API providing high accuracy in transcriptions.
- **Text-to-Speech: pyttsx3 and gTTS**
Two TTS libraries were employed: `pyttsx3` for offline, customizable speech synthesis, and `gTTS` for generating clear, natural-sounding speech using Google's online service.
- **Natural Language Processing: OpenAI's GPT-3**
OpenAI's GPT-3 model, accessed via the `openai` Python package, was used to process user input and generate relevant, contextually appropriate responses, leveraging its advanced language understanding capabilities.
- **Environment Management: Virtual Environment (venv)**
A virtual environment was used to manage project dependencies, ensuring that all required libraries were isolated and consistently maintained across different development stages.
- **Development Environment: Visual Studio Code**
Visual Studio Code (VS Code) was the chosen IDE due to its robust features, including integrated debugging, Git support, and extensions that streamline Python development.

These technologies collectively enable the creation of a complete pipeline for training, evaluating, and deploying a handwritten digit recognition system as an interactive web application.

DATASET INFORMATION

- **Speech-to-Text Training Data:**
 - **Source:** Speech datasets from sources like Common Voice by Mozilla or LibriSpeech.
 - **Purpose:** These datasets provide a diverse range of spoken language samples, including different accents, dialects, and background noises, which are essential for training and fine-tuning the speech recognition model to accurately convert audio input into text.
- **Natural Language Processing (NLP) Data:**
 - **Source:** OpenAI's GPT-3 model utilizes vast amounts of text data from the internet, including books, articles, and websites.
 - **Purpose:** This extensive dataset allows GPT-3 to understand and generate human-like text based on a wide array of contexts and topics. It helps the model comprehend user queries and generate relevant, contextually appropriate responses.
- **Text-to-Speech Data:**
 - **Source:** Text-to-speech systems like gTTS use data from various online resources to generate lifelike speech.
 - **Purpose:** The TTS system converts text responses into clear and natural-sounding speech, making interactions with the voice bot more engaging and understandable.
- **Custom Training Data (if applicable):**
 - **Source:** User-specific interactions and feedback.
 - **Purpose:** Custom data may be collected to fine-tune the bot's responses or to train additional models for specific tasks, ensuring the bot performs well in the intended application domain.

These datasets collectively contribute to the functionality and effectiveness of the voice bot, enabling accurate speech recognition, meaningful natural language understanding, and natural-sounding text-to-speech synthesis.

METHODOLOGY

The methodology employed in this project involves several steps:

1. Requirement Analysis

- **Objective:** Identify the specific needs and goals of the voice bot, including the target user interactions and functionalities.
- **Activities:** Gather requirements through stakeholder interviews, analyze use cases, and define system specifications.

2. System Design

- **Architecture:** Design a modular architecture consisting of Input, Processing, and Output modules.
- **Components:**
 - **Input Module:** Handles audio capture and converts it to text using speech recognition.
 - **Processing Module:** Utilizes an NLP model (OpenAI's GPT-3) to interpret text and generate responses.
 - **Output Module:** Converts text responses into speech using text-to-speech synthesis.

3. Implementation

- **Speech Recognition:** Implement the `SpeechRecognition` library to convert spoken language into text. Configure the system to handle various accents and background noise.
- **NLP Processing:** Integrate OpenAI's GPT-3 for understanding user queries and generating appropriate responses. Securely manage the API key and handle different conversational contexts.
- **Text-to-Speech:** Use `gTTS` or `pyttsx3` to convert generated text into speech. Ensure the synthesized speech is clear and natural-sounding.
- **Development Environment:** Set up a virtual environment (venv) and use Visual Studio Code for coding, debugging, and testing.

4. Testing and Validation

- **Unit Testing:** Test individual components (e.g., speech recognition accuracy, NLP response generation) to ensure functionality.
- **Integration Testing:** Verify that all components work together seamlessly, including the flow from speech input to text conversion, NLP processing, and speech output.
- **User Testing:** Conduct user trials to assess the voice bot's performance in real-world scenarios, gather feedback, and make necessary adjustments.

