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MINOR PROJECT REPORT

ON

**SciMeet – Progressive Web App**

Submitted in partial fulfillment of the requirements

for the award of the degree of

**BACHELOR OF TECHNOLOGY**

**IN**

**COMPUTER SCIENCE & ENGINEERING**

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**CERTIFICATE**

We hereby certify that the work that is being presented in the project report entitled **SciMeet-Progressive Web App** to the partial fulfillment of the requirements for the award of the degree of **Bachelor of Computer Science & Engineering** from **Dr. Akhilesh Das Gupta Institute of Technology & Management**, New Delhi. This is an authentic record of our own work carried out under the guidance of **Ms. Prachi Goel, Assistant Professor, CSE Department.**

The matter presented in this project has not been submitted by us for the award of any other degree elsewhere.

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Finally, yet importantly, we would like to express our heartfelt thanks to God, our beloved parents for their blessings, our friends/classmates for their help and wishes for the successful completion of this project.

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**ABSTRACT**

This project is dedicated to the development of an innovative Progressive Web App (PWA) that aims to revolutionize online communication experiences. The envisioned application will be a comprehensive platform integrating state-of-the-art WebRTC technology for seamless real-time interactions. Key features include robust multimedia sharing capabilities and an AI-driven chatbot powered by the GPT-4 API, enhancing user engagement and accessibility. By incorporating Speech-to-Text functionality, the platform strives to create an immersive and intuitive environment for online communication. The primary objective is to establish a cutting-edge web-based interaction paradigm, offering users an intelligent, feature-rich, and user-friendly platform that sets new standards in virtual communication.

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**CHAPTER 1**

**INTRODUCTION AND LITERATURE REVIEW**

**1.1 INTRODUCTION**

In an era marked by digital connectivity and the ever-evolving landscape of online interactions, our project stands as a beacon of innovation, offering a groundbreaking vision for the future of communication. Welcome to a paradigm-shifting initiative dedicated to crafting a next-generation Progressive Web App (PWA) that transcends the boundaries of conventional online communication.

At its core, this visionary project heralds a new era by integrating cutting-edge WebRTC (Web Real-Time Communication) technology, setting the stage for seamless, instantaneous interactions in real-time. This foundational technology empowers our application to facilitate dynamic, live exchanges, bridging geographical distances and enabling genuine connections regardless of location.

However, our aspirations reach beyond mere connectivity. We’ve engineered a feature-rich environment that not only fosters instantaneous conversations but also paves the way for effortless multimedia sharing. The application’s architecture is meticulously designed to enable users to share diverse media formats with ease, fostering richer, more immersive exchanges.

Central to this transformative venture is the introduction of an AI-powered chatbot, leveraging the formidable capabilities of the GPT-4 API. This cutting-edge integration of artificial intelligence breathes life into conversations, offering users an intelligent and responsive companion capable of engaging in dialogue with remarkable depth and relevance.

But innovation doesn’t stop there. With Speech-to-Text functionality seamlessly woven into its framework, this platform not only embraces but enhances accessibility. It empowers users to communicate through speech, breaking down barriers and fostering inclusivity across diverse audiences.

More than just an application, our project is an embodiment of a vision – a commitment to crafting an immersive, accessible, and intelligent online communication platform. We aspire to set new benchmarks, redefining the standards for web-based interactions. Our focus lies not just in technological prowess but in creating an experience that resonates with users on a profound level.

**1.2 LITERATURE OVERVIEW**

The advent of Progressive Web Applications (PWAs) had heralded a transformative shift in how users engage with web-based content. Their amalgamation of native app-like functionalities, such as offline access and push notifications, with the accessibility of web browsers has opened new frontiers for innovative applications. Within this landscape, the integration of cutting-edge technologies such as WebRTC stands as a linchpin for real-time, peer-to-peer interactions.

Scholars and technologists have extensively explored the potential of WebRTC as a catalyst for revolutionizing online communication. This technology, built into web browsers, enables seamless audio, video and data sharing without the need for additional plugins or applications. Research by Al-Fuqaha et al. (2015) emphasizes the significance of WebRTC in enabling peer-to- peer communication, citing its potential impact on diverse sectors ranging from telemedicine to gaming.

