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Unite - Video Conferencing System

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Abstract

The study presented in this paper introduces Unite—a browser-based video conferencing platform aimed at enhancing user communication through the integration of real-time multimedia and modern web technologies. The system is developed as an Internet-based application that offers a full-featured virtual meeting environment without requiring users to install additional software. The primary goal of this work is to propose a unified communication solution that differentiates itself through seamless integration, intelligent assistance, and enhanced accessibility across devices. Unite facilitates real-time audio, video, chat, and screen sharing, leveraging WebRTC and PeerJS for efficient peer-to-peer media exchange, and Node.js with Express.js for backend processing and signaling.

Keywords - WebRTC, Video Conferencing System, Real Time Communication.

I. Introduction

The increasing global shift towards remote collaboration, digital classrooms, and hybrid workspaces has driven a surge in demand for effective and accessible video conferencing solutions. Traditional video conferencing platforms, while functional, often come with limitations such as high subscription costs, lack of flexibility, platform dependency, and minimal integration with productivity tools. These challenges create barriers for educational institutions, small businesses, and individuals seeking a seamless and user-friendly communication experience. This paper introduces Unite—a web-based videoconferencing system designed to overcome these limitations by delivering real-time multimedia communication directly within web browsers. The platform eliminates the need for external software installations and provides a secure, scalable environment for virtual meetings. Built using WebRTC (Web Real-Time Communication), the system supports direct peer-to-peer media exchange, ensuring high-quality audio and video transmission with low latency. The backend infrastructure is powered by Node.js and Express.js, handling signaling, session management, and server-side operations. This paper outlines the system's design, implementation, and key functionalities, highlighting its relevance in addressing current and emerging challenges in remote communication. The Unite system is aimed at providing a comprehensive communication tool that merges security, efficiency, and ease.

II. Literature Survey

A. The proliferation of digital communication technologies has significantly transformed how individuals and organizations interact, particularly in the wake of the COVID-19 pandemic. Video conferencing has become a central mode of collaboration across industries, leading to the widespread adoption of platforms such as Zoom, Microsoft Teams, and Google Meet.

B. Zoom has gained popularity due to its ease of use and reliability in hosting large-scale meetings. However, it has faced scrutiny for its security vulnerabilities and lack of seamless integration with third-party productivity applications. Microsoft Teams offers deep integration with Microsoft 365, making it suitable for enterprise environments, and complex UI can hinder adoption among casual or non-technical users. Google Meet is browser-friendly and integrated with Google Workspace, yet it lacks extensive customization and feature-rich capabilities in its free version.

C. Open-source video conferencing solutions like Jitsi Meet and BigBlueButton have emerged as alternatives, particularly in academic and developer communities. These platforms allow for greater customization and self-hosting but often require technical expertise and high server resources, which can be a barrier for small organizations.

D. Recent research has highlighted the increasing role of WebRTC (Web Real-Time Communication) as a foundational technology in modern web-based conferencing. WebRTC enables real-time, peer-to-peer media streaming without additional plugins, promoting low-latency communication in browsers.

E. To address authentication and user management, Firebase Authentication has gained traction due to its simplicity, scalability, and secure handling of user credentials. For scheduling and calendar integration, APIs such as the Google Calendar API have enabled automated meeting management and notification features.

III. METHODOLGY

A. SOFTWARE OVERVIEW:

Unite is a browser-based video conferencing application developed using WebRTC, which allows users to initiate and join real-time audio and video communication without installing any additional software. The platform supports peer-to-peer media streaming, real-time chat, screen sharing, and smart features such as meeting summarization through AI. Video conferencing through Unite enables communication between two or more users where video, audio, and text signals are transmitted in real-time over the internet. It creates a collaborative environment where participants can interact visually and verbally, making communication more expressive and effective. As communication is a key aspect of modern life, the transition from traditional voice calls to video-based interaction marks a significant evolution. WebRTC plays a central role in enabling browser-based real-time media transmission. By granting access to media devices like webcams and microphones, WebRTC allows Unite to establish secure, low-latency audio and video connections between users. The system is fully web-based and platform-agnostic—functioning seamlessly across devices such as desktops, laptops, tablets, and smartphones. Using Express.js and Node.js for backend logic, PeerJS for WebRTC abstraction, and Firebase for authentication and data handling, Unite is designed as a complete virtual meeting solution. To address authentication and user management, Firebase Authentication has gained traction due to its simplicity, scalability, and secure handling of user credentials. For scheduling and calendar integration, APIs such as the Google Calendar API have enabled automated meeting management and notification features.

