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A Real-Time Artificial Intelligence System for Collaborative Document Editing and Workload Optimisation

NWOZOR, B. U. [1,*], *OBICHIE, O. F.*[2]

[1]*Department of Computer Science, Federal University of Petroleum Resources, Effurun Delta State*

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ABSTRACT

Managing and collaborating on documents has long been integral to work, education, and communication. In the digital age, these tasks demand greater speed, flexibility, and security. This dissertation proposes a Real-Time AI-Powered Document Editing System for Collaborative Workflows, designed to address the challenges of simultaneous multi-user editing, access control, and data protection. The primary aim is to develop a platform that enables multiple users to edit the same document in real-time with synchronized updates and intelligent conflict resolution. The system integrates an AI-driven permission management module that assigns and adjusts user roles dynamically, based on contextual analysis and behavioral patterns. To safeguard document integrity and user data, the system also includes encrypted file access, automated activity logging, and access anomaly detection. The solution is developed using an Object-Oriented Approach, paired with the Rapid Application Development (RAD) methodology. This ensures a modular, user-focused design process with frequent iterations and fast prototyping. The choice of RAD supports responsive adaptation to user feedback and evolving requirements during the development cycle. This research demonstrates how the combination of real-time collaboration, artificial intelligence, and secure design principles can enhance document management systems. The outcome is a scalable and intelligent platform that aligns with the growing demand for collaborative, efficient, and secure digital workspaces.

1. INTRODUCTION

Managing and collaborating on documents has always been a significant part of human work, education, and communication (Fong et al 2003). In today's digital age, the process has evolved significantly with the help of technology. For instance, if a contract needs periodic reviews, you can set reminders for notifications. Similarly, when files reach the end of their workflow, they may need to be securely sent to third parties or archived internally. In some cases, regulatory compliance mandates that certain documents must be archived or destroyed after a set period (Stoneburner et al 2002). These tasks, while often time-consuming and error-prone when handled manually, can now be automated with systems designed for efficiency and oversight. The rise of Artificial Intelligence (AI) has brought about transformative tools that redefine how we interact with documents. Among these tools are real-time AI-driven document editing systems (Ooi et al 2023). Unlike traditional platforms, these systems enable live

*Corresponding author, e-mail: nwozor.blessing@fupre.edu.ng, donfavdeking@Gmail.com

collaboration, adapt dynamically to user inputs, and intelligently manage content. Additionally, they incorporate automated permission management to ensure secure and controlled access to files, addressing growing concerns about data security and regulatory compliance in an increasingly interconnected world. Document editing has long been a cornerstone of various fields, including business, education, research, and communication (Sjoeberg et al, 2006). While traditional platforms have offered basic features like formatting and editing, they often fail to meet the demands of modern collaborative workflows. These workflows require systems capable of handling simultaneous edits, resolving conflicts, and protecting sensitive data. AI-driven editing systems overcome this challenge by leveraging advanced algorithms for text analysis, grammar correction, predictive editing, and intelligent suggestions. Such features not only improve efficiency but also ensure the quality and integrity of the documents being edited (Dwevidi et al, 2023). The demand for real-time collaboration tools is rooted in human nature. Collaboration has always been central to human progress, and technology, it mirrors how people naturally work together toward common goals. Whether multiple users are working on a document, surgeons are collaborating on surgeries via robotic controllers, or teams are managing corporate tasks in real-time, the concept remains consistent: using technology to facilitate near-instantaneous cooperation. Document collaboration is one of the most widely recognized forms of this technological application (Schneider et al, 2012). For example, tools like Google Docs enable users to edit a document simultaneously, providing a near-real-time experience that mimics physical collaboration. This concept extends to other fields, such as healthcare, where collaborative technologies enable remote surgeries, or construction, where machinery operators use shared tools across global sites. Corporate processes like project management, HR, and task planning also rely on similar systems to enhance productivity (Datta et al, 2005). However, the seamless operation of such collaborative systems presents challenges. Real-time document editing, particularly when integrated with automated permission management, must address technical requirements like availability, scalability, and security. For instance, in fields such as medicine, where failure is not an option, collaborative systems must be stable and reliable under all circumstances. This paper explores how modern AI-powered systems overcome these challenges to deliver efficient, secure, and scalable solutions. These systems bring a new level of sophistication to permission management**.** Traditional methods often rely on manual configurations, which can be inefficient and prone to errors. Intelligent permission management uses AI to automatically assign and adjust access rights based on user roles, behavioural patterns, and context. For instance, a user accessing sensitive information might only receive view-only permissions unless their role authorizes editing. This approach not only enhances security but also reduces administrative burdens. The integration of real-time collaboration and automated permission management demonstrates the vast potential of AI in modern workflows. By addressing key challenges such as availability, scalability, and disaster recovery, these systems provide robust solutions for industries where precision and security are paramount. From education and healthcare to finance and industrial engineering, the applications of these technologies are vast and transformative. This system combines advanced technology with human-centred design to create tools that are not only efficient but also secure and