Multimedia sharing, an integral aspect of modern communication, has garnered attention from both academia and industry alike. Studies by Hu et al. (2017) highlight the importance of effective multimedia sharing in enhancing user engagement and fostering richer, more immersive online experiences. The seamless integration of multimedia capabilities within communication platforms aligns with the contemporary trend towards visual and interactive content consumption.

Artificial Intelligence (AI) and its application within chatbots have been the focus of extensive research endeavors. The utilization of GPT (Generative Pre-trained Transformer) models, notably the GPT-4 API, has demonstrated remarkable capabilities in natural language processing and conversation generation. Research by Brown et al. (2020) showcases the advancements in language models, elucidating their potential to facilitate intelligent and contextually relevant conversations, thus significantly impacting user experiences in communication applications.

The inclusion of Speech-to-Text functionality holds profound implications for accessibility and inclusivity in online communication platforms. Research conducted by Wang et al. (2018) underscores the significance of speech recognition technologies in breaking communication barriers for individuals with disabilities, fostering an inclusive digital environment.

**1.3 MOTIVATION**

The impulsive behind the inception of this innovative project stems from a deeply rooted aspiration to address the evolving needs and challenges within the realm of online communication. In a world propelled by digital connectivity, the significance of seamless, engaging, and inclusive communication experiences cannot be overstated. As such, several key motivations underscore the development and pursuit of this pioneering venture.

**1.3.1 Bridging Technological Gaps:**

Traditional modes of online communication often face limitations in offering comprehensive real-time, and interactive experiences. The amalgamation of cutting-edge technologies within a Progressive Web App (PWA) framework aims to bridge these gaps, offering users an integrated platform that seamlessly merges convenience with sophistication.

**1.3.2 Empowering Real-Time Interactions:**

The utilization of WebRTC technology serves as a cornerstone in enabling instantaneous and immersive interactions. By harnessing the capabilities of WebRTC, our project seeks to empower users with the ability to engage in seamless, high-quality audio, video, and data exchanges, fostering genuine connections irrespective of geographical barriers.

**1.3.3 Enhancing User Engagement and Experience:**

The integration of multimedia sharing capabilities within the communication platform is propelled by the desire to elevate user engagement. Enabling effortless sharing of multimedia content facilitates a richer and more immersive communication experience, catering to the diverse preferences of modern-day users for interactive and visually stimulating content.

**1.3.4 Embracing AI-Powered Conversations:**

The introduction of an AI-powered chatbot, supported by the GPT-4 API, marks a paradigm shift in communication dynamics. Our Project envisions the deployment of advanced language models to create intelligent, context-aware conversations, enhancing user interactions and providing personalized experiences.

**1.3.5 Fostering Accessibility and Inclusivity:**

An essential motivation lies in the commitment to fostering inclusivity. By incorporating Speech-to-Text functionality, the project aims to break down barriers, making the platform accessible to users with diverse needs, including those with disabilities, thus championing a more inclusive digital environment.

**1.3.6 Setting New Standards in Online Communication:**

Ultimately, this project is driven by a collective aspiration to set new benchmarks in web-based interactions. The convergence of these state-of-the-art technologies within a single platform aims to redefine the standards of online communication, aspiring to create an environment that is intelligent, immersive, and accessible to all.

**1.4 ORGANIZATION OF PROJECT REPORT**

**1.4.1 Introduction**

**Overview:** Provides an introduction to the project, highlighting the goals, objectives, and significance.

**Motivation:** Explores the driving forces and incentives behind the project’s development.

**Project Scope:** Defines the scope and boundaries of the project, outlining its intended outcomes and limitations.

**1.4.2 Literature Review**

**Overview of WebRTC:** Explores the principles and significance of WebRTC technology in enabling real-time communication.

**Multimedia Sharing in Communication:** Discusses the importance and impact of multimedia sharing capabilities in enhancing user engagement.

**AI-Powered Chatbots and GPT-4 API:** Explores the advancements in AI-driven conversational agents and their implications for communication platforms.

**Accessibility and Speech-to-Text Functionality:** Highlights the significance of accessibility features like Speech-to-Text in fostering inclusivity in communication technologies.

**1.4.3 Methodology**

**Technological Framework:** Details the technical architecture, frameworks, and technologies used in the development of the PWA communication platform.

**Development Process:** Outlines the steps, methodologies, and tools employed during the project’s implementation phase.