B. USER ARCHITECTURE :

The Unite platform operates via a straightforward and intuitive web interface that includes functionality for creating, joining, and managing video conferencing rooms. The user flow is structured into two main roles:

➢ **Room Creator :**

- The user initiates the session by logging in and entering meeting details (e.g., topic, schedule).
- A unique meeting room is generated, and a link is produced automatically.
- This link can be shared with other users (invitees) via email or message.

➢ ***Invitee :***

- The invitee accesses the meeting room by clicking the shared link.
- They enter basic credentials (such as name or email) to join the room.
- Once authenticated, they enter the video chat environment.

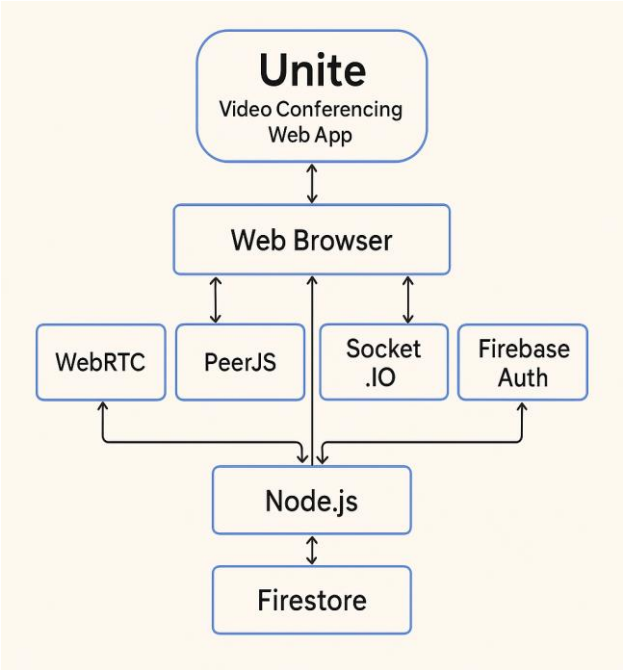
Both the Room Creator and Invitee join a secure, real-time video chat room through a peer-to-peer WebRTC connection. Within the room, users can perform the following actions:

- Enable or disable audio/video streams.
- Use the chat box for sending text messages.
- Share screens for presentations or collaborative tasks.
- Optionally access AI-powered features like meeting transcription and summaries.
- Submit feedback after the session ends for continual improvement.

The user interface is developed using HTML, CSS, and EJS templating, with responsive design principles to ensure accessibility across screen sizes. The backend handles session management, signaling, and Firebase integration for user authentication and data synchronization. Socket.IO is employed for maintaining real-time chat communication and user activity tracking. This methodology ensures that Unite remains lightweight, user-friendly, and feature-rich, while offering the flexibility and intelligence needed for modern virtual collaboration.

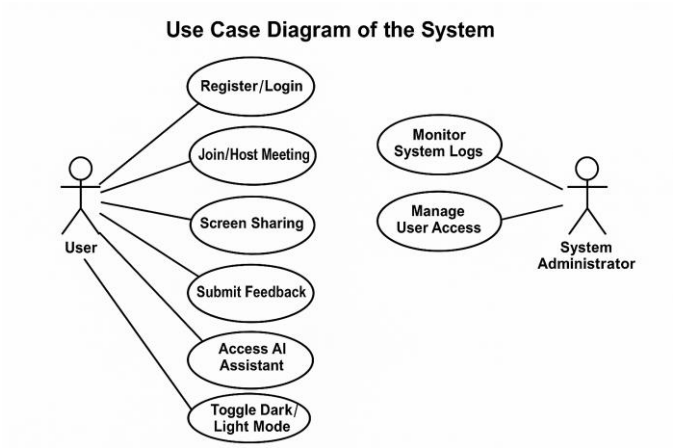
C. PROPOSED SYSTEM

a. **SYSTEM ARCHITECTURE**: The *Unite – Video Conferencing Web App* adopts a modular, hybrid architecture that combines client-server and peer-to-peer (P2P) models to optimize performance and scalability. The frontend is developed using HTML, EJS, and CSS to ensure responsive design and accessibility across devices. The backend is built with Node.js and Express.js, managing APIs, authentication workflows, and meeting data. Real-time video and audio communication are established using WebRTC and PeerJS, allowing direct P2P connections between clients to reduce server load and latency. Socket.IO facilitates real-time text chat, signaling, and control messages such as mute/unmute and user status updates. Firebase Authentication is used for secure user login, with JWT tokens ensuring protected data exchange. Google Calendar API enables seamless scheduling, while Gemini AI integration adds intelligent features like transcription and meeting summarization. The architecture supports cloud deployment for horizontal scaling and high availability, making Unite suitable for a wide range of users and use cases.