reliable. With the integration of Artificial Intelligence (AI)-driven automation, document editing is poised to undergo an important transformation. AI-powered systems enable real-time collaboration, where users whether company employees, external clients, or other stakeholders can seamlessly work together on a single document without delays or disruptions (Ooi et al, 2023). One of the key advantages of this technology lies in its intelligent permission management, which ensures that access control is dynamically monitored and enforced. This eliminates the risks of file corruption or unauthorized access that often plague manually managed systems. Such AI-driven advancements are not just convenient; they are a necessity in today's fast-paced, digital-first business environment. By enabling organizations to streamline workflows, enhance productivity, and maintain robust security measures, these systems lay the foundation for efficient collaboration (Hendriksen, 2023). Unlike traditional approaches, where manual oversight often introduces inefficiencies, real-time integration of AI ensures that documents are updated instantly while preserving their integrity. The adoption of these technologies reflects the growing need for Industry 4.0 solutions, where AI intersects with other emerging technologies such as the Internet of Things (IoT), blockchain, and cloud computing. This convergence is driving radical changes across industries, creating competitive advantages for businesses that embrace automation while addressing the demands of modern digit**.**

Text editors have come a long way since their early days, but even modern editors owe much to their earliest predecessors. Here's a quick look at the origins of text editing and its evolution from the punch card era. The advent of time-sharing systems and the teletype in the 1960s marked a turning point, enabling program editing for the first time. Instead of relying on punch cards, users could interact with computers in real time using an electromechanical typewriter-printer combination (Gugerli, 2022). Despite this advancement, early text editors were still rudimentary due to limited memory and slow response times. In 1965, the "Quick Editor" (QED) emerged as one of the first line-based text editors. Ken Thompson, a key contributor to the Unix operating system, later improved QED at Bell Labs, introducing features like regular expression search, text buffers, and macros. By 1971, as QED became increasingly complex and hardware advanced, Thompson developed a simplified version called ed, which debuted with the first version of Unix. Although ed retained the basic line-editing model, it pared down regular expressions and omitted multiple buffers (Mitchell et al, 2018). Its cryptic commands prompted the creation of alternative editors, notably em and ex.

By 1976, cheaper CRT displays allowed terminals to show multiple lines simultaneously, revolutionizing text editing. Bill Joy built on ideas from em and Bravo to add a screen mode to ex, resulting in the creation of vi (Senior, 1875). That same year, the first version of Emacs was introduced. Unlike vi, emacs was based on the Editor rather than ed (Kelty, 2008). Early emacs versions featured advanced macros and unified commands, but vi gained broader adoption, partly due to Bill Joy's involvement in Unix development. In 1985, Richard Stallman launched GNU emacs as the first project of the GNU initiative, implementing a full LISP interpreter. This free version of emacs was eventually ported to Unix and other platforms, solidifying its place as the most popular emacs variant, with active maintenance continuing today. In 1991, Bram Moolenaar released Vim (Vi Improved) for the Amiga, later expanding its

reach to nearly all Unix systems. Vim introduced significant enhancements, including plugins, syntax highlighting, improved macros, and an integrated help module (Andersen et al, 2020). While the last major Vim release was in 2010, its vibrant plugin ecosystem remains active.

Today, text editors have become more sophisticated, featuring graphical interfaces, integrated compilers, and debugging tools. Yet, traditional text-based editors like vi and emacs remain popular among developers for their efficiency in navigating and editing source code, even though they have steeper learning curves. Despite being over two decades old, these editors' influence persists. Many developers still use 80-character line limits, a practice rooted in punch card constraints, and emacs shortcut keys remain functional across numerous applications.