**1.4.4 System Design and Implementation**

**System Architecture:** Describes the architectural design of the PWA, emphasizing the integration of WebRTC, multimedia sharing, AI chatbots, and accessibility features.

**Implementation Details:** Provides insights into the implementation process, algorithms, coding, and data structures used in developing different modules.

**1.4.5 Results and Findings**

**Performance Evaluation:** Presents empirical data and performance metrics showcasing the effectiveness and efficiency of the developed platform.

**User Experience Analysis:** Summarizes user feedback, usability testing, and user experience evaluations to gauge the platform’s impact on users.

**1.4.6 Discussion**

**Technological Implications:** Discusses the technological implications and advancements introduced by the project.

**User-Centric Perspectives:** Explores user experiences, challenges, and potential enhancements based on user feedback and observations.

**1.4.7 Conclusion and Future Scope**

**Project Summary:** Summarizes key findings, achievements, and the overall impact of the project.

**Future Scope:** Proposes potential future enhancements, technological advancements, and areas for further research and development.

**1.4.8 References**

Lists all the sources, scholarly articles, research papers, and materials referenced throughout the report using proper citation formats.

**1.4.9 Appendices**

Includes supplementary materials such as code snippets, technical diagrams, additional data, or any extra information supporting the main content of the report.

**CHAPTER 2**

**METHODOLOGY ADOPTED**

**2.1 THEORY**

**2.1.1 WebRTC Technology:**

WebRTC (Web Real-Time Communication) is a free and open-source project providing web browsers and mobile applications with real-time communication (RTC) via application programming interfaces (APIs). It allows audio and video communication to work inside web pages by allowing direct peer-to-peer communication, eliminating the need to install plugins or download native apps.

According to the webrtc.org website, the purpose of the project is to “enable rich, high-quality RTC applications to be developed for the browser, mobile platforms, and IoT devices, and allow them all to communicate via a common set of protocols”.

Major components of WebRTC include several JavaScript APIs:

* *getUserMedia* acquires the audio and video media (e.g., by accessing a device’s camera and microphone).
* *RTCDataChannel* allows bidirectional communication of arbitrary data between peers. The data is transported using SCTP over DTLS. It uses the same API as WebSocket and has very low latency.
* *RTCPeerConnection* enables audio and video communication between peers. It performs signal processing, codec handling, peer-to-peer communication, security, and bandwidth management.

The WebRTC API also includes a statistics function:

* *getStats* allows the web application to retrieve a set of statistics about WebRTC sessions. These statistics data are being described in a separate W3C document.

WebRTC allows browsers to stream files directly to one another, reducing or entirely removing the need for server-side file hosting. WebTorrent uses a WebRTC transport to enable peer-to-peer file sharing using the BitTorrent protocol in the browser. Some file-sharing websites use it to allow users to send files directly to one another in their browsers, although this requires the uploader to keep the tab open until the file has been downloaded. A few CDNs, such as the Microsoft-owned Peer5, use the client’s bandwidth to upload media to other connected peers, enabling each peer to act as an edge server.

WebRTC (Web Real-Time Communication) technology plays a pivotal role in our project, offering significant advantages and functionalities that are crucial to the success and functionality of the developed communication platform. This technology serves as the cornerstone of our project, enabling real-time peer-to-peer communication with multimedia capabilities directly within web browsers. Its features encompassing real-time connectivity, multimedia sharing, cross-platform compatibility, security, and scalability align perfectly with the objectives of creating an immersive, accessible, and intelligent online communication platform as outlined in our project’s goals.

**2.1.2 Multimedia Sharing in Communication:**

Multimedia sharing is the use of visual, audio, and interactive elements to convey information or express ideas on social media platforms. Multimedia sharing within a communication platform holds immense significance in augmenting user engagement and interaction. The integration of multimedia features elevates the user experience by offering various ways to communicate and express ideas beyond traditional text-based interactions.

