Journal of Data Acquisition and Processing
ISSN: 1004-9037
https://sjcjycl.cn/
DOI: 10.5281/zenodo.755113

STEAM GAURDIAN: A SMART WEB APPLICATION FOR INSTANT ONLINE MEETINGS

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Abstract

In an era of escalating privacy concerns and remote cooperation, the WebRTC-Based Video Conference Portal with JWT Authentication provides a new viewpoint on managing secure and productive virtual meetings. This project uses WebRTC (Web Real-Time Communication) technology, which is well-known for its real-time audio and video communication capabilities, to provide a robust and smooth user experience. By implementing JWT (JSON Web Tokens) authentication, the research article strengthens its commitment to user data security and access control. The article provides a full explanation of the objectives, methodology, system design, and implementation. It covers the steps required to create software, with a focus on establishing the development environment, important features, and testing phases. Methods for protecting sensitive information, such as JWT authentication and data encryption, are thoroughly tested. The research article accomplishments and results demonstrate how it may improve the usability and security of virtual meetings by incorporating user feedback, essential functionality, and the user experience. The project timetable and recommended future work not only identify prospects for extension and enhancements, but they also address the issues encountered throughout development. This innovative and forward-thinking project has improved the virtual communication environment. Aside from satisfying the urgent demand for secure online meetings, it also allows for future adaptation and evolution, making it a realistic and relevant solution to a wide range of user requirements and industry expectations.

Keywords: Online Meeting Application, Internet, Real-time Synchronization, security exploitation.

1. Introduction

In today's world, where technology is continually advancing and boundaries are being broken down, virtual communication has become critical to both our personal and professional lives. As the demand for secure and effective remote collaboration develops, it becomes increasingly important to provide innovative solutions that allow users to connect easily in the virtual world. The current project plays a crucial role in this framework [10]. Providing a WebRTC-of-the-

art, WebRTC-based video conferencing platform WebRTC requires. This article is the outcome of extensive study, design, and development efforts. The core of this attempt is called WebRTC, which stands for Web Real-Time Communication. WebRTC is a driving force for change that represents the cornerstone of real-time audio and video interactions. It's more than just a technology. It has the ability to bridge time zones, geographical boundaries, and cultural gaps [11] [12]. In a world where connections are increasing, it promotes connectedness by bringing people together. WebRTC is more than a slogan; it reflects the digital era's ability to empower and unite people. Real-time communication is enabled via a browser-based API. It began as an open-source initiative and has since become the industry standard for secure, high-quality real-time audio and video interactions across a wide range of applications, including online gaming and video conferencing. The usage of JSON Web Token (JWT) authentication is critical to the project's objectives [13] [14]. The platform's security and access control are enhanced by JWT, an industry-standard technique for expressing claims between two parties. It serves as both a commitment to protecting user data and a security measure. The research article benefits from JWT's robust and sophisticated security, which ensures user data privacy and confidentiality. This research article uses the Karhunen Loeve Transform (KLT) algorithm in addition to WebRTC and JWT. The KLT method is a useful tool for both data analysis and image compression. Its powerful dimensionality reduction and feature extraction capabilities make it an important part of the project's design. The KLT algorithm enhances user experience and real-time data transfer by allowing the platform to process and analyze complex data more effectively [15] [16].