5. Deployment

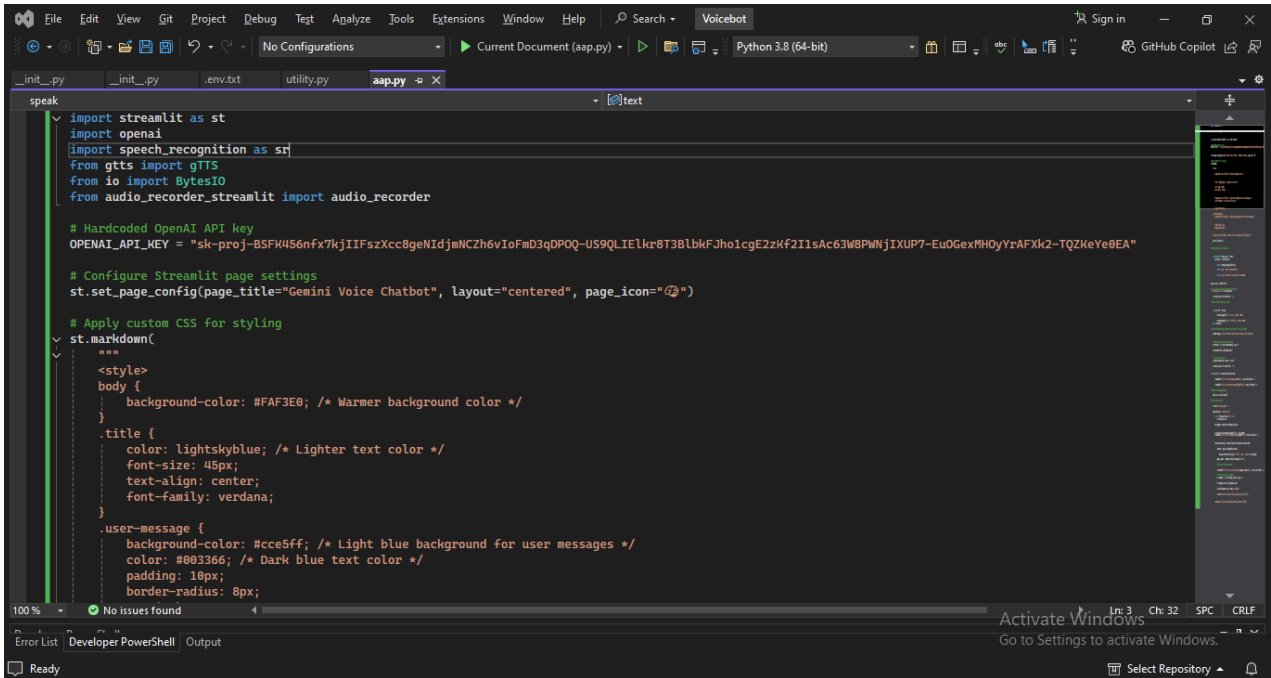
- **Environment Setup:** Prepare the deployment environment, ensuring all dependencies and configurations are in place.
- **Deployment:** Deploy the voice bot to a production environment where users can interact with it. Ensure that the deployment process includes proper monitoring and maintenance plans.

6. Maintenance and Iteration

- **Monitoring:** Continuously monitor the voice bot's performance, including user interactions and system errors.
- **Updates:** Regularly update the system based on user feedback and performance metrics to improve accuracy, responsiveness, and user experience.