1.1 Evolution of Collaborative Document Editing

Before the internet revolutionized communication, collaborative document editing was an in-person activity (Greenhow et al, 2009). Professionals had to gather physically to review, revise, and finalize text documents. Despite its limitations, this practice was a fundamental aspect of organizational workflows, especially in drafting critical documents like contracts, policies, and marketing materials (Wickert et al, 2016). For centuries, collaboration on written documents was conducted face-to-face, often with drafts and revisions circulated in physical formats like handwritten notes or typed manuscripts. For example, legal teams would meet to negotiate and refine contracts, and marketing teams would review ad copy together. While effective in fostering direct communication, this method was time-consuming and often prone to errors due to misaligned updates or misplaced drafts. The advent of personal computers in the late 20th century brought a seismic shift in how text documents were created and edited. Word processors like Microsoft Word and WordPerfect became essential tools for professionals, offering features that transformed collaborative editing. One of the most significant innovations was the introduction of “track changes” and commenting functionalities. These tools allowed users to suggest edits, highlight changes, and leave detailed notes within the document itself (Page et al, 2021). This eliminated the need for separate annotations on printed copies, streamlining the review process. Early word processors also improved version control by enabling users to save multiple iterations of a document. This made it easier to revert to previous versions if needed. However, without centralized storage systems, managing versions across multiple users still posed challenges. As companies adopted local area networks (LANs), collaborative editing took a step forward. Documents could now be shared across office computers, enabling teams to work on files without needing to physically exchange floppy disks or printed copies. Despite this progress, collaboration was still limited to individuals within the same physical office space or network (Morandi et al, 2012). Remote collaboration remained cumbersome, requiring files to be sent via email or physical media, which often led to issues like version mismatches or lost edits. Even with the advancements of LANs and email, document collaboration was far from seamless. While tools like Microsoft Word and WordPerfect introduced groundbreaking features, they were confined by the technology of their time (Dougherty and O’Donnell, 2015). Without cloud storage or internet-based file sharing, real-time collaboration was impossible. Documents existed in silos, with updates requiring manual distribution to collaborators. This resulted in inefficiencies,

such as delays in consolidating feedback or resolving conflicts between multiple edits. Despite these limitations, the groundwork laid by early word processors set the stage for modern collaborative tools. The ability to track changes, comment on specific sections, and manage version histories was a significant leap forward. These features, which are now taken for granted, were transformative when they first appeared, paving the way for the robust, real-time collaboration that internet-based platforms would later enable (Volmar and Stine, 2021).

1.2 Traditional Document Collaboration

Traditional document collaboration tools have transformed the way content teams work by enabling both asynchronous and distributed editing (Slater and Sanchez-Vives, 2016). With the emergence of better communication tools, emails and video calls became integral to team interactions and remain popular methods for sharing information, especially among external teams. Emails provide a platform for multiple collaborators, including those outside the immediate team, to share ideas, suggestions, and feedback during the document creation process (Dwivedi et al, 2023). This asynchronous approach allows contributors to respond and make changes at their convenience, ensuring flexibility and accommodating diverse schedules. On the other hand, video calls facilitate synchronous document editing, mirroring the advantages of in-person collaboration (Slater and Sanchez-Vives, 2016). They allow content teams, even those spread across the globe, to discuss and edit documents in real time, fostering immediate communication and clarity. However, the efficiency of these methods heavily relies on the availability of collaborative real-time editors like Google Docs or Microsoft Word Online (Gallaugher, 2015). Such tools simplify document production by providing centralized platforms for simultaneous editing and version control. Without these tools, managing document versions becomes challenging, leading to disorganized content management. Despite their benefits, these tools are not without drawbacks. Even with real-time editors, teams often struggle to locate relevant information within lengthy email threads. Similarly, scheduling and attending video calls can become a frustrating task, particularly for distributed teams with varying time zones and availability.

Another significant drawback is the issue of unintended participation. Collaborators frequently find themselves part of email chains or video calls that do not concern them, leading to wasted time and decreased productivity.

1.3 In-Person Collaborative Editing

In the pre-digital era, collaborative document editing involved assembling members of the documentation team in one room, often using a whiteboard or printed drafts to brainstorm, strategize, and refine content. Although many teams still use this method, it was once the standard practice when documents were primarily created and shared on paper.

One key advantage of in-person collaboration is the immediacy of face-to-face interactions during content creation (Gikas, and Grant, 2013). This approach allows team members to exchange ideas, clarify doubts, and resolve ambiguities effectively in real-time (Boote and Beile, 2005). Non-verbal cues, such as body language and tone of voice, enhance understanding and facilitate more accurate communication (Elo and Kyngäs, 2008). These qualities make in-person collaboration uniquely suited for complex discussions that require active participation from all stakeholders.

However, this method comes with notable limitations.

i. *Dependence on Physical Proximity:* In-person editing requires all team members to be present in the same location. This restricts participation to those who are geographically close, leaving remote contributors unable to engage in the process effectively.
ii. *Scheduling Challenges:* Coordinating schedules to ensure that everyone is available simultaneously can be time-consuming, especially in larger teams. Aligning calendars to accommodate discussions often leads to delays in the editing and approval process.
iii. *Lengthy Review Cycles:* The need for multiple meetings to review, discuss, and finalize documents can significantly extend the overall timeline. Setting up meetings, gathering everyone together, and resolving outstanding issues in person adds logistical complexity.
iv. *Resource-Intensive*: In-person collaboration demands substantial resources, including time, physical space, and transportation. For companies with distributed teams or limited budgets, these requirements can make this method impractical or inefficient.