b. USE CASE DIAGRAM OF THE SYSTEM :

The Unite – Video Conferencing Web App use case diagram illustrates the interaction between the system and its primary actors: User and System Administrator.

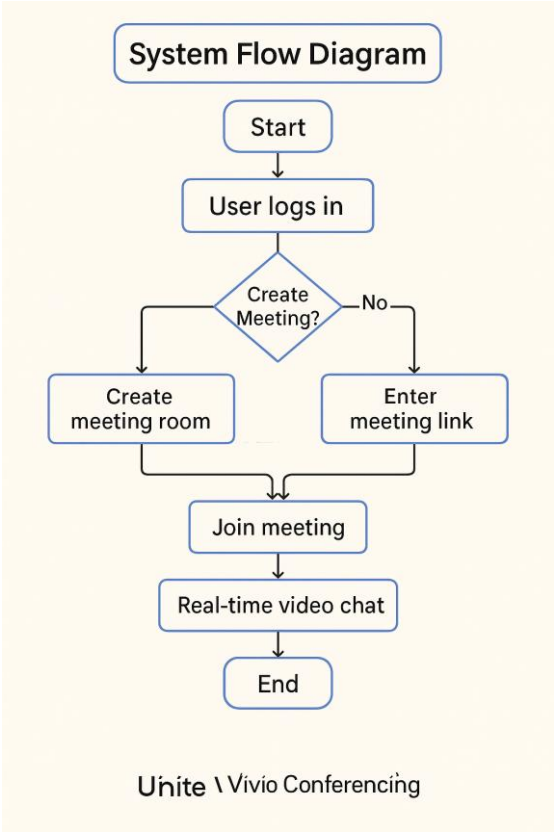


Primary Use Cases for Users:

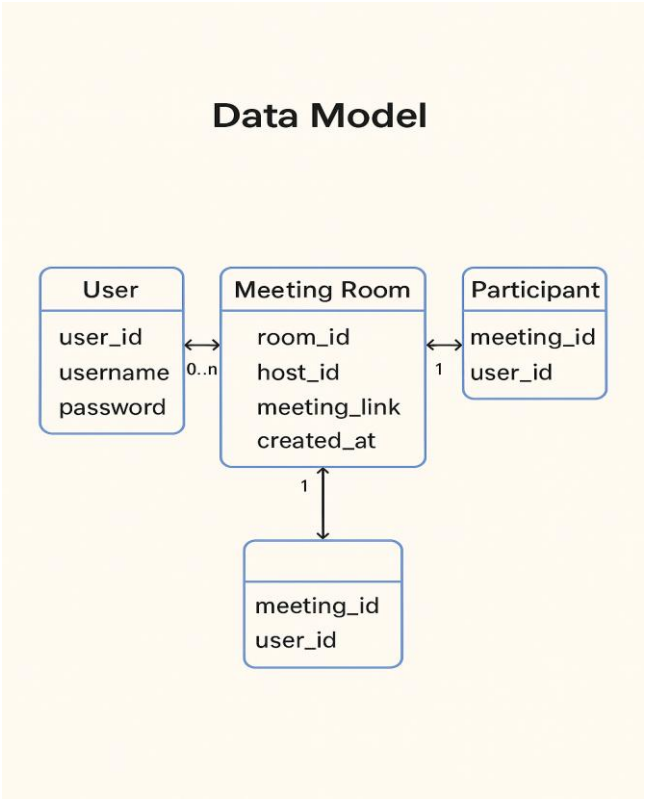
- **Register/Login:** Secure authentication via Firebase.
- **Join/Host Meeting:** Initiate or participate in real-time video sessions using WebRTC.
- **Chat in Meeting:** Exchange messages during calls via Socket.IO.
- **Screen Sharing:** Share screen content for presentations or collaboration.
- **Schedule Meeting:** Create and manage meetings using Google Calendar integration.
- Submit Feedback: Rate meeting experience and provide suggestions.
- Access AI Assistant: **Use Gemini AI for transcription, summaries, and contextual queries.**
- Toggle Dark/Light Mode.

c. SYSTEM FLOW DIAGRAM :

The following Sequence Diagram of the entire system explains how the various entities interact with each other and also provides a sequence of the general events that occur during the use of the application. To access the system, users must first create a room. After submit, room link will be generated. Room Creator should Share this with invitee for Video Conferencing. Each Peer in video chat room can on/off camera, mute/unmute audio, Chat, Share.