The main purpose of this paper is to ensure that users can connect electronically with total confidence that their data is secure and confidential. Security is built into the gateway, not added after. This article usage of the KLT algorithm, JWT authentication, and data encryption gives a level of security that is both robust and sophisticated in its simplicity. Moreover, the initiative is founded on a dedication to providing outstanding user experiences. This commitment to user-centricity is reflected in the feature set, user interface, and design decisions. The goal of this project is to create a platform that people will be eager to use and find engaging, rather than just a safe means of communication. This initiative, like any other significant undertaking, has experienced challenges; nonetheless, these have been overcome through the use of inventive strategies and resourcefulness. The team's resilience and commitment to achievement are mirrored in the challenges they overcome. The conclusion of this project is not the end, but rather the beginning of an exciting new chapter. This article presents a summary of the project's development and results to date, with a focus on user feedback, which has been critical in influencing its direction. It is a never-ending journey as it adapts to the ever-changing digital environment [17]. The study proceeds to outline the future vision. The road map includes proposed additions and upgrades, demonstrating the project's continued commitment to creating cutting-edge virtual communication experiences. With its unwavering focus on security, privacy, adaptability, and user satisfaction, this paper is poised to leave an indelible mark on the world of virtual communication. The paper is completely revealed on the pages that follow. The architecture, design decisions, development process, security mechanisms, and user experiences are all thoroughly reviewed. Every aspect demonstrates the enthusiasm, ingenuity, and attention poured into this undertaking [18].

To summarize, this paper is more than just a technical endeavor; it represents the realization of the seemingly limitless possibilities of modern technology. It's a tribute to the interconnectedness that transcends geographical barriers and brings us together, one safe and joyful online meeting at a time.

2. Literature Review

In this digital age, virtual communication is critical for global connectivity. Web-based tools for real-time audio and video communication have transformed human contact. Here are some of the most influential articles on WebRTC, Jwt, and KLT algorithms:

In [1], Anupam Baruah and Lakshmi Prasad Saikia proposed a biometric face recognition strategy based on Wiener filtering techniques and the KLT algorithm. This method comprises comparing real-time faces to previously saved faces by registering a set of human faces in a face database. This strategy makes use of Matlab based apps. The KLT approach is utilised for both face recognition and database construction. Wiener filtering is used to extract illusion-invariant information from facial photographs.

In [2], Shivam Singh and S. Graceline Jasmine proposed an autonomous facial recognition system. This programme employs face detection, feature extraction, and identification algorithms to automatically recognise a person's face in front of a camera. We used the KLT and Viola-Jones algorithms for face recognition, which leverage the Haar cascade classifier to detect human faces. Nonetheless, the camera recognises faces in each frame and uses the PCA technique to choose features. To reproduce the geometric characteristics of the human face, we use model combining techniques.

In order to allow users to communicate with high-speed data transfer via the communication channel, Zena Hussain, Sarah Faris Amer, & Zinah Tareq Nayyef presented a web-based peer-to-peer real-time communication system that uses HTML5, WebRTC technology, and a Node.js server address in [3]. The results demonstrate that the system is reliable, secure, and capable of delivering and receiving multimedia data in real time between users on a real network.

The goal of method proposed by Hakim Allali, Omar Bouattane, Mohamed Youssfi and Badr Eddine Sabir in [4] is to address load balancing and agent communication security issues by providing a novel distributed system model that takes use of JSON Web Token (JWT) technology. This approach is built on a new middleware for multi-agent systems. The core component of the proposed paradigm is an authentication module that use asymmetric cryptography to assure agent authentication, non-repudiation, and message integrity in order to provide effective load balancing and communication security. This work offers a highly scalable, safe, and lightweight strategy for improving load balancing and security in distributed systems, as well as conducting a theoretical analysis of the suggested model architecture.

In [5], the face recognition and tracking process was highlighted by Shaker Fouad Asma Abdulelah Abdulrahman, Tahir Al-azawia, and two algorithms were developed to illustrate how the MATLAB software functioned to give a core framework for facial tracking and detection. The face was tracked in the first scenario, demonstrating how to use Algorithm1 with the CAMShift method. However, because there was enough contrast between the face and the background, the results were not as striking. To implement the concept, Kanade Lucas Tomasi (KLT) created a basic system that can detect and track faces using the Duration

Geometric Transform (DGT) and Estim Geometric Transform (EGT) functions. Algorithm1 was designed to accomplish this. Algorithm 2 was designed to put the idea into action. The examples in the paper demonstrate how to use and how successful the provided algorithms are. The face recognition and tracking technique was stressed in [6] by Shaker Fouad Tahir Al Azawia and Asma Abdulelah Abdulrahman, and two algorithms were built to clarify how the MATLAB code worked to provide a basic system for facial tracking and detection. In the first example, the face was tracked to show how to use Algorithm1 and the CAMShift technique. However, the findings were less noticeable because the face and background were sufficiently contrasted. The technique was implemented with the Kanade Lucas Tomasi (KLT) system, which detects and tracks faces using the Duration Geometric Transform (DGT) and Estim Geometric Transform (EGT) functions. This is what Algorithm 1 was intended to do. To put the concept into action, algorithm 2 was created. The paper's examples explain how to use and the effectiveness of the offered algorithms.