According to Lau and Lee (2012) in-person collaborative editing promotes deeper interpersonal connections and reduces communication gaps, its constraints have led many organizations to adopt more flexible, technology-driven approaches. As remote work and digital tools gain prominence, teams now have access to collaborative methods that streamline processes without requiring everyone to be in the same room.

1.4 Online Collaborative Document Editing

Real-time collaborative editing software, such as Google Docs and Microsoft Word Online, has greatly transformed the way teams approach content production workflows (Bulger et al, 2011). These tools have made it possible for individuals to work on the same document simultaneously, regardless of location, eliminating the need for long email threads or time-consuming video calls (Dwivedi et al, 2021). One of the most transformative aspects of these platforms is their ability to streamline collaboration through features like tagging, commenting, and suggesting. Tagging allows team members to assign tasks or draw attention to specific sections of the document, ensuring clarity in responsibilities. Commenting facilitates in-context discussions, enabling contributors to provide feedback directly on relevant parts of the text. Suggesting mode allows edits to be proposed without altering the original content, giving teams greater control over revisions. These functionalities have become indispensable for users, addressing many of the inefficiencies associated with traditional collaboration methods. For instance, in-person meetings, once necessary for brainstorming and document review, often required significant coordination and resources. Real-time collaborative tools eliminate this hurdle, allowing ideas to flow freely without the need for physical presence. Also, the issue of managing disorganized email threads, where feedback can become lost or confusing, is resolved by these platforms. Comments and changes are centralized within the document itself, providing a clear and cohesive record of all edits and discussions (Bennett and Segerberg, 2011). Similarly, the logistical challenges of scheduling video calls, particularly for distributed teams across different time zones, are mitigated by the asynchronous and real-time capabilities of

these tools. By simplifying communication and enhancing document management, real-time collaborative editing software has revolutionized the way teams create and refine content (Ooi et al, 2023). These tools continue to shape modern workflows, making collaboration more efficient and accessible than ever before.

2. OVERVIEW OF WORD PROCESSING SOFTWARE

The history of the word processor is a fascinating journey from simple typewriters to sophisticated digital tools that revolutionized how we create and edit text. Below is a brief exploration of the key developments that shaped modern word processors. The roots of word processing trace back to the invention of the typewriter in the 1860s. The first commercially successful typewriter, developed by Christopher Latham Sholes and marketed by Remington in 1874, allowed for faster and more legible writing compared to handwriting (Heide, 2010). Though purely mechanical, the typewriter was the precursor to word processors, as it formalized the concept of text creation in a structured format. This invention set the stage for future advancements by introducing features like the QWERTY keyboard, which remains a standard today (Schmiedchen et al, 2022). By the 1930s, the electric typewriter was introduced, significantly improving typing efficiency. IBM played a leading role in this era with the release of the IBM Electric Typewriter in 1935. These machines replaced manual key presses with electrically powered mechanisms, allowing for smoother operation and faster typing (Leveson, 2012). By the 1950s, additional features, such as proportional spacing and automatic carriage return, enhanced the user experience, making text creation more seamless. While still limited to linear text production, electric typewriters were a major step toward automated document processing. The 1960s saw the introduction of electronic word processing systems, which began to integrate text storage and editing capabilities. IBM's Magnetic Tape Selectric Typewriter (MT/ST), launched in 1964, was a groundbreaking device that allowed users to save documents on magnetic tape for future editing. This innovation marked the first-time text could be stored electronically, paving the way for more advanced systems. In the 1970s, Wang Laboratories became a leader in dedicated word processing machines, offering devices with screens for displaying text, storage options, and features like text formatting. These machines were widely adopted in business environments, as they provided significant efficiency improvements over manual and electric typewriters (Gordon, 2012). The 1980s brought a seismic shift in word processing with the advent of personal computers (PCs). Early software-based word processors replaced bulky dedicated machines, offering more flexibility and functionality. Key players in this era included WordStar (introduced in 1978), which became the first popular word-processing software, and WordPerfect (1980), known for its robust features and wide compatibility. In 1983, Microsoft Word was released, initially for MS-DOS and later for Windows. Microsoft Word introduced user-friendly features like pull-down menus and support for mouse input, making word processing accessible to a broader audience. PCs and software-based word processors made it possible for individuals and businesses to produce professional-quality documents at lower costs. The 1990s witnessed the proliferation of graphical user interfaces (GUIs) in word processing software. Programs like Microsoft Word for Windows and Corel WordPerfect introduced WYSIWYG (What You See Is What You Get) editing, where the on-screen

