

Research Paper Assistance using Web-based Tools

Ayush Thakur¹, Bhumi Bhatt² and Megha Bhatt³

¹⁻³Department of Computer Science, Jims Engineering Management Technical Campus, Greater Noida, India.
Email: ayushthakur827@gmail.com, bhumibhatt7575@gmail.com, meghabhhatt0403@gmail.com

Abstract— Academic writing is a complex process that involves multiple stages such as grammar refinement, citation management, PDF analysis, and collaborative editing. Traditionally, these tasks require the use of several disjointed tools, leading to frequent context-switching, reduced productivity, and a fragmented user experience. This challenge is particularly significant for students and early-career researchers, who often face difficulties in managing their academic workflows efficiently.

This study presents Paper Pilot, a comprehensive web-based research assistant designed to streamline the academic writing process by integrating essential tools into a single platform. The system incorporates grammar and style checking, citation generation, PDF uploading and extraction, and real-time collaborative editing. Built using modern technologies such as React.js, Express.js, and Firebase, alongside natural language processing libraries like NLTK and spaCy, the platform offers intelligent and context-aware assistance. Real-time collaboration is facilitated through Socket.io, enabling seamless teamwork across users.

By consolidating critical functionalities into one environment, Paper Pilot minimizes cognitive load, enhances writing efficiency, and improves overall user experience. This approach contributes to the democratization of academic productivity by making high-quality research tools more accessible, reducing workflow friction, and enabling users to focus on content generation rather than tool management.

Keywords— Research Assistant, Citation Generation, PDF Reader, Integrated Platform, Text Extraction, Reference Management, Research Workflows, Grammar and Spell Checking, PDF Uploading, Real-time Collaborative Editing.

I. INTRODUCTION

Academic writing serves as the medium of communication in education and research fields. Whether it is an essay, article, report, or research paper, it is always useful in expressing your ideas, thoughts, and findings to a larger audience, contributing to society. In today's academic landscape, researchers and students are heavily reliant on a range of digital tools to support their research journey. From checking grammar to generating citations, from reading articles to collaborative writing—each task often demands a different application. This fragmented workflow hampers efficiency and cognitive focus.

Most researchers and students have to switch between various platforms—Google Docs for collaboration, Grammarly for grammar checking, EasyBib for citation generation, and various PDF extractors for extracting content summaries. The major problem is that many of these tools have limited free usage, and after that, you have to pay to continue their services, which are further divided into tiers that might be costly for students.

In order to address this gap, this research introduces a web application to guide users in designing their research from start to finish.

This platform integrates various essential tools that are helpful for users while working on academic papers—real-time collaboration using Socket.io, AI assistance in writing academic papers, a grammar and spell checker using LangTool, a summary extractor from PDFs using AI assistance, an article reader where users can read articles with difficult spellings, allowing them to see definitions while reading the article without visiting any search engine. It also provides a citation generator that supports various referencing formats. The tech stack used is: React for frontend, Express for backend, and Firebase for user authentication, respectively.

Inspired by a real-world experience where a peer struggled with switching tabs between a PDF reader and online resources while conducting research, Paper Pilot was designed to eliminate such friction. The web app centralizes multiple research tools, creating a seamless research environment tailored for the modern student.

The primary goal of this project is to simplify the process of academic writing by offering an all-in-one solution that is easy to use and navigate. This paper documents the motivation behind this project, its architecture and features and challenges faced during development.

A. Problem Statement and Significance

- **Fragmented Workflow:** Researchers and students rely on multiple disconnected tools (Google Docs, Grammarly, EasyBib, PDF readers, etc.) for different tasks, leading to inefficient workflow and disruptions in doing the tasks.
- **Cognitive Overload:** Constantly switching between different applications reduces focus and increases mental fatigue leading to poor work performance.
- **Limited Access:** Most tools (like Grammarly and citation generators) offer limited free features, and the rest of the features are hidden behind a paywall.
- **No Unified Solution:** There are many tools which solve the subproblem but no integrated version of it i.e. all of them do not exist in one website.
- **Accessibility Barriers:** Difficulties in reading complex articles or extracting summaries from PDFs require additional tools.

B. Aim and Motivation

- **Integrate Essential Tools:** Combine real time collaboration, AI assisted writing, grammar checking, PDF summarization, article reading aids and citation generation in a single platform.
- **Increased Efficiency:** Reduces the need to constantly switch between multiple applications, reducing the cognitive overhead.
- **Improve Accessibility:** Provides free alternatives of expensive tools like Grammarly.
- **Supports Multiple Reference Styles:** Offers a citation generator with APA ,MLA and Chicago style.