Leandros Maglaras, Nick Ayres and Maria Papathanasaki in [7] provides a complete overview of modern authentication technologies. We begin by discussing the importance of various authentication methods and procedures. Following that, we outline the authentication criteria used and evaluate several authentication methods based on their effectiveness, acceptability, spoofing, universality, collectability, and uniqueness. Finally, we explore the future of multi-factor authentication, as well as the security risks and challenges that come with it.

Blerim Rexha, Ahmet Bucko, Kamer Vishi and Bujar Krasniqi [8] describes a technique for increasing the trustworthiness of user authentication in online applications by leveraging the user's previous conduct. The approach allocates a weight or percentage to each variable based on parameters such as the user agent type, IP address consistency, and amount of password attempts. These weights are put together, saved in the user's account, and updated with each transaction. The proposed approach was carried out utilising the PostgreSQL database, the.NET framework, and the C-Sharp programming language. The results suggest that the recommended patch significantly boosts trust in user authentication. In the paper's conclusion, the advantages and disadvantages of the recommended technique are discussed.

Bikhtiyar Firyad Abdulrahman and Sameer Jasim Karam [9] used a mesh topology, this study seeks to provide a bi-directional WebRTC video conferencing system for many-to-many peers. Signal acquisition was accomplished using the Socket.io Library in this study. To assess the effectiveness of the suggested technique, we considered both CPU performance and quality of experience (QoE). Furthermore, to validate the simulation's results, a real-world implementation was carried out utilising the following situations. a) connecting with several peers at the same time; b) initiating multiple video rooms at the same time; c) ensuring that a session continues even after the person who initiated it leaves; and d) introducing new users to existing participants.

3. Methodology

This cutting-edge online communication solution can be designed and deployed using the procedures mentioned in the process for creating a WebRTC based video conferencing site with KLT integration and JWT authentication. This methodology is a comprehensive strategy that outlines all of the actions, methods, and considerations required to complete the project. Following this strategy will create new standards for virtual communication and ensure that the platform is secure, efficient, and user-centered.

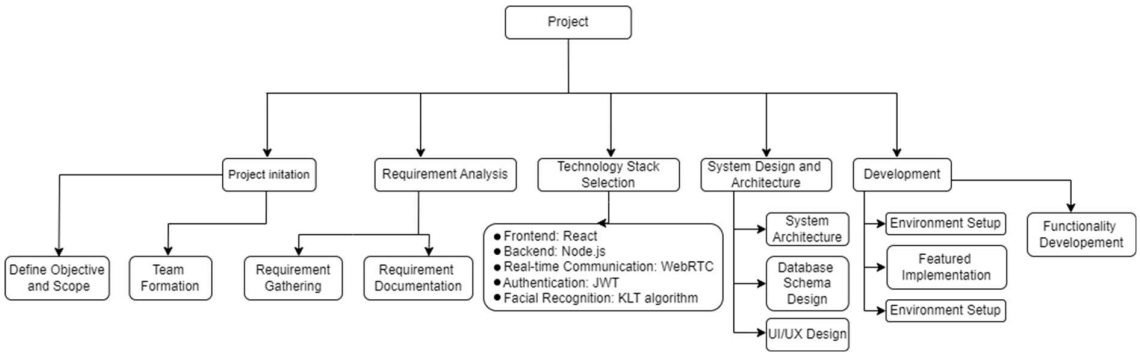

Figure 3.1: Methodology

3.1. Project Initiation (Scope Definition)

(a) Define Project Objectives and Goals - The project's objectives and goals must be precisely defined as the first stage in this process. This entails outlining the platform's goal, the features that are wanted, and the results that are anticipated. Developing a safe video conferencing platform with excellent audio and video streaming is one example of an aim.