text mirrored the printed output. This made formatting and layout design intuitive, significantly enhancing usability. Additional features, such as spell check, grammar check, and templates for document creation, became standard during this time. These advancements empowered users to create polished, professional documents without requiring technical expertise. With the rise of the internet and cloud computing, word processing underwent another transformation. Online tools like Google Docs (introduced in 2006) offered real-time collaboration, automatic saving, and access from any internet-connected device. These tools revolutionized teamwork, enabling multiple users to edit and comment on the same document simultaneously. Microsoft Word also transitioned to the cloud with the introduction of Office 365, integrating similar collaborative features. These platforms offered a hybrid experience, combining the power of desktop applications with the convenience of online accessibility (Basak et al, 2018). Today, word processors are sophisticated tools that go beyond text creation. Features like integrated compilers, advanced formatting, multimedia embedding, and even artificial intelligence for content suggestions are now commonplace. Programs like Google Docs, Microsoft Word, and Apple Pages offer seamless integration with other software and devices, making them indispensable for personal and professional use (Cohen and Wang, 2014). Despite these advancements, many modern practices, such as the 80-character line limit, trace back to early word processing technologies and punch card constraints. Also, shortcut keys developed for early systems like emacs still influence the design of current tools.

2.1 Google Docs

Google Docs is a cloud-based word processing tool developed by Google, part of the Google Drive suite of productivity tools. Launched in 2006, it revolutionized the way people create, edit, and collaborate on documents by providing a seamless, real-time editing experience. Unlike traditional word processing software that requires local storage, Google Docs allows users to access and edit their documents from any device with an internet connection (Crescente and Lee, 2011). One of the key features of Google Docs is its real-time collaboration functionality. Multiple users can work on the same document at the same time, making edits, leaving comments, and suggesting changes (Strauss, 1987). Each participant's contributions are highlighted with different colours, making it easy to track changes and maintain clarity on who made each update. The ability to tag collaborators in comments ensures that feedback is directed to the right people, streamlining communication within teams. In addition to collaboration, Google Docs offers a range of tools to enhance document creation. These include basic text formatting options, support for images and tables, and a variety of add-ons that extend its functionality. Google Docs also supports version control, meaning that every change made to a document is automatically saved, and users can access a full revision history to review past edits and restore earlier versions if needed. Another advantage of Google Docs is its integration with other Google Workspace tools, such as Google Sheets, Google Slides, and Gmail, making it easy to switch between different tasks and seamlessly incorporate data from other documents into your work. Security and sharing are also central to Google Docs. Users can set permissions for who can view, comment, or edit a document, and these permissions can be adjusted at any time

(Estrin, 2010). Additionally, Google Docs is encrypted, ensuring that your documents are stored securely in the cloud. Overall, Google Docs has become an indispensable tool for individuals, businesses, and educational institutions, offering an easy-to-use, collaborative, and versatile platform for document creation and editing.

2.2 Microsoft Word Online

According to Miller (2019) Microsoft Word Online is the cloud-based version of Microsoft Word, part of the Microsoft 365 suite of productivity tools and it provides users with a familiar word-processing interface while offering the convenience and flexibility of cloud-based access. Released as a part of the broader shift towards online productivity tools, Word Online is designed to be used directly from a web browser, eliminating the need for users to install software on their devices (Badger et al, 2012). One of the standout features of Microsoft Word Online is its real-time collaboration capabilities. Just like its desktop counterpart, users can work on documents simultaneously, making edits, adding comments, and reviewing changes in real-time. This collaborative environment allows teams to seamlessly work together on a document, regardless of location, making it particularly beneficial for remote work and distributed teams (Gilson et al, 2014). In addition, Word Online keeps track of all changes with version history, enabling users to see previous edits and restore earlier versions when necessary. The tool supports a wide range of formatting options similar to the desktop version of Word. Users can insert images, tables, hyperlinks, and other multimedia elements, format text, and customize their documents to meet professional standards (Money and Agius, 2007). Word Online also integrates with other Microsoft 365 apps, such as Excel, PowerPoint, and OneNote, making it easy to collaborate across different formats and seamlessly incorporate data from other documents. One significant advantage of Microsoft Word Online is its compatibility with traditional Microsoft Word files (.docx), ensuring that users can easily share documents across different platforms without losing formatting or functionality. Additionally, it offers cloud storage through OneDrive, so documents are automatically saved and accessible from any device with an internet connection. Microsoft Word Online also provides robust sharing and permission options. Users can control who has access to a document, choosing whether individuals can view, comment, or edit the content. Permissions can be adjusted at any time, ensuring that only the intended users have access to sensitive documents. Furthermore, like Google Docs, Word Online is encrypted, providing a high level of security for stored documents.

Overall, Microsoft Word Online combines the robust features of traditional Microsoft Word with the flexibility and convenience of cloud-based collaboration. It offers a reliable, user-friendly platform for creating, editing, and sharing documents, making it an essential tool for both personal and professional use.

