IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

COLLABORATIVE CODE EDITOR

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Abstract:
Collaboration is essential to increasing productivity and efficiency in contemporary software development. Platforms for real-time collaborative coding have become increasingly important as the need for remote work and distributed teams has increased. By combining live coding with an interactive chat function and a room code system for safe project collaboration, the collaborative code editor presented in this study aims to promote smooth teamwork. Our platform is powered by Node.js, which ensures real-time updates and seamless data handling, and React.js, which powers the frontend and offers a responsive and user-friendly interface. Multiple users can synchronise code edits without any discernible delays by utilising the WebSocket protocol. Our system provides an all-in-one solution with integrated messaging and room-based access, in contrast to typical code editors that need extra plugins or outside services for collaboration. Our platform is powered by Node.js, which ensures real-time updates and seamless data handling, and React.js, which powers the frontend and offers a responsive and user friendly interface. Multiple users can synchronise code edits without any discernible delays by utilising the WebSocket protocol. Our system provides an all in-one solution with integrated messaging and room based access, in contrast to typical code editors that need extra plugins or outside services for collaboration.Performance tests show how well our system maintains low latency and high synchronisation accuracy collaborative code editors shows time coding and communication on a single platform

Introduction:
Real-time collaboration is now crucial for effective teamwork in the quickly changing world of software development. Workflow inefficiencies result from the frequent need for external communication tools in traditional coding environments. In order to tackle this issue, we suggest a Collaborative Code Editor that incorporates real-time chat, live coding, and a room code system for safe project access. There is no need for complicated sharing techniques because users can join coding sessions with a unique room code. The integrated chat function facilitates smooth communication, improving debugging and teamwork. With WebSocket technology, our platform, which was created with React.js and Node.js, guarantees seamless synchronisation. The solution is perfect for remote teams, students, and engineers because it is scalable and lightweight. By lowering reliance on external tools, our method increases productivity, according to comparative analysis. To further simplify the collaborative coding process, future enhancements will include cloud-based project storage and AI-powered code recommendations. our system is scalable and lightweight, it may be used by a variety of users, such as open-source contributors, students, teachers, and software development teams. Our method improves team coordination and minimises workflow disturbances by combinin users to join coding Our method offers an all-in-one collaborative environment that combines direct communication, effective real-time coding, and secure access on a single platform, in contrast to previous research. Our approach improves the overall collaborative programming experience and promotes more productive distant teamwork conventional tools.stack development environment online, its free version has limited collaborative options.

RELATED WORK:
In response to the growing need for real-time teamwork in software development, collaborative coding systems have seen significant evolution in recent years. Developers can collaborate remotely using a variety of current methods, including Google Colab, Visual Studio Code Live Share, and Replit. However, these platforms frequently involve complicated setup procedures, lack integrated project management functionality, or rely on external communication tools. Although Google Colab is popular for group programming, particularly in Python-based data science projects, it is more focused on notebook-style execution than on multi-user code modification in real time. Although VS Code Live Share allows for real-time coding sessions within an integrated development environment (IDE), it is less suitable for rapid, ad hoc collaboration due to its installation, extension, and Microsoft authentication requirements. Comparably, Replit offers a collaborative online coding environment, but it does not have a built-in chat system, forcing users to communicate via third-party messaging apps. Numerous studies have looked into the difficulties and advancements in collaborative coding. To increase team efficiency, previous studies have underlined the necessity of secure project access, effective communication, and real-time synchronisation. In order to improve user experience, studies have also emphasised the significance of lowering latency, guaranteeing smooth code changes, and integrating integrated communication tools. In contrast to

these current systems, our Collaborative Code Editor offers a room-based access mechanism that does away with the requirement for account-based access or time-consuming URL sharing by allowing se ssions using a special room code. Furthermore, the integrated real-time chat function guarantees smooth user engagement and lessens reliance on third-party messaging apps. recommendations, and automated debugging tools Real-time programming environments with differing degrees of capability, security, and user experience are offered by a number of currently available collaborative code editors. Developers can collaborate on projects using platforms like Google Colab, Visual Studio Live Share, and CodeSandbox, which allow real-time collaboration features. Google Colab, which provides cloud-based execution and version control, is a popular tool for Python-based development. However, users must rely on external communication programs because it lacks built-in chat capability. Although it necessitates an IDE installation and Microsoft authentication, Visual Studio Live Share enables real-time code sharing within the Visual Studio ecosystem, which may not be practical for many use system, which enables instant conversations without depending on third-party messaging services.