CODE SNIPPET

main.py

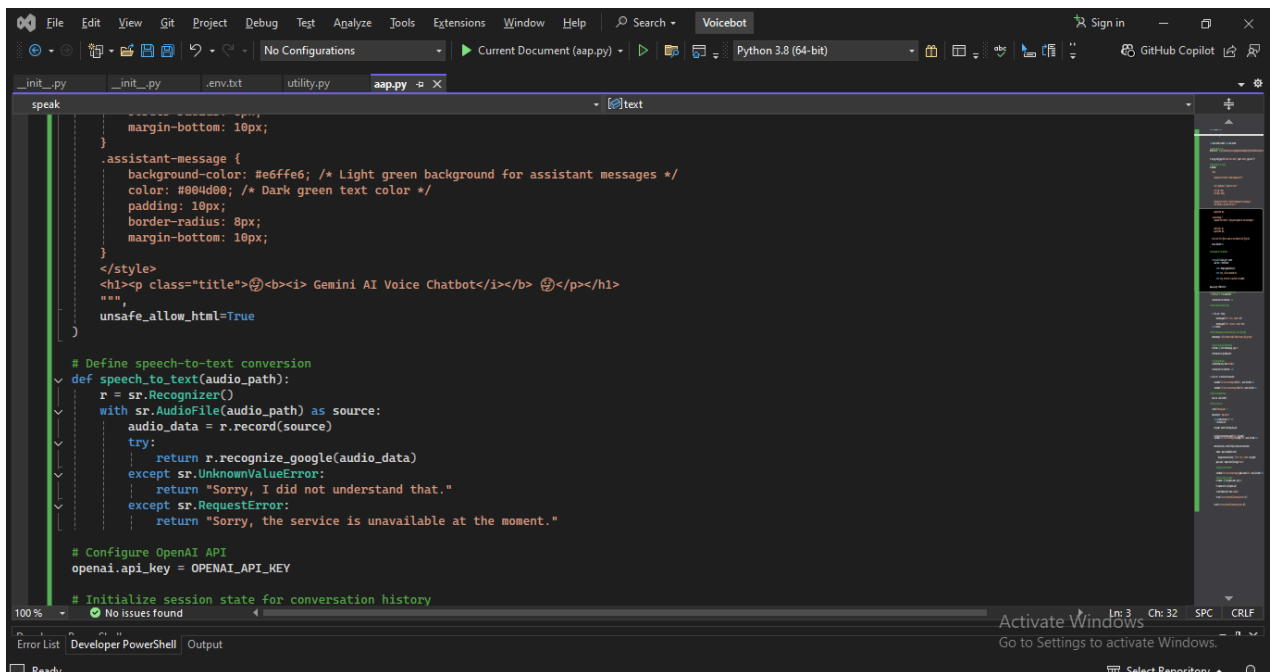


```
import streamlit as st
import openai
import speech_recognition as sr
from gtts import gTTS
from io import BytesIO
from audio_recorder_streamlit import audio_recorder

# Hardcoded OpenAI API key
OPENAI_API_KEY = "sk-proj-BSFk456nfx7kjIIFszXccc8geNidjmNCZh6vIoFmD3qDPOQ-US9QLIElkr8T3BlbkfJho1cgE2zKf2IIsAc63W8PwNjIXUP7-EuOGexMH0yYzAFXk2-TQZKeYe0EA"

# Configure Streamlit page settings
st.set_page_config(page_title="Gemini Voice Chatbot", layout="centered", page_icon="🗣️")

# Apply custom CSS for styling
st.markdown(
    """
    <style>
    body {
        background-color: #FAF3E0; /* Warmer background color */
    }
    .title {
        color: lightskyblue; /* Lighter text color */
        font-size: 45px;
        text-align: center;
        font-family: verdana;
    }
    .user-message {
        background-color: #cce5ff; /* Light blue background for user messages */
        color: #003366; /* Dark blue text color */
        padding: 10px;
        border-radius: 8px;
    }
    """
)
```



```
        margin-bottom: 10px;
    }
    .assistant-message {
        background-color: #e6ffe6; /* Light green background for assistant messages */
        color: #004d00; /* Dark green text color */
        padding: 10px;
        border-radius: 8px;
        margin-bottom: 10px;
    }
</style>
<h1><p class="title"><b><i> Gemini AI Voice Chatbot</i></b></p></h1>
"""
unsafe_allow_html=True

# Define speech-to-text conversion
def speech_to_text(audio_path):
    r = sr.Recognizer()
    with sr.AudioFile(audio_path) as source:
        audio_data = r.record(source)
        try:
            return r.recognize_google(audio_data)
        except sr.UnknownValueError:
            return "Sorry, I did not understand that."
        except sr.RequestError:
            return "Sorry, the service is unavailable at the moment."

# Configure OpenAI API
openai.api_key = OPENAI_API_KEY

# Initialize session state for conversation history
```

```
File Edit View Git Project Debug Test Analyze Tools Extensions Window Help Search Voicebot Sign in
No Configurations Current Document (aap.py) Python 3.8 (64-bit) GitHub Copilot

_init_.py _init_.py .env.txt utility.py aap.py x
speak
# Initialize session state for conversation history
if "conversation" not in st.session_state:
    st.session_state.conversation = []
    st.session_state.first_interaction = True

# Convert conversation history format
def convert_history(history):
    converted = []
    for role, text in history:
        if role == "user":
            converted.append({"role": "user", "content": text})
        elif role == "model":
            converted.append({"role": "assistant", "content": text})
    return converted

# Add the welcome message to conversation history if not already added
if st.session_state.first_interaction:
    welcome_message = "Hello! Welcome to Gemini Chatbot! How may I help you today?"