2.3 Importance of Real-Time Collaboration in Modern Applications

Real-time collaboration has become a cornerstone of modern applications, enabling users to work together seamlessly, regardless of location. In an increasingly interconnected world, the ability to collaborate instantaneously is critical for enhancing productivity, improving communication, and driving innovation (Buhalis and O'Connor (2005). One of the primary benefits of real-time collaboration is its ability to streamline workflows. Traditional methods of

collaboration, such as email exchanges or periodic updates, are often time-consuming and prone to delays. Real-time applications, like Google Docs or Slack, allow multiple users to edit, comment, and share updates instantaneously, ensuring that projects progress efficiently. This capability is particularly valuable in industries where speed and accuracy are crucial, such as software development, healthcare, and financial services.

Real-time collaboration also enhances decision-making processes by providing immediate access to shared resources and insights (Frenk et al, 2010). Teams can brainstorm, review data, and implement solutions collectively, fostering a dynamic environment that promotes innovation. For instance, during a crisis, real-time collaboration tools enable rapid coordination, reducing response times and mitigating risks effectively. In addition, these applications play a significant role in bridging geographical and cultural divides. As remote work becomes the norm, tools like Microsoft Teams and Zoom facilitate virtual meetings, enabling diverse teams to interact as if they were in the same physical space. This inclusivity not only enhances team cohesion but also allows organizations to tap into global talent pools. Real-time collaboration improves transparency and accountability. By tracking changes, contributions, and interactions in real time, modern applications provide clear visibility into who did what and when (Swan, 2012). This fosters trust among team members and helps in identifying and addressing bottlenecks.

The demand for real-time collaboration in modern applications continues to grow, driven by advancements in cloud computing, low-latency networks, and AI integration (Akyildiz, Kak and Nie, 2020). These tools are no longer just conveniences but essential components of contemporary workflows. Organizations that embrace real-time collaboration are better positioned to adapt to evolving challenges, enhance user experiences, and maintain a competitive edge in a fast-paced digital landscape.

3. METHODOLOGY

A methodology refers to a structured framework of principles, techniques, and procedures applied within a specific field of study to guide the systematic analysis, design, and implementation of a project. This study employs an Object-Oriented Approach in conjunction with the Rapid Application Development (RAD) methodology, ensuring an iterative, user-centric design that facilitates faster development cycles and adaptive refinements. The implementation leverages the MERN stack—a full-stack JavaScript framework comprising MongoDB, Express.js, React.js, and Node.js—which provides a seamless integration between frontend and backend operations.

MongoDB serves as the system's database management solution, utilizing a document-oriented NoSQL architecture that stores data in a flexible JSON-like format. This schema-less approach enhances scalability and accommodates dynamic data structures, making it ideal for modern web applications. The backend logic is powered by Express.js, a minimalist yet powerful web framework built on Node.js, facilitating the development of RESTful APIs and middleware functionalities. Express.js is an open-source framework, licensed under MIT, ensuring flexibility and extensibility in backend service architecture.

On the front end, the system utilizes React.js, a declarative and component-based JavaScript library optimized for building dynamic and interactive user interfaces. To enhance performance, maintainability, and AI-driven capabilities, the author has upgraded React.js to Next.js 14, leveraging

its server-side rendering (SSR) and static site generation (SSG) features for faster load times and improved SEO.

Finally, Node.js functions as the runtime environment, enabling asynchronous, event-driven programming across multiple operating systems, including Linux, macOS, and Windows. Its non-blocking, I/O model significantly enhances application responsiveness, making it an efficient choice for handling concurrent client requests in a scalable web ecosystem.

This combined methodology ensures a robust, high-performance application architecture, aligning with modern software engineering best practices.