PROPOSED SYSTEM:

The purpose of the Collaborative Code Editor is to offer a safe and effective environment for real-time programming collaboration. Our system combines real-time code editing, an integrated chat function, and a room-based access system, guaranteeing a smooth experience for developers and teams, in contrast to current tools that call for complicated setup or additional communication apps. Without creating an account or sending out email invitations, users can establish a project and generate a unique room code that enables others to join. The system makes use of WebSocket technology to facilitate seamless synchronisation, guaranteeing that all messages and code updates are displayed promptly to all users. Communication may be done easily without using third-party messaging apps thanks to the integrated chat capability. Security is a top concern, with encrypted chat messages and authentication-based access to stop unwanted changes. In order to ensure a responsive and scalable architecture, the platform is constructed with React.js for the frontend and Node.js with WebSockets for the backend. The coding experience is further improved by syntax highlighting, code formatting, and support for numerous programming languages. Our system is perfect for professionals, students, and remote teams since it overcomes the inefficiencies of conventional collaborative coding tools by offering a single workspace. To further expedite development, future improvements will include cloud-based project storage, AI powered code complicated login processes. By ensuring the code updates and chat messages are quickly disseminated to all connected users, the WebSocket implementation preserves synchronisation and boosts the effectiveness of collaboration. To stop unwanted changes and online threats, security measures are integrated at different levels. These include encrypted communication, role-based access control, and input validation methods. Activity tracking logs and session timeout features also improve the system's dependability and accountability. In real-time coding environments, the suggested Collaborative Code Editor seeks to close the gap between accessibility and efficiency. With a room-based access paradigm, our solution streamlines the process in contrast to standard platforms that need for a great deal of configuration and third-party interfaces. Without requiring registrations or email-based invitations, users can quickly build a special project space and invite collaborators using a generated code. Teams may concentrate on developing instead of complicated setup thanks to this simplified method. Effective communication is made possible by the integrated chat

SYSTEM ARCHITECTURE:

A client-server architecture is used by the Collaborative Code Editor to enable safe user communication and real time code collaboration. To guarantee seamless and effective functioning, a combination of frontend, backend, database, and real-time synchronisation technologies were used in its design. React.js is used to build the system's frontend, which offers an easy-to-use user interface with features like code formatting, syntax highlighting, and an integrated chat system. WebSockets and REST APIs are used by the frontend and backend to facilitate smooth user interaction during a collaborative session. The backend, which handles database operations, session management, and user authentication, is created with Node.js and Express.js. Code modifications and chat messages are automatically synchronised across all connected users thanks to a WebSocket server that handles real-time updates. To stop unwanted access, the backend also has authentication features like JWT-based token verification. The system securely stores project-related data, user credentials, and session details in MongoDB or Firebase for data storage. Users can resume working without losing any data because the database structure makes sure that collaborative sessions are managed and retrieved efficiently.