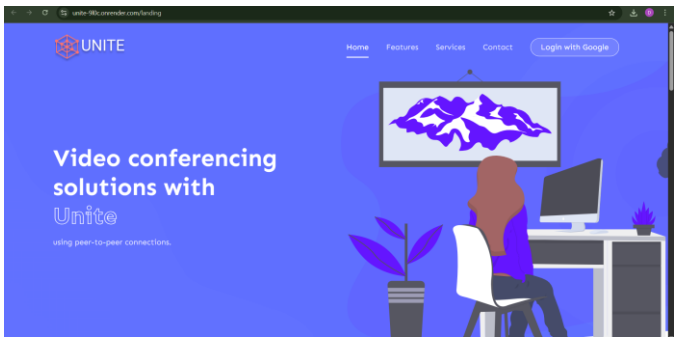

System Flow Diagram
Start
User logs in
Create Meeting?
No
Create meeting room
Enter meeting link
Join meeting
Real-time video chat
End
Unite \ Vivio Conferencing

d. DATA MODEL :


Data Model
User
user_id
username
password
0..n
Meeting Room
room_id
host_id
meeting_link
created_at
1
Participant
meeting_id
user_id
1
meeting_id
user_id

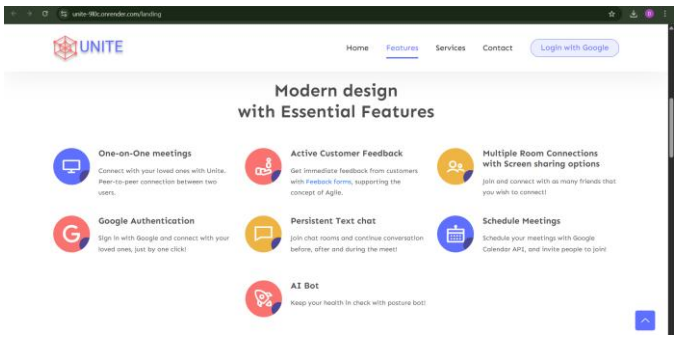
e. RESULTS:

As Shown in the below Figure(E.1) Video Conferencing web application has a clean and easy interface. This justifies the idea of the project by making it clear about the functioning of the platform.

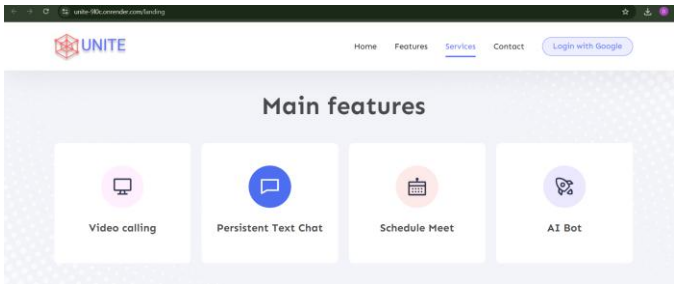


(Figure No. : E.1)

As Shown in the below Figure(E.2) Video Conferencing web application has a features section. This justifies the features involved in the platform like One-to-One Meeting, AI Bot, Google Authentication, Active Customer Feedback, Scheduling Meeting, Persistent Text Chat, etc.



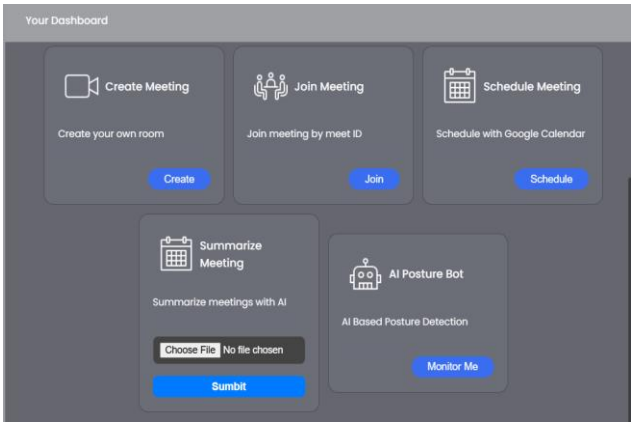
(Figure No. E.2)