3.2 Analysis of Existing System

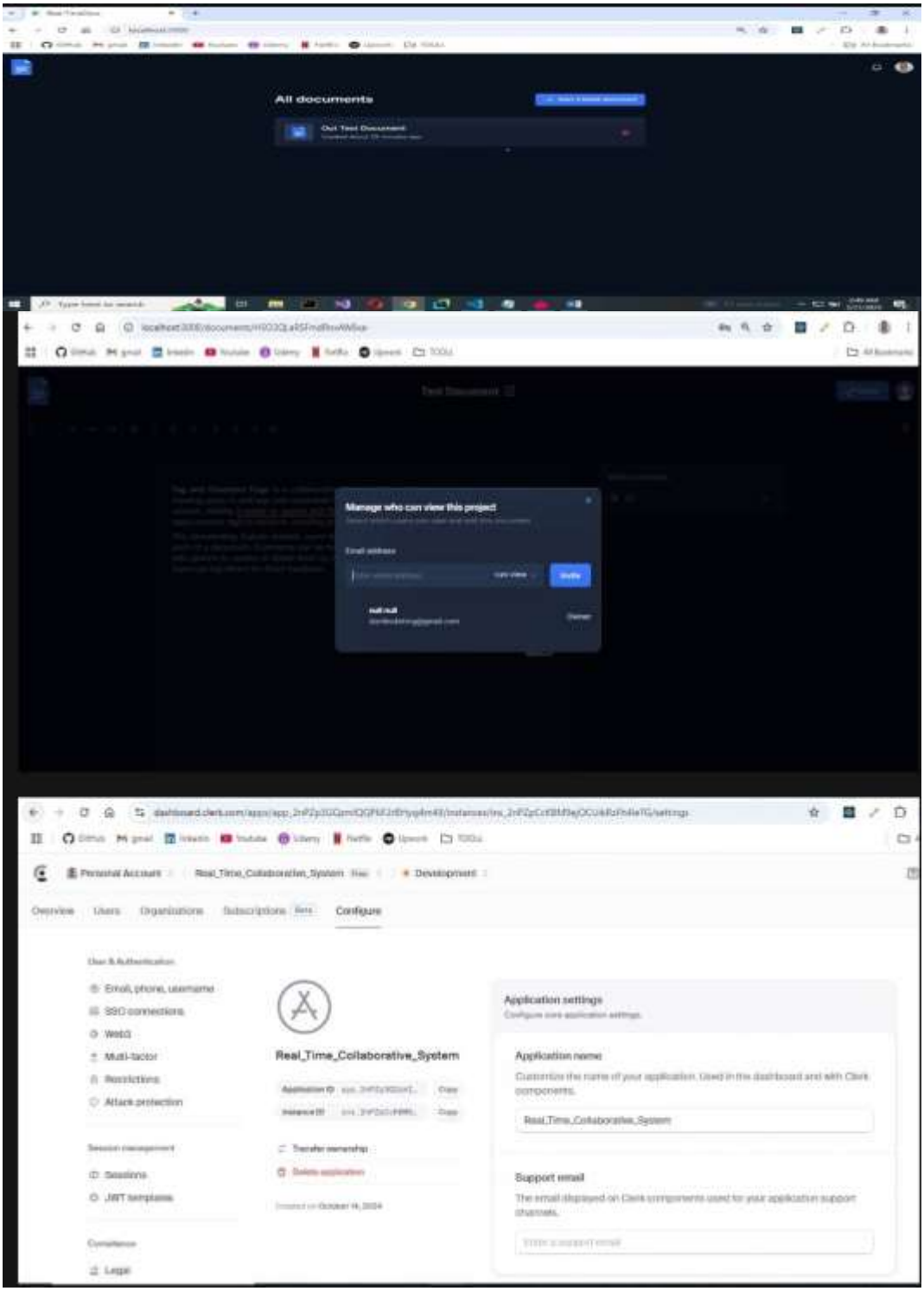
The existing system proposed by Julia (2023), "How to Build a Document Management System," introduces an innovative approach to document editing and management. The authors leverage advanced document processing techniques to retrieve, organize, and manage information efficiently. To achieve this, a computer application was developed to automate document structuring, ensuring consistency and accuracy across various document types. The system streamlines document editing by providing tools for content organization, version control, and collaborative editing. It allows users to efficiently store, track, and update documents in real-time, ensuring that changes are synchronized across multiple users. By incorporating intelligent tagging and categorization, the system makes it easier to locate specific documents, reducing time spent searching for files. Also, integrated security features help maintain document integrity and prevent unauthorized modifications.

The author designed distinct experiments to test the proposed methodology. All experiments were successfully executed, demonstrating the feasibility and efficiency of using an automated approach for document management and editing. The results indicated that automated document handling significantly reduces errors and improves overall productivity, making it a valuable tool for businesses, educational institutions, and research organizations.

This methodology presents a novel application of document management principles, significantly enhancing the editing process by automating critical aspects of document organization and accessibility. By integrating intelligent document processing, the system improves efficiency, reduces manual effort, and ensures seamless document workflow in various professional settings. Likewise, the ability to track revisions and maintain document history ensures accountability and transparency, making it easier to audit and review changes over time. Overall, this system represents a major advancement in document management, enabling users to handle large volumes of documents with greater accuracy and ease.