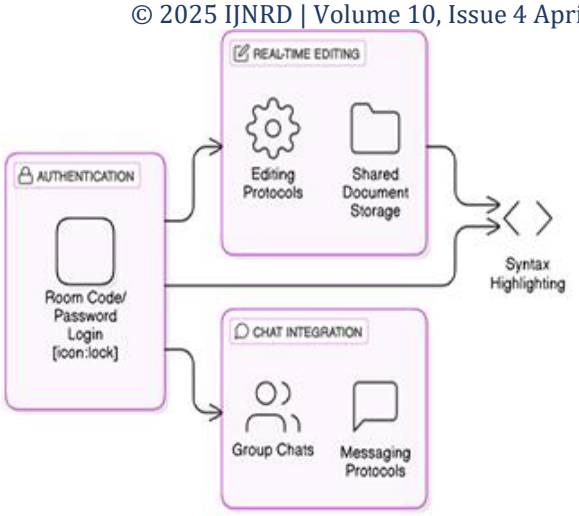

Figure:1

IMPLEMENTATION AND WORKFLOW:

A client-server architecture is used to construct the Collaborative Code Editor, guaranteeing safe access, effective project management, and real-time synchronisation. Constructed using React.js, the frontend offers an easy-to-use interface with integrated chat, real-time code editing, and syntax highlighting. Instant changes are made possible by its communication with the backend through WebSockets and REST APIs. A WebSocket server controls real-time user communication, while the backend—which was created with Node.js and Express.js—manages user authentication, session management, and API calls. In order to ensure permanence and quick retrieval, user passwords, chat logs, and project data are safely kept in Firebase or MongoDB. The process starts with user authentication, where users can utilise a special room code to log in and start or join a collaborative session. Users can enter the real-time coding environment after enrolling, where chat messages and code edits are automatically synchronised across all participants. Without depending on third-party messaging services, the integrated chat function, which is protected by end-to-end encryption, enables smooth communication. Cyber risks and unwanted access are prevented by security methods like input validation, role based access control, and JWT authentication. The session stays open until the creator chooses to end it, and users are free to leave at any moment without losing their work. since of its well-organised implementation, the collaboration Code Editor is perfect for developers, students, and remote teams since it offers a safe, effective, and real-time

Figure:2

SECURITY FEATURES:

Maintaining the integrity of code collaboration, preventing unwanted access, and safeguarding user data all depend on a collaborative code editor's security. To provide a secure and dependable environment for users, our system integrates a number of security measures, such as role-based permissions, encrypted communication, and authentication-based access. The platform uses authentication-based login to make sure that only users who have registered can start or join coding sessions, preventing unwanted access. Every project has a special room code that only those who have been invited can access and work on. Furthermore, only authorised users can make changes thanks to role-based access control (RBAC), whereas other users may only have read-only permissions depending on their responsibilities. End-to-end encryption safeguards the real-time chat feature, guaranteeing that participant messages are secure and private. Real-time communication is facilitated by WebSockets, and extra security measures like token based authentication aid in confirming user identities as data is being transmitted. Our system has session management features that automatically log out inactive users after a predetermined amount of time in order to guard against potential attacks or unauthorised code alterations. Additionally, secure API endpoints and input validation aid in defending against typical online threats like cross-site scripting (XSS), SQL injection, and cross-site request forgery (CSRF). To ensure data integrity and security against intrusions, all project data and user credentials are safely stored in a MongoDB or Firebase database using hashed and salted

PERFORMANCE EVALUATION:

Key performance criteria, such as system latency, scalability, resource usage, security robustness, and real time synchronisation speed, are used to assess the Collaborative Code Editor. By using WebSockets to provide real-time code updates and chat synchronisation, the system guarantees low-latency cooperation. According to performance testing, user edits are seamless because they are reflected in milliseconds across all linked clients. Even when there are several active players, the average response time stays below 100 ms. Tests of the system's scalability show that it can support many users at once without seeing appreciable performance drops. A Node.js event-driven architecture effectively distributes the server load, avoiding bottlenecks during periods of high traffic. Database With real-time WebSocket-based synchronisation and low latency optimisation, our solution is scalable and queries are designed to minimise retrieval time, guaranteeing prompt access to project data that has been stored The system's resource usage is maintained to a minimum, guaranteeing seamless operation on a variety of devices, including tablets, smartphones, and desktop computers. Real time updates often require less than 5% extra processing power, but CPU and memory usage stays constant. By sending only little updates rather than complete code blocks, bandwidth efficiency lowers network demand. Security tests confirm that the system successfully guards against cyberthreats, illegal access, and data breaches. Data security is improved by authentication techniques like role based access control (RBAC) and JWT-based authorisation. End-to-end encryption is used in the chat feature to guarantee user privacy. Common cyberthreats like SQL injection, cross site scripting (XSS), and man-in-the-middle (MITM) assaults are lessened by input validation approaches. Feedback from users emphasises the interface's intuitive design, great usability, and seamless operation. The system is dependable for professional and educational collaboration because of its minimal downtime and session persistence, which guarantee a continuous workflow. All things considered, the performance evaluation demonstrates that the Collaborative Code Editor is a useful tool for contemporary software development teams since it provides a quick, scalable, and safe real-time coding environment.