II. LITERATURE SURVEY

A. Applications of Generative AI

Generative AI, a dynamic subfield of artificial intelligence, focuses on the autonomous creation of novel content such as text, images, music, and more by learning patterns from large datasets. Built on foundational models like Generative Adversarial Networks (GANs) and Variational Autoencoders (VAEs), generative AI enables machines to mimic human creativity through deep learning techniques (Ramdurai & Adhithya, 2023). Its applications span diverse domains including art, design, scientific research, and entertainment, making it a transformative tool for both innovation and automation.

B. Generative AI in Education

The use of generative AI in education has gained traction in recent years, with tools like ChatGPT demonstrating significant potential for enhancing teaching and learning (Dwivedi et al., 2021; Su & Yang, 2022). Developed by OpenAI, ChatGPT is a conversational AI model capable of generating human-like responses, making it useful for tutoring, content creation, and personalized support (Lebrenz et al., 2023; Lund & Wang, 2023). Its adoption in education can also promote AI literacy among students and teachers, fostering critical understanding of AI technologies and their societal impacts (Ng et al., 2021; Su et al., 2022).

C. Generative AI in Research and Academia

Park and Lee (1) explored recent AI-assisted tools that support ideation, sensemaking, and scientific creativity. Their work provided a broad overview of existing tools and showed how AI is helping researchers during the early and most critical stages of idea development. Similarly, Wang et al. (2) introduced ResearchAgent, a system that uses large language models (LLMs) to generate research ideas by analyzing scientific literature

iteratively. This approach helped automate the brainstorming process and allowed researchers to interactively refine their topics.

D. Collaborative Writing Systems and Generative AI

Yin and Zhang (3) focused on real-time document collaboration, highlighting the architectural and design choices necessary to build smooth and responsive writing platforms. Their study emphasized the need for systems that can handle multiple users editing a document at the same time without delay. Li et al. (4) supported this by presenting an earlier model of a collaborative document management system. Though basic, their work laid the foundation for modern collaborative tools used in academic environments.

E. AI Tools for Enhancing Academic Writing

Sharma (5) discussed how AI is transforming academic writing and publishing. The paper outlined how tools like grammar checkers, citation generators, and paraphrasing assistants are making research writing easier for students and early-career researchers. Kumar and Singh (6) also explored this idea by focusing on AI in academic writing, showing how it helps with structuring arguments and improving the overall quality of submissions.

F. Gen AI in Research Support and Tool Assistance

Zawacki-Richter et al. (7) took a broader view by conducting a systematic review of AI tools used in higher education. They identified a key gap in the availability of platforms that offer multiple research support functions in one place.

More recently, Woolston (8) provided a guide on choosing the right AI research tools. The paper focused on helping users select tools based on their goals—whether it’s literature discovery, summarization, or collaborative editing. Lee and Patel (9) also discussed modern research tools that use AI to synthesize literature more efficiently, making it easier for users to grasp key ideas from large volumes of academic texts.

While these studies contribute significantly, most existing solutions focus on specific tasks, such as writing or idea generation, and often require users to switch between tools. In our project, we aim to solve this issue by creating Paper Pilot—a single web platform that supports grammar and spell checking, citation generation, PDF uploading, article reading, and real-time collaborative editing.

G. Grammar and Language Enhancement Agents in Academic Writing

TABLE I. LITERATURE SURVEY

Authors	Methodology	Key Contributions	Shortcomings
Park, K., & Lee, B. (1)	Qualitative analysis of existing AI tools; framework-based categorization	Defines a design space for AI tools aiding ideation and creativity in research	Lacks empirical evaluation of tool effectiveness
Wang, Z., et al. (2)	Implementation and evaluation of LLM-based system (ResearchAgent)	Introduces an AI agent for iterative idea generation over scientific literature	Dependent on LLM quality; may generate irrelevant ideas
Yin, X., & Zhang, J. (3)	System architecture design; technical case study	Proposes efficient architecture for real-time document collaboration	Limited testing in large-scale collaborative environments
Li, X., et al. (4)	System design & prototype implementation	Early work on real-time collaborative document systems	Dated technology; lacks support for modern cloud infrastructure
Sharma, A. (5)	Conceptual discussion with examples of AI tools	Highlights the impact of AI on writing and publishing workflows	Overviews tools without deep technical evaluation
Kumar, R. & Singh M. (6)	Literature review and conceptual framework	Explores AI's role in academic research and writing	Broad scope with limited practical tool examples
Zawacki-Richter, et al. (7)	Systematic literature review	Comprehensive review of AI applications in higher education	Outdated for rapidly advancing AI landscape
Woolston, C. (8)	Comparative analysis; tool review	Provides practical guidance for selecting AI tools in research	Journalistic style; lacks in-depth methodological rigor
Lee, J., & Patel, R. (9)	Evaluation of AI tools for literature discovery	Reviews next-gen AI tools for research synthesis and discovery	Focus on tool features more than user outcomes