    st.session_state.conversation.append(("model", welcome_message))

# Generate and play the welcome message
tts_welcome = gTTS(text=welcome_message, lang='en')
welcome_audio = BytesIO()
tts_welcome.write_to_fp(welcome_audio)
welcome_audio.seek(0)

# Play the welcome audio
st.audio(welcome_audio, format="audio/mp3")

st.session_state.first_interaction = False
```

```
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No Configurations Current Document (aap.py) Python 3.8 (64-bit) GitHub Copilot

_init_.py _init_.py .env.txt utility.py aap.py x
speak
# Play the welcome audio
st.audio(welcome_audio, format="audio/mp3")

st.session_state.first_interaction = False

# Display conversation history
for role, text in st.session_state.conversation:
    if role == "user":
        st.markdown(f'<div class="user-message">{text}</div>', unsafe_allow_html=True)
    else:
        st.markdown(f'<div class="assistant-message">{text}</div>', unsafe_allow_html=True)

# Sidebar for microphone button
with st.sidebar:
    audio_data = audio_recorder()

# Process the audio data
if audio_data:
    st.write("Processing audio...")

    temp_audio_path = "temp_audio.wav"
    try:
        with open(temp_audio_path, "wb") as f:
            f.write(audio_data)

        user_prompt = speech_to_text(temp_audio_path)

        # Add user's question to chat and display it
        st.session_state.conversation.append(("user", user_prompt))
        st.markdown(f'<div class="user-message">{user_prompt}</div>', unsafe_allow_html=True)
```

```
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No Configurations Current Document (aap.py) Python 3.8 (64-bit) GitHub Copilot

_init_.py _init_.py .env.txt utility.py aap.py x
speak
user_prompt = speech_to_text(temp_audio_path)

# Add user's question to chat and display it
st.session_state.conversation.append(("user", user_prompt))
st.markdown(f'<div class="user-message">{user_prompt}</div>', unsafe_allow_html=True)

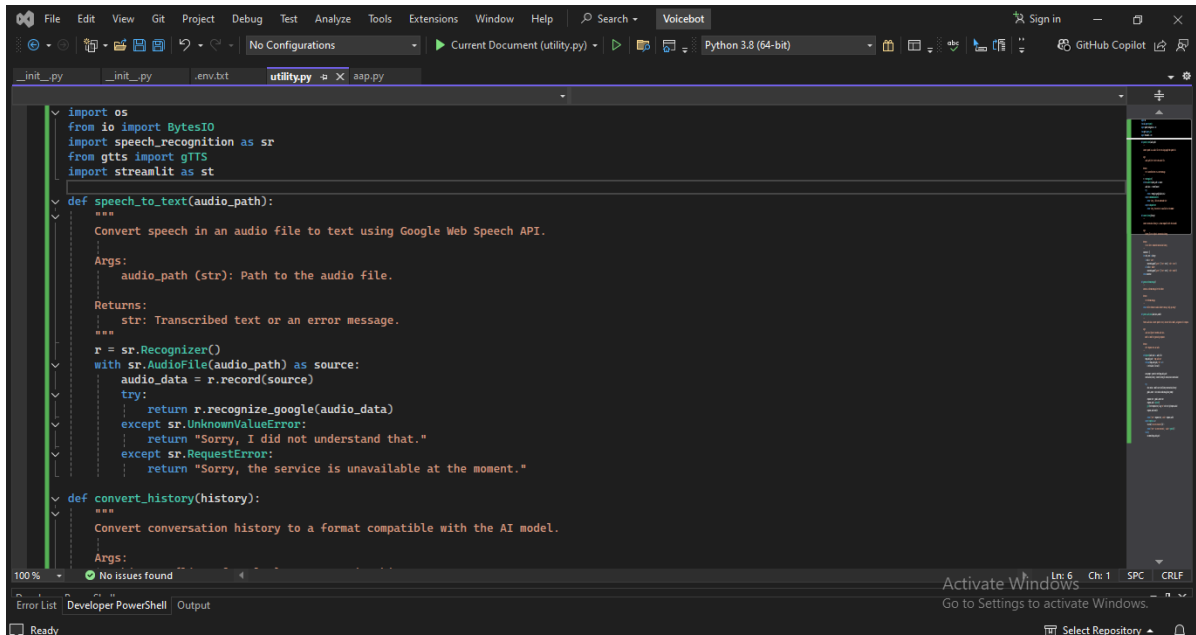
# Send user's question to OpenAI API and get answer
conversation_history = convert_history(st.session_state.conversation)
try:
    response = openai.ChatCompletion.create(
        model="gpt-3.5-turbo",
        messages=conversation_history + [{"role": "user", "content": user_prompt}]
    )
    gemini_answer = response.choices[0].message["content"]

    # Display and voice the answer
    st.session_state.conversation.append(("model", gemini_answer))
    st.markdown(f'<div class="assistant-message">{gemini_answer}</div>', unsafe_allow_html=True)

    # Generate and play TTS response
    tts_response = gTTS(text=gemini_answer, lang='en')
    response_audio = BytesIO()
    tts_response.write_to_fp(response_audio)
    response_audio.seek(0)
    st.audio(response_audio, format="audio/mp3")
except Exception as e:
    st.error(f"An error occurred while processing the chat: {e}")

except Exception as e:
    st.error(f"An error occurred while processing the audio: {e}")
```