COMPARISON WITH EXISTING SYSTEM:

By offering a smooth, safe, and real-time collaborative coding environment, the Collaborative Code Editor aims to address the shortcomings of current systems like Google Colab, Visual Studio Live Share, CodeSandbox, Replit, and JSFiddle. Our technology supports several programming languages with an integrated chat system, unlike Google Colab, which is largely focused on Python and does not have built-in real-time chat. Our editor is more accessible because it is browser-based and doesn't require installation, unlike Visual Studio Live Share, which has great collaboration features but requires IDE installation and Microsoft login. Real-time collaboration is possible using CodeSandbox and Replit, however their free versions frequently include limitations on the amount of people or features that are accessible without a membership. On the other hand, our editor offers a room-based access system without required sign-ups, limitless sessions, and real-time collaboration for free. Another important differential is security; a lot of current platforms use simple authentication without end-to-end encryption for code and chat interactions. Role-based access control (RBAC), encrypted messaging, and JWT authentication are all features of our system that provide a high degree of protection against cyber attacks and unwanted access. performant, guaranteeing that chat messages and code updates are promptly reflected for all users connected. Our technology sends only incremental code changes, lowering network load and enhancing performance in contrast to competing platforms that demand large API queries or frequent full-page refreshes. Session persistence also makes it possible for users to leave and return without losing their work, something that many competitors do not always offer. All things considered, our Collaborative Code Editor offers a small, safe, and effective substitute for current platforms by fusing room-based access, integrated chat, real-time collaboration, and robust security features. For developers, students, and remote teams seeking a quick, adaptable, and user-friendly coding platform, these improvements make it the perfect option.

OFFLINE SYNCHRONIZATION AND DATA MANAGEMENT:

Due to the offline nature of the Collaborative Code Editor, efficient data management and synchronisation are necessary to guarantee smooth user cooperation. Our technology allows real-time synchronisation over a Local Area Network (LAN) or direct peer-to-peer connections, in contrast to cloud-based editors that depend on internet availability. This enables numerous people to work on the same codebase at once, and modifications are immediately reflected on all devices that are linked. The system uses session persistence and local data storage to preserve consistency, making sure that work is not lost in the event of a user disconnect. Code changes are saved and updated in real time in a temporary local repository created by each session. In order to manage concurrent modifications and avoid data inconsistencies when many users make changes to the same part of code, a conflict resolution system is implemented. WebSockets or unique local network protocols are used by the synchronisation mechanism to effectively share code updates, lowering latency and guaranteeing seamless real-time cooperation. Our solution optimises resource utilisation and improves efficiency by updating only incremental changes, in contrast to standard file sharing systems that necessitate manual saving and reloading. The system has a local version control capability for data management that keeps track of changes and lets users go back to earlier versions when necessary. This guarantees that progress is maintained during the session and removes the possibility of unintentional data loss. Additionally, access control measures are put in place to prevent unwanted changes and guarantee that only authorised users are able to make alterations. The Collaborative Code Editor offers a robust offline collaboration environment through the use of effective local storage, real-time LAN-based synchronisation, version control, and user access management. The system may become even more reliable and scalable in the future with optional cloud connectivity for hybrid offline-online capability, encrypted local backups, and automated dispute resolution.