(b) Establish the Project Scope - Define the project's scope by listing the essential elements, integrating technologies, and features. Setting limits and controlling expectations require doing this action. The scope in this instance includes user interface development, WebRTC, JWT authentication, and KLT integration.

3.2. Requirement Analysis

(a) User Requirements - Use user workshops, interviews, or surveys to gather needs from users. Determine the particular requirements and expectations of the target audience, which includes companies, instructors, medical professionals, and individual users. Users could need user-friendly interfaces and safe login alternatives, for instance.

(b) Technical Requirements - Keep track of the platform's technical specifications, including its scalability, data handling capability, and browser compatibility. Technical needs might include real-time audio and video streaming using WebRTC, effective data transmission via the KLT algorithm, jwt authentication, and socket.io for the socket's operation.

3.3. Architecture and Design

(a) System Architecture Design - Create the system architecture, as previously mentioned. This entails developing a thorough design for the platform's architecture, considering server infrastructure, WebRTC components, JWT authentication, and KLT integration.

(b) Database Design - Create the database schema that will hold JWT token data, conference information, and user account information. When designing a database, take privacy and data security into account.

(c) User Interface Design - Consider usability and user experience while designing the user interface. For the controls, chat, audio and video feeds, and other user interface components, create wireframes and mockups.

(d) Security Design - Arrange for security precautions such as access control, encryption, and JWT implementation. Establish security procedures to safeguard user information and correspondence.

3.4. Technology Selection

(a) WebRTC Selection - Decide which WebRTC implementation and libraries best fit the needs of the project. Consider choices related to real-time communication and browser compatibility.
(b) JWT Library Selection - Choose a JWT implementation or library to manage access control and user authentication. Think about things like compatibility with the framework and programming language of choice.
(c) KLT Algorithm Selection - Select the KLT method or library that best suits the demands of the project's data optimization. Make sure the method you choose is appropriate for processing data in real-time.
(d) Socket.io Selection - Socket.IO was established in 2010. It was developed to encourage real-time communication, which at the time was still a somewhat novel idea. Bidirectional connections between the client and the server are made possible via Socket.IO. The Socket.IO package must be installed on both the server and the client's browser in order for bidirectional communication to occur. While there are other forms in which data may be sent, JSON is the simplest. In order to establish a connection and transfer data between the client and server, Socket.IO uses Engine.IO. Internal usage only, this is a low-level implementation. Engine.IO-client is used to implement the client, whereas Engine.IO is used to implement the server.