(Figure No. E.3)

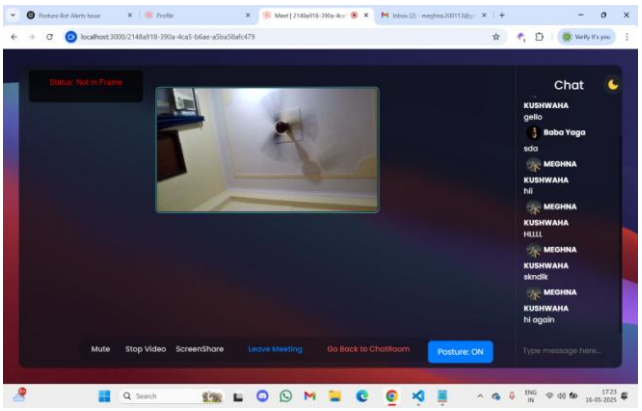
As shown in Figure E.4 below, this is the dashboard section of the application, where users can create, join, and schedule meetings. It also displays relevant meeting details and user information.

Figure No. (E.4)



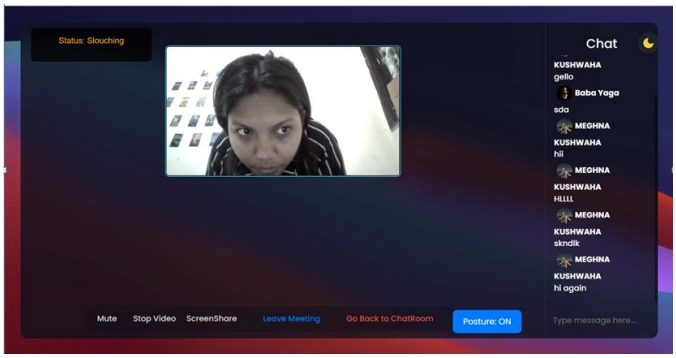
(Figure No. : E.5)

As shown in Figures E.6, E.7, E.8, and E.9 below, the application demonstrates the functionality of the integrated AI-Bot, which provides insights regarding the user's posture and body orientation, such as the way they are leaning.



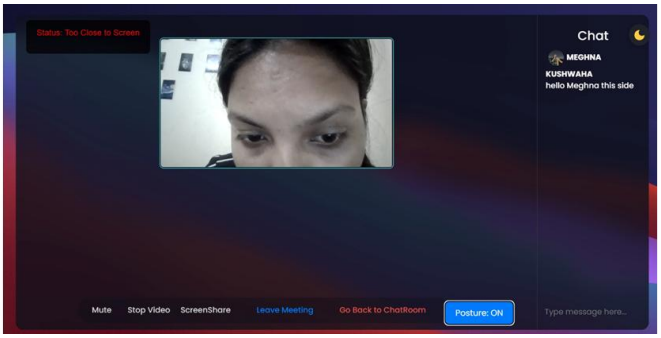
(Figure No. : E.6)

As shown in Figures E.6 above, the application demonstrates the functionality of that no-one is in the frame as it can't detect the human in the camera screen.



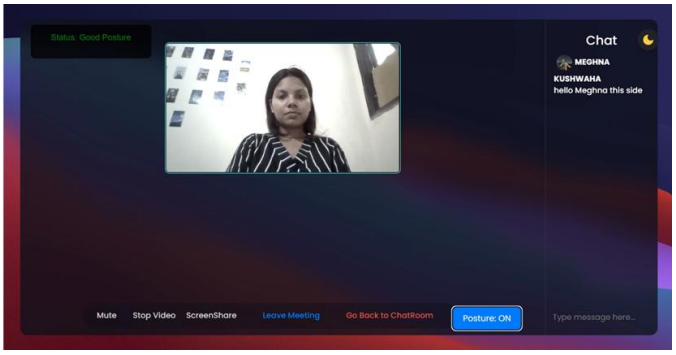
(Figure No. E.7)

As shown in Figures E.6 above, the application demonstrates the functionality of that the person detect in the camers is slouching and not in correct posture.