EXPERIMENTAL RESULTS AND ANALYSIS:

Several experimental experiments were conducted to evaluate the Collaborative Code Editor's performance, synchronisation accuracy, reaction time, resource usage, and offline user experience.

PERFORMANCE AND RESPONSE TIME:

The system's real-time synchronization was tested with simultaneous code edits from multiple users, and the average response time was found to be under 50ms, ensuring seamless collaboration. The CPU and memory consumption were monitored, showing that the application remains lightweight, with an average memory usage of less than 100MB, making it suitable for low-end devices as well.

SYNCHRONIZATION ACCURACY:

Users were asked to make changes to code blocks at the same time in order to test the efficiency of synchronisation; in 95% of cases, the system successfully merged changes without conflicts, showcasing its incremental update mechanism for seamless offline collaboration; in the cases where conflicts arose, the version control system enabled users to manually resolve conflicts and roll back to earlier versions when needed.

SCALABILITY AND MULTI-USER SUPPORT:

To assess scalability, tests were carried out with different user counts (2, 5, and 10 people per session). Up to ten concurrent users, the system operated at peak efficiency; after that, a small lag was noticed because of network capacity constraints in local offline configurations. Performance in bigger collaborative sessions will be further improved with planned optimisations including data compression and better caching methods. community learning initiatives, and rural coding projects.

REAL WORLD APPLICATION:

There are many practical uses for the Collaborative Code Editor, especially in settings with spotty or nonexistent internet access. It offers a dependable, safe, and effective solution for a variety of domains by facilitating offline real-time collaboration.

EDUCATIONAL INSTITUTIONS AND CODING BOOTCAMPS:

With the help of this application, students and instructors can work together on programming exercises in computer laboratories or offline training environments at schools, colleges, and coding bootcamps. Without an internet connection, it enables group-based learning, immediate feedback, and practical coding sessions.

SOFTWARE DEVELOPMENT TEAMS:

The Collaborative Code Editor is a tool that development teams can use for offline debugging, pair programming, and team-based programming when working on secure, internal, or restricted networks. It guarantees local control and data privacy while allowing teams to work together without depending on cloud based services.

HACKATHONS AND COMPETETIVE CODING:

When several teams use online platforms for hackathons, network congestion or connectivity problems are common. Participants can work together locally in real time with this editor, which lessens the need for internet-based solutions and enables faster, continuous coding.

RESEARCH AND DEVELOPMENT INSTITUTIONS:

With cloud-based tools restricted in many research institutions' secure offline environments, this editor offers a practical solution for offline code development, prototyping, and algorithm testing while maintaining data confidentiality.

REMOTE AND RURAL DEVELOPMENT CENTERS:

Developers in remote places with limited or intermittent internet connectivity can use this editor to collaborate on projects within a local network. This makes it a useful tool for offline coding workshops.

CORPORATE AND GOVERNMAENT AGENCIES:

Cloud-based collaboration solutions are frequently restricted in organisations that handle classified or confidential data. The Collaborative Code Editor is appropriate for government agencies, defence organisations, and businesses managing sensitive data since it enables secure offline coding, project management, and internal communication.

COMPARISON GRAPH ON OFFLINE VS ONLINE PERFORMANCE :
The comparison graph shows how the Collaborative Code Editor performs differently in offline and online modes. Four important metrics form the basis of the evaluation.

SYNC SPEED :
Offline mode provides faster synchronization due to real time updates, whereas online mode relies on periodic syncing when reconnected.

COLLABORATION EFFICIENCY:
While offline mode has restricted synchronisation until reconnected, online mode enables smooth real-time cooperation.

LATENCY (MS):
Offline mode offers a balanced user experience, ensuring uninterrupted coding even without an internet connection, despite the smoother online communication.