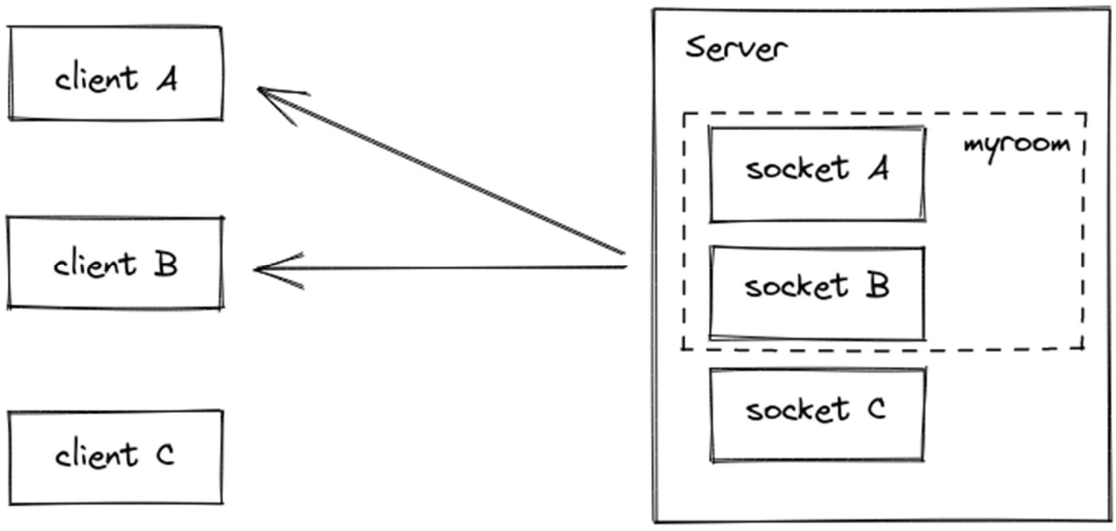

Figure 3.2: Socket.io

3.5. Development

(a) User Management Module - Create the user administration module, which will manage profile settings, login, and user registration. Use JWT authentication to ensure safe logins.
(b) WebRTC Integration - Integrate data channels, audio and video streams, peer connections, and other WebRTC components. Put in place features for real-time communication.
(c) KLT Integration - Apply the chosen KLT algorithm to enhance data processing. Use KLT to implement effective data transport and compression.
(d) User Interface Development - Create the user interface in accordance with the design guidelines. Provide chat, user controls, and streaming audio and video options.
(e) Security Implementation - Put security mechanisms in place, such as access restriction, encryption, and JWT token validation. Protect and preserve data privacy.

3.6. Testing and Quality Assurance

(a) Functional Testing - Test features functionally to make sure they all perform as planned. Test the chat feature, security measures, streaming of voice and video, user registration, and login.
(b) Usability Testing - Test the usability of the interface with target consumers to acquire their input. Determine where the user experience needs to be improved.
(c) Security Testing - Carry out security testing to find weaknesses and counter any dangers. Check how well JWT encryption and authentication work.
(d) Performance Testing - Evaluate the platform's performance, considering latency, data handling efficiency, and capacity for numerous concurrent users.

3.7. Deployment and Scaling

(a) Define Project Objectives and Goals - Install the platform on specified servers, such as web, database, and media servers.
(b) Scaling Strategies - Put in place plans for expanding the platform's user base through scalability. Think about cloud-based solutions, server redundancy, and load balancing.

3.8. User Training and Documentation

(a) User Training - Offer user training to guarantee that users are able to utilize the platform efficiently. Provide tips, lessons, and resources.
(b) Documentation - Provide thorough documentation for developers and admins. Record the architecture, APIs, and security protocols of the platform.

3.9. Maintenance and Future Development

(a) Ongoing Maintenance - Create a maintenance schedule for frequent upgrades, security improvements, and bug fixes.
(b) Future Development - Take customer input, security enhancements, and new features into account when planning for future development.

3.10. Project Conclusion and Evaluation

(a) Project Evaluation - Assess the project's performance in relation to its stated aims and objectives. Analyse system performance, security efficacy, and user satisfaction.
(b) Conclusion and Delivery - Deliver the fully functional WebRTC-based video conferencing platform with JWT authentication and KLT integration to users and stakeholders to mark the project's conclusion.
(c) Knowledge Transfer - Pass on expertise to the group in charge of continuing development and maintenance.

3.11. Project Documentation and Reporting

(a) Project Documentation - Produce thorough project documentation that include all data related to design, development, testing, and deployment.
(b) Final Report - Write a final project report that includes an overview of the project's methods, successes, difficulties, and suggestions for the future.

4. Results

4.1. Technical Results:

(a) Secure and Effective Platform - The platform's security and effectiveness are guaranteed by the effective use of KLT integration and JWT authentication. Users may feel secure knowing that communication is easy and their data is safe.

(b) Real-Time Communication - High-quality real-time audio and video communication is made possible by the platform's incorporation of WebRTC. Webinars, online meetings, and cooperative sessions may be easily conducted by users.
(c) Data Optimization - By drastically cutting latency and data transmission times, the KLT algorithm produces better data handling. As a result, the user experience is quicker and more seamless.
(d) Scalability - The platform can adapt to a rising user base and increasing workloads with the help of load balancing and cloud-based solutions.
(e) Performance Optimization - To maintain the platform's high responsiveness, ongoing performance monitoring and optimization techniques are used.
(f) Data Privacy - Enhanced security measures and data encryption protect user privacy and data from unauthorized access.