AI-powered grammar and language tools such as Grammarly, QuillBot, and ChatGPT have significantly improved the quality and accessibility of academic writing. These agents offer real-time grammar checking, style refinement, and coherence suggestions, enabling users to produce polished and professional academic texts. Bryan (11) discussed the growing reliance on such tools in quantitative social science, noting their role in enhancing writing clarity and reducing linguistic barriers for non-native English speakers. Chen et al. (9)

examined the opportunities and pitfalls of LLM-assisted collaborative writing, revealing how tools like ChatGPT can support content structuring and improve fluency. While these systems offer substantial benefits in drafting and editing, Martin-Boyle et al. (12) cautioned against the superficial synthesis of knowledge, emphasizing the importance of human oversight in ensuring academic integrity and depth.

III. METHODOLOGY

In this section, we outline the methodological framework employed in the development of Paper Pilot—an AI-powered research assistant web application. The approach is modular, encompassing key components that together provide an integrated, user-friendly environment for academic writing and literature analysis. The pipeline includes requirement analysis, feature implementation, backend integration, frontend development, and real-time evaluation.

The development began with identifying the common pain points faced by students and researchers, such as grammar correction, citation formatting, document comprehension, and constant tab-switching between tools. Based on these insights, we designed a centralized platform with the following core features: grammar and spell checker, citation generator, article reader with explanation support, PDF uploader, and real-time collaborative editor.

A. User Navigation Flow for Application

- Homepage: Users are introduced to the platform here, where they can explore the services offered and get a clear idea of what to expect.
- User Login/SignUp: New users can register for an account, while returning users can log in to access the platform.
- PDF Uploader: Here users can upload a pdf to open and get its content in a summarized form.
- Article Reader: Here users can paste the article with difficult words and get the processed article with words and their meanings.
- Citation Generator: Here users can generate citations in formats like APA, MLA and Chicago.
- Collaborator: Here users can collaborate with other users on documents and research work and have AI assistance.

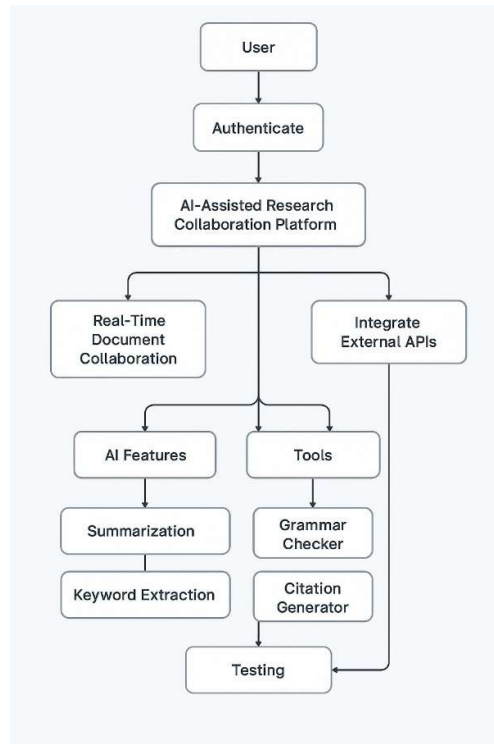


Fig 1. Work Flow Diagram

B. Technology Stack

- Frontend: The frontend is developed using React.js, a JavaScript library known for its efficiency in building dynamic and component-based user interfaces. React's modular architecture enables developers to compartmentalize features like the grammar checker, citation generator, article reader, and real-time editor into reusable components. This improves code maintainability and responsiveness across the application.
- Backend: The backend of Paper Pilot is built using Express.js, which handles API requests, routes, and integrates third-party services. Data from the frontend is processed and analyzed through a combination of custom scripts and pre-trained language models.
- Authentication: It is implemented using Firebase, allowing users to sign up and log in using their email or through Google authentication.