* Enhanced Communication and Expression: Multimedia allows users to convey messages, emotions, and ideas more effectively through images, videos, and graphics, enabling a richer form of expression compared to text alone. Users can share various content formats such as images, videos, documents, presentations, and audio clips, catering to different communication needs and preferences.
* Increased User Engagement: Multimedia content encourages interaction and engagement among users, fostering active participation and deeper involvement in conversations. Users can engage in more immersive and dynamic conversations by sharing multimedia content, leading to increased interest and participation.
* Contextual Clarity and Understanding: Images, infographics, and diagrams aid in clarifying complex topics or instructions, enhancing understanding and retention of information. Videos or screen-sharing facilitate demonstrations, tutorials, or presentations, enabling users to better comprehend concepts or procedures.
* Emotional Connect and Personalization: Multimedia content allows users to evoke emotions and connect on a deeper level through visual or auditory stimuli, fostering a more personal and emotive interaction. Users can personalize conversations by sharing personal photos, videos, or audio messages, creating a more intimate and engaging communication environment.
* Improved Storytelling and Engagement: Multimedia serves as a powerful storytelling medium, enabling users to narrate stories, experiences, or ideas more vividly and compellingly. Captivating visual or interactive content captures users’ attention, prolonging their engagement and interest in ongoing discussions.
* Versatile Collaboration and Creativity: Multimedia sharing fosters collaboration by allowing multiple users to work on and discuss visual content simultaneously. Users can express creativity through multimedia content, encouraging innovative and imaginative contributions to conversations.

Implementing multimedia capabilities within the communication platform involves leveraging technology to facilitate seamless sharing of diverse content types such as images, videos, and documents in real-time interactions. Hers’s an explanation of how our project has implemented these capabilities:

* File Type Handling: Implemented a system that recognizes various file types (images, videos, documents) uploaded or shared by users. Utilized appropriate libraries or APIs that support the handling and processing of different file formats effectively.
* Media Upload and Sharing: Designed a user-friendly interface allowing users to easily upload and share multimedia content during conversations. Enabled real-time sharing of multimedia content, ensuring instant display or playback for all participants in the conversation.
* Compression and Optimization: Implemented compression and optimization techniques to minimize file sizes while maintaining quality, ensuring faster upload and download speeds. For videos, employed adaptive streaming techniques to dynamically adjust video quality based on users’ network bandwidth.
* Metadata Handling: Extracted and handled metadata associated with multimedia content, such as title, description, author, and timestamp, to enhance content organization and retrieval. Implemented search and filtering functionalities based on metadata, enabling users to easily find and access shared multimedia content.
* Security and Privacy Measures: Implemented encryption protocols to ensure the security and privacy of shared multimedia content during transmission and storage. Provided granular control over access rights to multimedia content, allowing users to define permissions for viewing, downloading, or editing.
* Cross-Platform Compatibility: Ensured cross-browser compatibility for multimedia playback or display, allowing users on different browsers to seamlessly view shared content. Optimized multimedia content for different devices (desktops, laptops, tablets, mobiles) to ensure a consistent viewing experience.
* Integration with Communication Features: Integrated multimedia sharing seamlessly with other communication features such as text messaging, video conferencing, or chatbots. Allowed users to multitask during multimedia sharing, enabling concurrent communication while viewing shared content.
* User Feedback and Interaction: Implemented interactive features like annotations, comments, or reactions on shared multimedia content, enhancing user engagement. Incorporated a feedback mechanism to gather user input on the usability and effectiveness of multimedia sharing features.

**2.1.3 AI-Powered Chatbots and GPT-4 API:**

Advancements in AI-driven conversational agents, particularly with the utilization of advanced models like the GPT-4 (Generative Pre-trained Transformer 4) API, signify a remarkable leap in natural language processing (NLP) capabilities. Here’s an elaboration on the capabilities of this technology in generating intelligent and contextually relevant conversations:

* Language Understanding and Contextual Awareness: GPT-4 ahs been trained on an extensive dataset, enabling it to comprehend and interpret language patterns, contexts, and nuances with greater accuracy. It demonstrates enhanced contextual awareness, maintaining context across longer conversations, which allows for more coherent and contextually relevant responses.
* Sophisticated Language Generation: GPT-4 excels in generating human-like text, producing more coherent, fluent, and contextually relevant responses, surpassing its predecessors in language fluency and coherence. It boasts and expanded vocabulary and a diverse range of phrasing styles, resulting in more varied and expressive conversational outputs.
* Adaptability and Fine-Tuning Capabilities: GPT-4 offers enhanced fine-tuning capabilities, allowing developers to train the model further for specific domains or tasks, leading to more specialized and accurate responses. It adapts to user dynamically, allowing for personalized and tailored responses based on ongoing interactions and user-specific preferences.
* Multi-Turn Conversations and Coherence: GPT-4 demonstrates improved handling of multi-turn conversations, maintaining coherence and consistency across multiple exchanges, leading to more natural and engaging dialogues. It can generate responses that logically follow the conversation’s flow, ensuring smoother transitions between different topics or queries.
* Ethical and Bias Consideration: Efforts have been made to reduce biases in the GPT-4 model, aiming for more neutral and unbiased language generation, though challenges in bias mitigation persist in AI models. Researchers and developers are increasingly emphasizing ethical considerations and guidelines in the development and deployment of AI model like GPT-4 to ensure responsible and fair use.
* Potential for Diverse Applications: The enhanced capabilities of GPT-4 open doors for diverse applications, including customer service chatbots, content generation, language translation, education, and more, where intelligent and contextually relevant conversations are crucial.

The integration of an AI-powered chatbot, especially leveraging sophisticated technology like the GPT-4 API, significantly enhances user interactions within the communication platform by offering personalized and intelligent responses to users’ queries and conversations. It enriches user experiences by providing tailored assistance, relevant information, and engaging conversations, contributing to improved user engagement and satisfaction within the platform.

**2.1.4 Accessibility and Speech-to-Text Functionality:**

Accessibility features like Speech-to-Text functionality play a pivotal role in creating an inclusive communication platform by ensuring that individuals with diverse needs can access, interact, and participate effectively. Here’s a discussion on the importance and significance of such features:

* Catering to Different Abilities: Accessibility features cater to users with varying abilities, including those with visual, motor or cognitive impairments, ensuring an inclusive environment for all users. Speech-to-Text functionality specifically benefits users who might face challenges in typing, reading, or navigating traditional text-based interfaces.
* Breaking Communication Barriers: For users with certain disabilities, Speech-to-Text functionality enables them to communicate more easily and effectively, breaking barriers posed by conventional text-based communication methods. It ensures that users with speech impediments, dyslexia, or other conditions that affect traditional typing or reading abilities can actively participate in conversations and engagements.
* Improved User Experience: Speech-to-Text features offer a more intuitive and user-friendly interaction method, enhancing the overall user experience within the platform. Users can express themselves more quickly through speech, leading to faster input and responses compared to typing, thus improving the efficiency of communication.
* Inclusivity and Empowerment: By incorporating accessibility features, the platform ensures equal access to its functionalities and content, fostering a sense of inclusivity and empowerment among all users. It empowers individuals with disabilities by providing them with tools to navigate and interact independently within the communication platform.
* Compliance with Accessibility Standards: In many regions, compliance with accessibility standards is mandatory. Implementing Speech-to-Text functionality ensures adherence to such regulations, avoiding legal implications and promoting a socially responsible platform.
* Social Responsibility and Ethical Considerations: Ensuring accessibility aligns with ethical principles, demonstrating the commitment to providing equitable opportunities and access to technology for all individuals. A platform that prioritizes accessibility fosters a positive societal impact, promoting diversity, equality, and social inclusion in the digital sphere.

The integration of Speech-to-Text functionality into the platform involves implementing technology that enables users to convert spoken words into written text, thereby enhancing accessibility and facilitating communication through speech. Here’s an explanation of how this feature can be integrated and its impact on accessibility within the platform:

* Integration of Speech Recognition Technology: Integrated a robust Speech Recognition API, capable of accurately transcribing spoken words into text. Developed backend systems that receive audio input from users, process it through the Speech Recognition API, and return the transcribed text to the platform’s interface.
* User Interface Design: Designed the user interface to include a voice input option prominently, allowing users to easily access and utilize the Speech-to-Text functionality during interactions. Implemented visual or auditory feedback to indicate the system’s response to the spoken input, confirming successful recognition and transcription of the speech.
* Real-Time Transcription and Feedback: Ensured that the Speech-to-Text system operates in near real-time, providing instantaneous transcription of spoken words into text. Displayed the transcribed text in a user-friendly format within the platform’s interface, maintaining the context of ongoing conversations or interactions.
* Customization and Adaptation: Offered options for users to customize speech recognition settings, such as language preferences or accent adaptations, to enhance accuracy and adaptability. Implemented mechanisms for the system to learn and adapt to user speech patterns over time, improving accuracy and recognition rates.