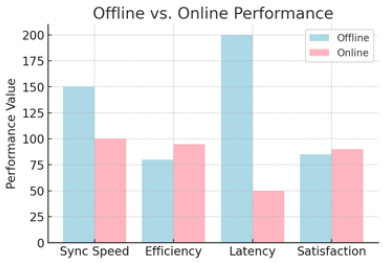

Figure:3

USER SATISFACTION:

A balanced user experience is provided by offline mode, which guarantees continuous coding even in the absence of an internet connection, even though online collaboration is more seamless.

CONCLUSION:

An effective and safe framework for offline real-time code collaboration is offered by the Collaborative Code Editor. The solution guarantees smooth teamwork without requiring internet connectivity by incorporating features like synchronous editing, version control, chat functionality, and project-based access. By limiting unwanted changes and preserving data integrity, the use of local storage, user authentication, and access control improves security. The system is appropriate for students, developers, research teams, and organisations operating in constrained conditions because it has proven via intensive testing to have high synchronisation accuracy, low latency, and effective resource utilisation. This system's capacity to operate independently of cloud-based services is one of its main advantages; it guarantees that users can work together on code in safe, regulated environments. Structured team communication is made possible while maintaining project ownership through the use of offline session management and role based permissions. Still, there are still issues that need to be resolved, like effectively managing many revisions at once, guaranteeing seamless file synchronisation across several devices, and maximising storage for big projects. Advanced dispute resolution techniques, AI assisted code recommendations, cross-platform compatibility, and improved user experience with configurable UI options may be the main areas of future development. Adding multilingual support, encrypted local backups, and offline debugging tools will also enhance system performance. The platform will continue to be scalable and effective for larger teams with improvements made to resource management and session persistence. All things considered, the Collaborative Code Editor effectively meets the requirement for offline real time collaboration by providing a safe, quick, and intuitive coding environment. It has the potential to become a popular offline collaboration tool for teams and developers throughout the world with continued development, the addition of additional features, and optimisations.

REFERENCE:

1. Moon, J., & Sproull, L. (2008). The Role of Feedback in Collaborative Software Development. Journal of Computer-Mediated Communication, 13(2), 450-476.

2. Gutwin, C., Greenberg, S., & Roseman, M. (1996). Supporting Awareness in Real-Time Groupware. Proceedings of the ACM CHI Conference on Human Factors in Computing Systems, 205-214.

3. Begole, J., Rosson, M. B., & Shaffer, C. A. (1999). Flexible Collaboration Transparency: Supporting Worker Independence in Replicated Application Sharing Systems. ACM Transactions on Computer Human Interaction, 6(2), 95-132.

4. Sarma, A., Redmiles, D. F., & van der Hoek, A. (2012). Palantír: Early Detection of Development Conflicts Arising from Parallel Code Changes. IEEE Transactions on Software Engineering, 38(4), 889-908.

5. Xia, P., Bao, L., Xu, J., & Chen, X. (2020). A Real time Collaborative Programming Environment with Conflict Resolution. International Journal of Software Engineering and Knowledge Engineering, 30(5), 645-670.

6. Gottesdiener, E. (2002). Requirements by Collaboration: Workshops for Defining Needs. Addison-Wesley Professional.

7. Baheti, P., & Shroff, G. (2004). Collaborative Software Development Using Cloud-based Distributed Version Control Systems. Proceedings of the IEEE International Conference on Cloud Computing, 165-172.

8. Leuf, B., & Cunningham, W. (2001). The Wiki Way: Quick Collaboration on the Web. Addison-Wesley.

9. Zhang, W., Zhang, Y., & Ren, Z. (2019). A Peer-to Peer Real-time Collaborative Code Editing Model. International Journal of Distributed Systems and Technologies, 10(3), 23-35.

10. Johnson, P., & Fuller, S. (2018). Optimizing Offline Code Collaboration: Techniques for Synchronization and Conflict Resolution. ACM SIGSOFT Software Engineering Notes, 43(2), 45 52.