4. RESULT AND DISCUSION

System implementation involves the coordination of various system components to ensure not only functionality but also high efficiency and reliability (Ekanem, 2014). This chapter presents the demonstration of the system's implementation, which is structured based on the design and methodology outlined in the previous chapter. The implementation phase consists of a well-organized set of activities aimed at making the system fully operational and ensuring it meets the predefined objectives. These activities include setting up the required hardware and software infrastructure, configuring system components according to the design specifications, and integrating various modules for seamless operation. The ultimate goal is to ensure that the system can provide


All documents
Manage who can view this project
Overview
Users
Organizations
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Real_Time_Collaborative_System
Application settings
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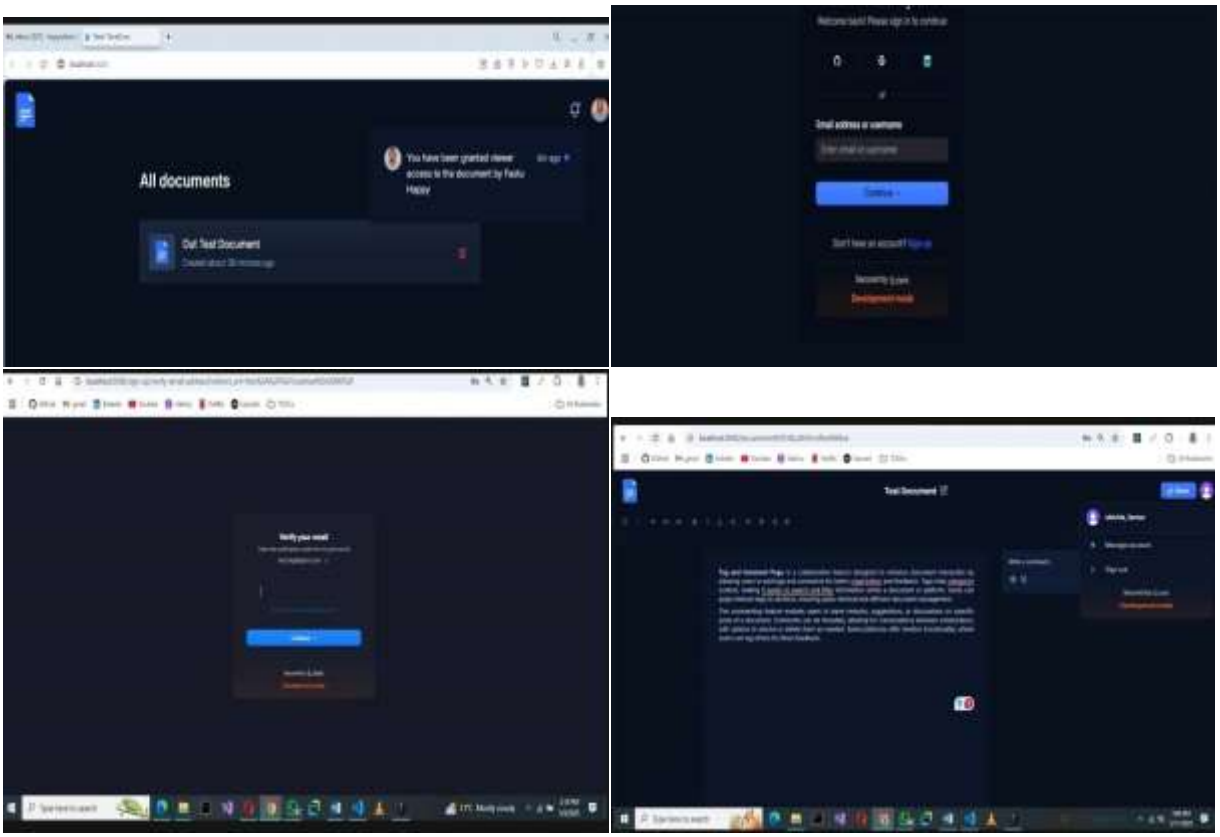

Plate 1: Web interface

explainable insights into the fall prediction model's decision-making process, thereby enhancing its usability and interpretability. System implementation involves transforming the theoretical and logical system design into a fully functional software solution. This includes several essential activities such as selecting the appropriate programming languages and frameworks, installing necessary development tools, writing code, debugging errors, conducting software testing, and documenting the entire process. In this research, Visual Studio Code was installed as the primary development environment. The system was developed using React.js for the frontend, Node.js for the backend, and MongoDB as the database. The coding phase involved a systematic approach where the system's model was translated into an automated form, ensuring accuracy and efficiency. The software was successfully deployed on a local server, adhering to the architectural structure defined in the design. Extensive testing was conducted to verify the system's functionality, performance, and reliability. The results indicate that the system runs efficiently, meeting all predefined specifications and objectives are shown in Figure 1.

5. CONCLUSION

The CRM system integrates web-based functionality, bringing innovation to scheduling and customer management by ensuring seamless information accessibility. This dissertation presents a software application designed to assist business owners in efficiently managing customer tasks.

The application was successfully developed, tested, and validated, demonstrating its effectiveness. It efficiently stores and processes user data with high speed and accuracy while presenting outputs in required formats. Also, the system streamlines task scheduling and customer query management. The application is user-friendly, incorporates essential security measures, and maintains data integrity through the use of a relational database management system.

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