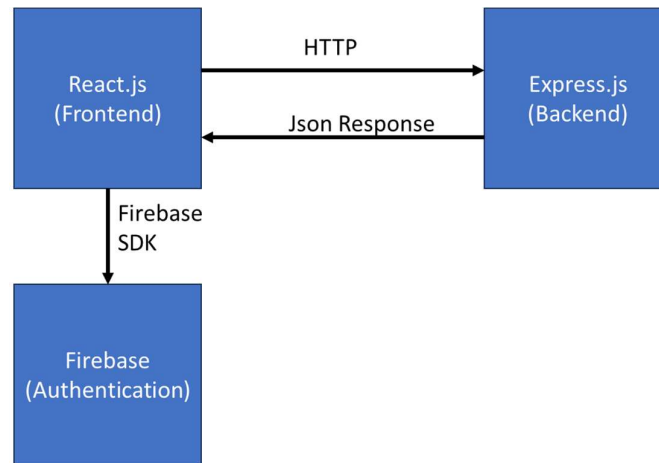


Fig 2 Client Server Interaction

C. User Data Storage

In the frontend, users can seamlessly navigate through the application and access the login or sign-up features for authentication purposes. Firebase is integrated to manage this authentication process, providing a secure, scalable, and user-friendly solution. It supports a variety of authentication methods, including traditional email/password login as well as third-party providers such as Google sign-in. Upon successful authentication, Firebase stores essential user details such as the user's name, chosen authentication method, and a unique user ID. This setup ensures a smooth onboarding experience and facilitates secure access control throughout the application.

D. Backend API Design

The backend of this application is built using Express.js, a lightweight and flexible web framework for Node.js. It serves as the bridge between the frontend and backend services, particularly Firebase, which handles authentication and data storage. The backend is responsible for processing client requests, managing session-related logic, and securely interacting with Firebase services.

It leverages RESTful APIs to perform essential operations such as user login, authentication, and data validation. These APIs enable seamless communication between the client and server, ensuring a responsive and secure user experience.

The APIs used are:

- /analyze: It is used to process the pdf received from the client and give a summary for the pdf.
- /gemini: It is used to send requests to gemini if user asks question in real time collaboration
- /langtool: It is used for grammar correction and spell checking.

E. Testing

To ensure the reliability of the backend APIs, Postman is used for testing. With the help of Postman we can simulate the event of an api endpoint being hit and to check if the valid response is being received making it ideal for validating RESTful APIs. It is useful in identifying incorrect status codes, improper input validation and authentication failures. It makes it possible to identify errors before integrating with the frontend.

F. Deployment

Deployment can be done on platforms like Vercel, Heroku or Render as they are popular cloud platforms used to deploy modern web-applications with ease. Vercel is widely used for deploying frontend applications especially those built with React.js and Next.js. Users can easily deploy by connecting with their github accounts. Renderer and Heroku are used to host Backend services such as Node.js and Express.js.

F. Future Aspects

- **Enhanced AI Capabilities:** Future versions of Paper Pilot could integrate more advanced and specialized language models to offer discipline-aware writing suggestions, improve contextual understanding, and provide more accurate grammar, style, and citation feedback.
- **Semantic Search and Literature Mapping:** Incorporating AI-powered semantic search can help users identify relevant research papers and automatically map literature trends, enabling faster and smarter literature reviews.
- **Adaptive Learning for Writing Style Personalization:** By using machine learning algorithms, Paper Pilot could learn from each user's writing patterns over time. This adaptive system could then offer personalized writing tips, citation preferences, and structural feedback to improve user productivity and writing quality.
- **Mobile Access and Offline Functionality:** Introducing a mobile application with offline editing features can significantly improve accessibility for users who work in low-connectivity environments or prefer writing on the go. Synchronization with cloud storage once reconnected ensures a seamless user experience.
- **Advanced Collaboration Tools:** Introducing features like role-based editing, in-text commenting with AI-generated suggestions, and version control will enhance real-time collaborative writing among research teams.

G. Summary

The modular development of Paper Pilot ensures that each component contributes meaningfully toward the unified goal of supporting researchers and students through an all-in-one web-based assistant. The frontend built with React.js offers a smooth and accessible interface, while backend services powered by Express and Google GenAI deliver smart, contextual support. Real-time collaboration and secure authentication via Firebase further enhance usability. By combining these elements, Paper Pilot successfully addresses the fragmented research workflow problem—offering a centralized, intelligent platform that reduces the need to switch between multiple tools and tabs.

IV. CONCLUSION

In this study, we introduced Paper Pilot, a unified AI-powered web application designed to streamline the academic research workflow for students and researchers. By integrating diverse functionalities such as a grammar and spell checker, citation generator, article reader, PDF uploader, and a real-time collaborative editor, Paper Pilot eliminates the need to switch between multiple tools and platforms.

Our system leverages a robust technological stack comprising document processing tools (PDF.js, PDFParse), and real-time frameworks (Socket.io, Firebase) to provide a seamless and efficient user experience. The frontend, built with React.js, prioritizes usability and accessibility, while the backend ensures accurate text analysis and secure user authentication.

Through iterative testing and user feedback, we validated the effectiveness of Paper Pilot in simplifying research-related tasks and improving user productivity. The positive reception and time-saving potential underline its practical relevance and usability in academic settings.

This project not only addresses current gaps in the research assistance landscape but also lays the groundwork for future innovations. With further development, Paper Pilot has the potential to evolve into a comprehensive AI research assistant adaptable to a wide range of academic and professional contexts.

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