Figure 4.1: First Interface for Making Room ID

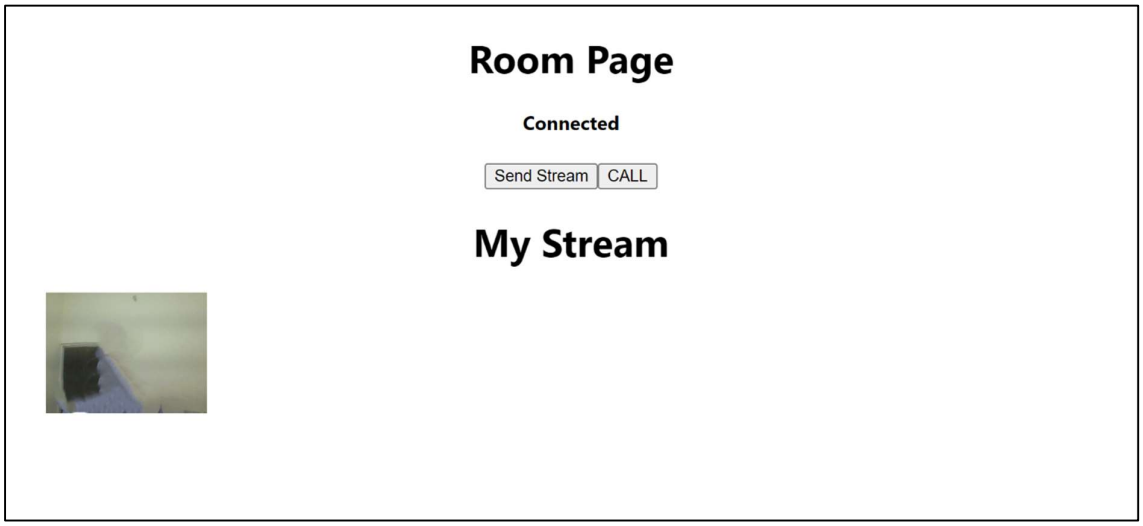

Figure 4.2: Room Created and Joined

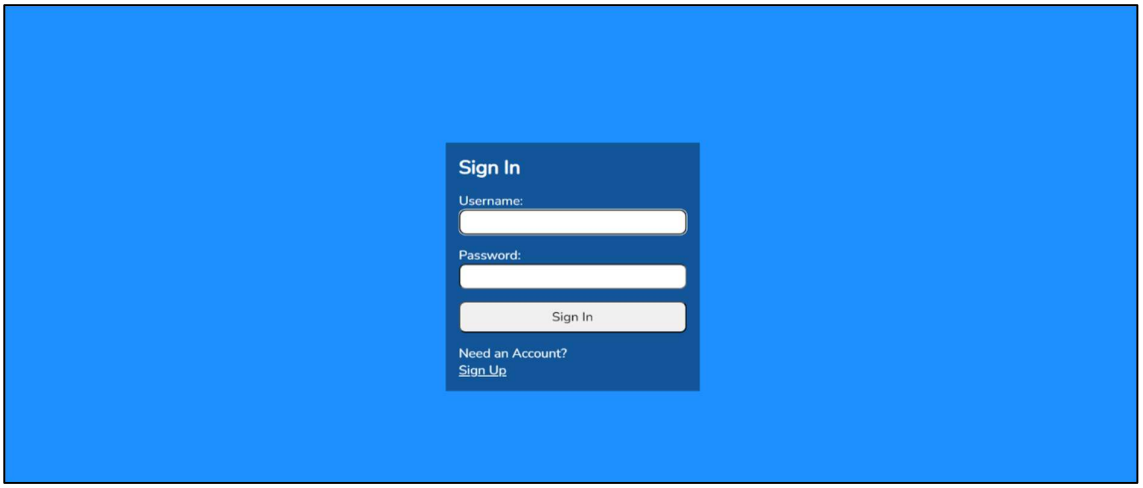

Figure 4.3: Sign-in Page for Room

4.2. Intuitive User Interface:

(a) Intuitive User Interface - The platform is now more user-friendly and intuitive thanks to the user interface improvements. It is simple for users to explore, adjust the audio and video settings, and participate in chat.