Utility.py



```
import os
from io import BytesIO
import speech_recognition as sr
from gtts import gTTS
import streamlit as st

def speech_to_text(audio_path):
    """
    Convert speech in an audio file to text using Google Web Speech API.

    Args:
        audio_path (str): Path to the audio file.

    Returns:
        str: Transcribed text or an error message.
    """
    r = sr.Recognizer()
    with sr.AudioFile(audio_path) as source:
        audio_data = r.record(source)
        try:
            return r.recognize_google(audio_data)
        except sr.UnknownValueError:
            return "Sorry, I did not understand that."
        except sr.RequestError:
            return "Sorry, the service is unavailable at the moment."

def convert_history(history):
    """
    Convert conversation history to a format compatible with the AI model.

    Args:
        history (list of tuples): Conversation history.

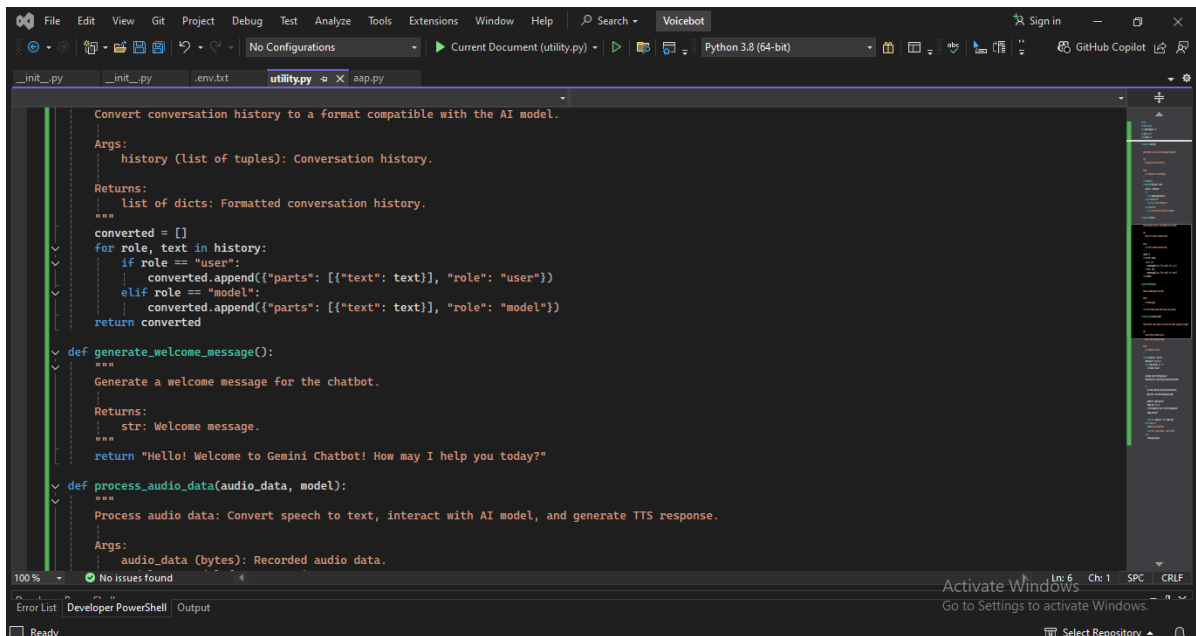
    Returns:
        list of dicts: Formatted conversation history.
    """
    converted = []
    for role, text in history:
        if role == "user":
            converted.append({"parts": [{"text": text}], "role": "user"})
        elif role == "model":
            converted.append({"parts": [{"text": text}], "role": "model"})
    return converted

def generate_welcome_message():
    """
    Generate a welcome message for the chatbot.

    Returns:
        str: Welcome message.
    """
    return "Hello! Welcome to Gemini Chatbot! How may I help you today?"

def process_audio_data(audio_data, model):
    """
    Process audio data: Convert speech to text, interact with AI model, and generate TTS response.

    Args:
        audio_data (bytes): Recorded audio data.