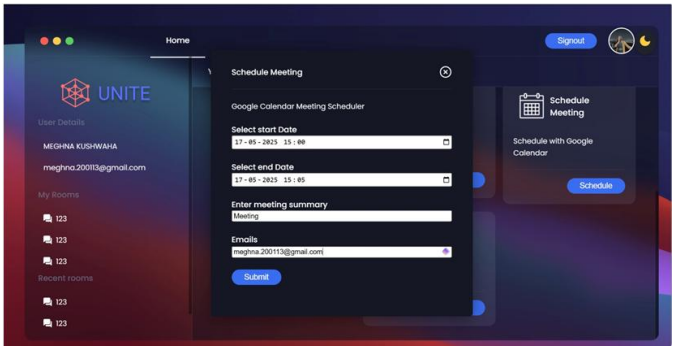
(Figure No. : E.8)

As shown in Figures E.6 above, the application demonstrates the functionality of that no-one is in the frame as it can't detect the human in the camera screen.



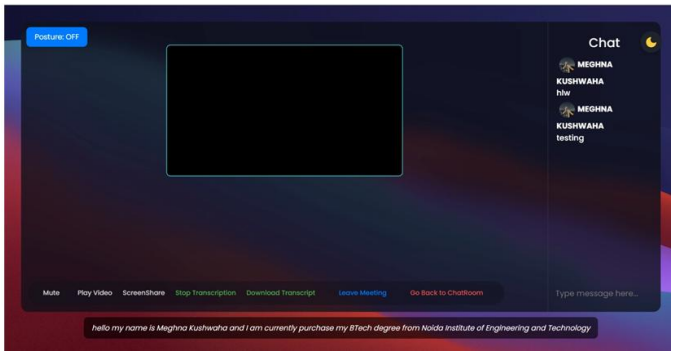
(Figure No. E.9)

As shown in Figures E.6, E.7, E.8, and E.9 above, the application demonstrates the functionality of the integrated



(Figure No. : E. 10)

As shown in Figures E.10 above, the application demonstrates the functionality of the calendar, in-order to remember the meeting time and data. Even, this calendar can sync with your original Google Calendar for better functionality.



(Figure No. : E.11)

As shown in Figures E.11 above, the application demonstrates the functionality of the subtitle of the discussion, had been occurred during the conversation.

IV. CONCLUSIONS :

In this paper, we presented Unite, a browser-based video conferencing web application designed to meet the growing demands of secure, accessible, and intelligent remote communication. Through the integration of modern web technologies such as WebRTC, PeerJS, Socket.IO, and Firebase, Unite offers a seamless platform for real-time video, audio, and text-based collaboration—without the need for additional software installations. The system addresses several limitations found in existing solutions, including high cost, complexity, and poor extensibility. With built-in features such as user authentication, screen sharing, Google Calendar scheduling, and AI-driven meeting assistance via Gemini AI, Unite delivers an end-to-end experience tailored for users in academic, professional, and personal settings. Its lightweight architecture and device-agnostic design ensure broad accessibility and scalability. The successful implementation and testing of Unite validate its practical potential as an open, extensible, and cost-effective alternative to mainstream video conferencing platforms. The project not only demonstrates the technical viability of full-stack web communication systems but also contributes to ongoing research in integrating artificial intelligence with real-time collaboration tools. Future work will explore enhancements such as mobile app development, role-based access control, advanced security measures, and expanded AI features like live translation and intelligent task tracking. Through these extensions, Unite aims to evolve into a comprehensive digital communication ecosystem that aligns with the future of work, education, and global connectivity.

V. FUTURE WORK :

The *Unite – Video Conferencing Web App* lays a strong foundation for future enhancements. Planned improvements include mobile application development for Android and iOS platforms, integration of role-based access controls for better meeting management, and features like meeting recording and playback. To further enrich the user experience, the platform can incorporate features such as secure meeting recording and playback, with timestamped transcripts to aid in content review. Enhanced AI capabilities hold significant promise, including real-time transcription, sentiment analysis, live language translation, intelligent meeting summaries, and voice-command-based navigation for improved interactivity and productivity. Security can be strengthened through two-factor authentication (2FA), CAPTCHA verification, session timeouts, and end-to-end encryption to ensure safe and private communication. Enhanced AI functionalities—such as live transcription, real-time translation, sentiment analysis, and intelligent task

tracking—can further improve productivity. These developments will transform *Unite* into a comprehensive, competitive solution for modern digital communication.

VI. ACKNOWLEDGEMENT:

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