The integration of Speech-to-Text functionality within the communication platform significantly enhances accessibility and transforms the user experience in multiple ways:

It serves as a critical tool for inclusivity, allowing users with speech impediments, motor disabilities, or other challenges to communicate effectively within the platform. By providing an alternative means of interaction, it ensures a broader range of users can actively participate in conversations, fostering a more inclusive environment.

For individuals facing difficulties in typing or navigating text-based interfaces, Speech-to-Text features offer a more intuitive and natural interaction method. This enhancement reduces barriers to communication, making the platform more accessible and user-friendly, thereby enhancing the overall experience.

It enables faster communication compared to traditional typing methods. Users can articulate their thoughts more rapidly, resulting in quicker input and responses. Eliminating the need for manual typing reduces cognitive load, allowing users to concentrate on content and context, ultimately improving engagement.

Integration of Speech-to-Text fosters a more natural conversational environment, within the platform. Users experience interactions that resemble real-life conversations, enhancing cofort and engagement. The seamless integration enables users to switch effortlessly between speech and text-based communication modes based on their preferences or needs, providing flexibility in engagement styles.

**2.2 METHODOLOGY ADOPTED**

**2.2.1 Technological Framework and Architecture:**

The technical framework adopted for the development of the SciMeet – a Progressive Web App (PWA) involves the selection of various tools, programming languages, and frameworks to create a robust and feature-rich communication platform. Below is the overview:

Fig 1. Flowchart of the Front-end Part of SciMeet

HTML5, CSS3 and JavaScript, these core web technologies form the foundation of the front-end development, providing structure, styling, and interactivity to the user interface. React.js framework is used as leveraging modern JavaScript frameworks for building user interfaces, enabling the creation of interactive and responsive components within the PWA. Utilizing frontend frameworks for designing a consistent and visually appealing user interface across various devices and screen sizes. Tailwind CSS is used for frontend development to create sleek and responsive user interfaces. It enhances the styling capabilities of our web application. Firebase is used for Firebase Hosting for deploying our web app. WebRTC (Web Real-Time Communication) is implemented to facilitate real-time audio, video, and data communication between users directly within web browsers, ensuring seamless interactions.

Now moving onto the backend side of the project SciMeet – a progressive web app. It also divides into several categories to better understand this let us consider another flowchart to understand the backend side of the SciMeet project.

Fig 2. Flowchart of the Back-end part of the SciMeet

Employing Node.js as a server-side runtime environment for executing JavaScript code, enabling the handling or server-side logic and communication with the front-end. Using Express.js as a minimal and flexible web application framework for Node.js to create robust APIs and manage server-side functionalities. With the combination of Node.js and Express.js, as a framework, the use of TypeScript is legal. With the help of Typescript, the server-side code is written for improved safety and development experience. Implementing Socket.IO for real-time, bidirectional, and event-based communication between the server and clients, supporting features like chat and notifications. Firebase offers services that can power the backend like Firestore or Realtime Database for data storage, Firebase Authentication for user management, Could Functions for serverless backend logic. Choosing a suitable database system (NoSQL or relational) based on specific requirements for data storage, retrieval, and management within the application and MongoDB is the best for it. Utilizing Object-Relational Mapping (ORM) or Object-Document Mapping (ODM) libraries for simplified database interactions and schema management and for this Mongoose is best.

One more thing in backend is left that is APIs. It’s not mentioned in any category in flowchart as it has to be dealt separately. Now for the two features, i.e. AI-Powered Chatbot and Speech-to-Text Functionality, APIs are used.

Natural Language Processing (NLP) and AI: Integrating the GPT-4 API for advanced natural language processing capabilities within the chatbot, allowing intelligent and contextually relevant conversation generation.

Speech-to-Text Functionality: Implementing robust speech recognition APIs to enable Speech-to-Text functionality within the platform, allowing users to communicate via speech. In this project Google Cloud Speech-to-Text API is used.

Employing testing frameworks for unit testing, integration testing, and ensuring the reliability and functionality of the application. Choosing suitable hosting services for deploying the PWA (Progressive Web App), ensuring scalability, security, and optimal performance. For this PWA, Railway platform is used for deploying.

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