(b) User Training and Documentation - Up-to-date documentation and training materials enable users to get the most out of their experience and make efficient use of platform capabilities.

(c) Ongoing User Support - Having post-implementation user support and feedback gathering methods in place guarantees that users are satisfied and can quickly address any problems.

(d) Community Building - Collaborating and exchanging information are facilitated by cultivating a user community, which is advantageous to both users and developers.

4.3. Business and Impact Results:

(a) Competitive Advantage - In the virtual communication industry, the platform's cutting-edge features and security safeguards provide it a competitive advantage.

(b) User happiness - High levels of user happiness are a result of users' access to a dependable, safe, and user-friendly platform.

(c) Business development - By handling additional users and workloads, scalability and performance optimization promote business development.

(d) Community Engagement - Strong user communities promote more user involvement, adherence, and word-of-mouth referrals.

(e) Data Analytics and Insights - By gathering information on user activity, the platform may assist companies in making data-driven choices and enhancements.

(f) Research and Innovation - The project's dedication to R and D, especially in investigating sophisticated KLT algorithms, promotes innovation and places the platform at the forefront of data optimization technology.

(g) Innovation and Research - The project's commitment to research and development, particularly in exploring advanced KLT algorithms, fosters innovation and positions the platform at the forefront of data optimization technology.

(h) Adaptability - The modular design and ongoing development ensure that the platform can adapt to changing user needs and emerging technologies.
(i) Contributions to Virtual Communication - The project contributes to the advancement of virtual communication technology by providing a secure, efficient, and user-centric solution that meets the needs of individuals, businesses, and organizations.

5. Conclusion

The creation of a WebRTC-based video conferencing gateway with JWT authentication and KLT integration is a major milestone in the quickly changing field of digital communication. The goal of this project has been to provide a flexible and dependable platform for online collaboration. It has been a journey including innovation, security, and user-centric design. The outcome of this paper is evidence of our dedication to high technological standards. Users may confidently interact in real time because to the seamless integration of WebRTC, JWT authentication, and the Karhunen-Lo`eve Transform (KLT) algorithm. The platform contributes to a safe and effective user experience by providing appropriate data processing, data privacy, and high quality streaming of audio and video. Our efforts have been centered around user pleasure. Our commitment to providing users with the tools they need to feel empowered and have a pleasurable and smooth platform experience is shown in the user-friendly interface, user training materials, and continuous user support. The growth of a user base encourages cooperation and information exchange even more.
The project's performance optimization and scalability provide the groundwork for future expansion from a business standpoint. In addition to creating a competitive edge, we have also offered a solution that satisfies the various demands of both people and enterprises. Because of its flexibility, the platform can keep up with changing customer needs and new technological advancements. The project's performance optimization and scalability provide the groundwork for future expansion from a business standpoint. In addition to creating a competitive edge, we have also offered a solution that satisfies the various demands of both people and enterprises. Because of its flexibility, the platform can keep up with changing customer needs and new technological advancements. As we wrap up this project, we understand that it marks the start of a new chapter as well as the conclusion of a development cycle. We anticipate continuing upkeep, product improvements, and interaction with our user base. The road continues, and our commitment to provide a safe, effective, and user-focused virtual communication platform that brings people closer, facilitates collaboration, and fosters meaningful connections.
This WebRTC-based video conferencing platform was developed successfully, which is evidence of the collaboration between technological know-how, user-centred design, and innovative spirit. We are proud of what we've accomplished and look forward to this project's beneficial effects on the digital communication environment.

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