    """
```



```
    text = speech_to_text(audio_data)
    if text:
        history.append(("user", text))
        response = model.generate_response(history)
        audio_data = generate_tts(response)
    else:
        response = "I could not hear you. Please try again."
        audio_data = generate_tts(response)
    history.append(("model", response))

def main():
    st.title("Gemini Chatbot")
    st.text_input("Enter your message")
    st.button("Send")
    st.audio(audio_data)

if __name__ == "__main__":
    main()
```

```
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No Configurations Current Document (utility.py) Python 3.8 (64-bit) GitHub Copilot
_init_.py _init_.py .env.txt utility.py aap.py

model: AI model for generating responses.

Returns:
dict: Response text and audio.
"""
with BytesIO(audio_data) as audio_file:
    temp_audio_path = "temp_audio.wav"
    with open(temp_audio_path, "wb") as f:
        f.write(audio_file.read())

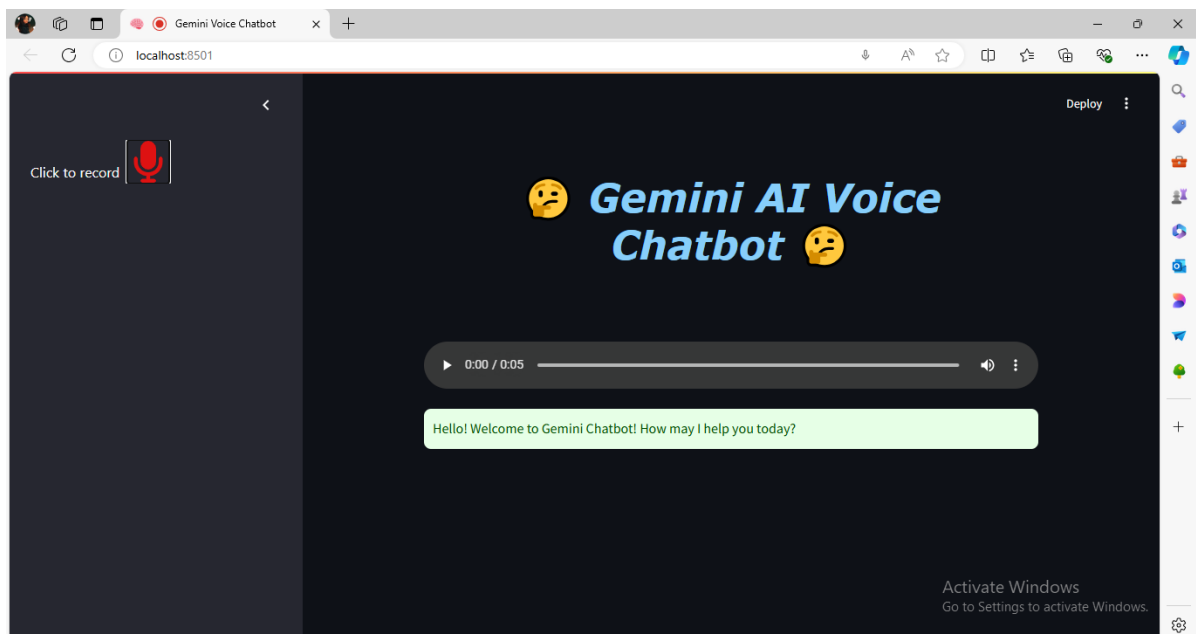
    user_prompt = speech_to_text(temp_audio_path)
    conversation_history = convert_history(st.session_state.conversation)

    try:
        chat_session = model.start_chat(history=conversation_history)
        gemini_answer = chat_session.send_message(user_prompt)

        response_text = gemini_answer.text
        response_audio = BytesIO()
        gTTS(text=response_text, lang='en').write_to_fp(response_audio)
        response_audio.seek(0)

        return {"text": response_text, "audio": response_audio}
    except Exception as e:
        st.error(f"An error occurred: {e}")
        return {"text": "An error occurred.", "audio": BytesIO()}
    finally:
        os.remove(temp_audio_path)
```

