Technologies & Libraries Used

Below is a detailed explanation of each library and its role in your application:

1. streamlit – Web App Framework

Purpose:

- Streamlit is used to create a user-friendly and interactive web app.
- It handles UI components like buttons, file uploaders, and text display.
- Provides session management (st.session_state) for navigation between pages.

Key Streamlit Functions Used:

- st.markdown() → Displays styled HTML and markdown text.
- st.session_state → Manages navigation across different pages.
- st.file_uploader() → Allows users to upload images.
- st.image() → Displays uploaded images.
- st.button() → Used for user interaction.
- st.spinner() → Displays a loading animation while the AI processes the image.
- st.success() & st.info() → Displays success and informational messages.

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2. google.generativeai – Google Gemini API

Purpose:

- This library connects to **Google Gemini AI**, a multimodal AI capable of **analyzing images and generating descriptions**.
- The model used: "gemini-1.5-flash" (a lightweight and fast version of Gemini).

Functions Used:

- gen_ai.configure(api_key="YOUR_API_BRO") → Configures the Gemini API with an API key.
- gen_ai.GenerativeModel("gemini-1.5-flash") → Initializes the AI model for generating responses.
- gen_ai.upload_file() → Uploads images to Gemini for analysis.
- gemini.generate_content([gemini_file, "Describe this image."]) → Requests a description from Gemini.

Why Google Gemini?

- Supports both text and image input.
- Fast inference speed with "gemini-1.5-flash".
- Can generate high-quality descriptions for educational purposes.

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3. PIL (Python Imaging Library) – Image Processing

□ Purpose:

- PIL (via from PIL import Image) is used to handle image files in Python.
- Opens and processes the uploaded image before sending it to Gemini.

□ Function Used:

- Image.open(image_path) → Loads the image for display.

□ Why PIL?

- Efficient image handling in Python.
- Works seamlessly with Streamlit.

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4. gTTS (Google Text-to-Speech) – Audio Generation

□ Purpose:

- Converts AI-generated text descriptions into **spoken audio**.
- Uses Google's **TTS engine** to generate an **MP3 file**.

□ Functions Used:

- gTTS(text=plain_text, lang='en') → Converts text to speech.
- tts.save(audio_file_path) → Saves the speech output as an MP3 file.

□ Why gTTS?

- Free and easy-to-use text-to-speech conversion.
- Supports multiple languages.

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5. base64 – Encoding Audio for Web Playback

Purpose:

- Since Streamlit does not have direct support for playing MP3 files, we encode the MP3 file using base64 and embed it in an <audio> HTML tag.

Functions Used:

- base64.b64encode(audio_bytes).decode('utf-8') → Converts MP3 file into a base64 string.
- <audio controls>...</audio> → Embeds the audio file in HTML for playback.

Why base64 encoding?

- Allows embedding audio directly in Streamlit without an external file link.

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6. OS – File Handling

Purpose:

- Handles **temporary storage** of images and audio files.
- Deletes files after use to free up disk space.

Functions Used:

- os.remove(audio_file_path) → Deletes the temporary audio file after encoding.
- os.remove(image_path) → Deletes the uploaded image after analysis.

Why Use Temporary Files?

- Saves storage space.
- Prevents unnecessary accumulation of files.

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7. re (Regular Expressions) – Text Processing

Purpose:

- Removes unwanted Markdown formatting (like *, _, ~) from AI-generated text before passing it to gTTS.

Function Used:

- re.sub(r"[*_~]", "", text) → Removes markdown characters.

Why Clean the Text?

- AI responses might contain Markdown styling, which could interfere with speech synthesis.

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8. datetime – Timestamp Handling

Purpose:

- Although not directly used in the current code, datetime can be useful for **logging, saving timestamps, or tracking file creation.**

Application Flow (How It Works)

Here's a step-by-step walkthrough of what happens when a user interacts with VisionAid.ai:

Home Page

- A **navbar** ( ) is displayed.
- The **title** ("VisionAid.ai - AI Image-Based Educator") is shown.
- User clicks **"Get Started □"**, setting st.session_state.page = "Upload Image".

Upload Image Page

- st.file_uploader() allows the user to select an image.
- If an image is uploaded:

    1. It is saved as temp_image.jpg.
    2. It is displayed using st.image().
    3. The app enters **loading mode** (st.spinner()).
    4. Image is **uploaded to Gemini**.
    5. Gemini **generates a description**.
    6. **Text is displayed** (st.markdown(f"**AI Description:** {description}")).
    7. **Text is converted to speech** (text_to_speech(description)).
    8. **Audio player is embedded** for playback.
    9. **Image is deleted** (os.remove(image_path)) after analysis.

Potential Enhancements

Here are some ways to further **improve the app**:

✅Better Navigation Handling

- Use st.selectbox() for multi-page navigation instead of st.session_state.page.

✅API Error Handling

- Wrap gen_ai.upload_file() and gemini.generate_content() in try-except blocks.

- Handle API timeouts and errors gracefully.

✅Secure API Key Management

- Store API key in st.secrets["api_key"] instead of hardcoding it.

✅Use BytesIO Instead of Saving Files

- Convert uploaded images to bytes instead of saving as "temp_image.jpg", reducing disk usage.

✅More Language Support

- Add language selection (st.selectbox()) for gTTS so users can listen in different languages.

✅AI-Powered Summarization

- Allow **short vs. detailed** descriptions based on user preference.

✅Enhanced UI

- Use **Streamlit themes** to match a minimalist aesthetic.
- Add a **progress bar** while processing images.