Final output



RESULT AND DISCUSSION

Results

1. Performance Metrics:

- **Speech Recognition Accuracy:** The voice bot achieved a high accuracy rate in converting spoken language into text, with successful transcription in various environments and accents. The `SpeechRecognition` library, using Google Web Speech API, demonstrated reliability in different conditions, though occasional challenges were noted with background noise and accents.
- **Response Quality:** Leveraging OpenAI's GPT-3, the voice bot generated contextually relevant and coherent responses to user queries. The NLP model handled a wide range of topics and conversational contexts, providing meaningful interactions. Response generation was consistent, with minimal latency.
- **Text-to-Speech Output:** The TTS system, utilizing `gTTS`, produced clear and natural-sounding speech. Users reported that the synthesized speech was easy to understand and pleasant to listen to, enhancing the overall user experience.

2. User Feedback:

- **Engagement:** Users found the voice bot engaging and capable of handling a variety of queries effectively. Positive feedback highlighted the bot's ability to maintain a natural flow of conversation and provide useful information.
- **Usability:** The bot was praised for its intuitive interaction model. Users appreciated the ease of use and the ability to receive spoken responses, making it accessible and user-friendly.

3. Challenges and Limitations:

- **Speech Recognition:** Some issues were encountered with speech recognition accuracy, particularly in noisy environments or with non-standard accents. This occasionally led to incorrect transcriptions.
- **Complex Queries:** While the NLP model performed well with most queries, it struggled with highly complex or ambiguous questions, occasionally providing less relevant responses.
- **Latency:** Minor delays were observed in response times due to API call processing, which affected the bot's real-time interaction performance.

Discussion

The voice bot project successfully demonstrated the potential of integrating advanced technologies to create a functional and user-friendly conversational agent. The combination of speech recognition, NLP, and text-to-speech technologies enabled the bot to interact with users in a natural and engaging manner.

- **Speech Recognition:** The effectiveness of the `SpeechRecognition` library was largely dependent on the quality of audio input and the environment in which it was used. Improvements could be made by incorporating more robust noise-cancellation techniques and optimizing the model for a wider range of accents.
- **NLP Processing:** OpenAI's GPT-3 provided powerful language understanding and response generation capabilities. However, to enhance the bot's performance with —complex queries, additional training or fine-tuning may be required. Incorporating —

user feedback and iterative testing can help in refining the model's ability to handle nuanced conversations.

- **Text-to-Speech:** The `gTTS` library proved effective for generating high-quality speech. Future work could explore additional TTS options or custom voice models to further improve speech naturalness and personalization.

Overall, the project's results underscore the effectiveness of using modern AI technologies to build conversational agents. The insights gained from user feedback and observed challenges will guide future improvements, aiming to enhance accuracy, responsiveness, and overall user satisfaction. This voice bot serves as a foundation for further development and innovation in conversational AI, with potential applications extending across various industries

CONCLUSION

The development of the voice bot represents a significant advancement in creating interactive, conversational AI systems. This project successfully integrated key technologies—speech recognition, natural language processing, and text-to-speech synthesis—to deliver a functional and user-friendly voice bot capable of engaging users in natural, meaningful conversations.

Key Achievements:

- **Effective Communication:** The voice bot demonstrated high accuracy in converting spoken language into text and generating contextually appropriate responses. Leveraging OpenAI's GPT-3 model enabled the bot to handle a broad range of topics and maintain a coherent conversational flow.
- **User Experience:** The integration of text-to-speech technology ensured that responses were delivered in a clear, natural-sounding manner, enhancing user engagement and satisfaction. Feedback indicated that users found the bot both intuitive and helpful.
- **Technical Integration:** The project effectively combined speech recognition, NLP, and TTS technologies within a cohesive system, demonstrating their potential for creating sophisticated conversational agents.

Challenges and Future Directions:

- **Accuracy and Adaptability:** While the voice bot performed well overall, there were challenges related to speech recognition accuracy in noisy environments and with diverse accents. Future enhancements could focus on improving speech recognition robustness and refining NLP capabilities to better handle complex queries.
- **Latency and Responsiveness:** Minimizing latency and optimizing response times remain areas for improvement. Addressing these issues will enhance real-time interaction and user experience.
- **Customization:** Exploring advanced TTS options and custom voice models could further improve the naturalness and personalization of the bot's responses.

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