STM JOURNALS

International Journal of
Electrical and Communication
Engineering Technology

Volume 2, Issue 2, 2024
July–December
DOI (Journal): 10.37591/IJECET

https://journals.stmjournals.com/ijecet

Review IJECET

Creative Collaboration on a Digital Canvas

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Abstract

A collaborative whiteboard is presented in this study where users at multiple locations can communicate with each other. The system features a virtual environment with vivid avatars, stroke compression and streaming technology to effectively deliver stroke data across meeting participants, friendly human interaction and navigation, virtual and physical presentation. The whiteboard is both a physical platform for our input/output interfaces and a virtual screen for sharing common multimedia. It is this whiteboard correspondence that allows the user to physically write on the virtual whiteboard. In addition to drawing on the shared virtual board, the immersive whiteboard in our setup permits users to control the application menus, insert multimedia objects into the world, and navigate around the virtual environment. By integrating multimedia objects and avatar representations into an immersive environment, we provide the users with a more transparent medium so that they feel as if they are communicating and interacting face-to-face. The whiteboard efficiently pulls all the collaboration technologies together. The goal of this collaborative system is to provide a convenient environment for participants to interact with each other and support collaborative applications such as instant messaging, distance learning and conferencing.

Keywords: Real time, collaborative whiteboard, immersive, application, distance learning, brainstorm, internet connection

INTRODUCTION

A collaborative virtual whiteboard is an online platform where multiple users can work together in real-time, just like on a physical whiteboard. It enables people to draw, write, add images, and interact simultaneously, regardless of their location. This digital tool is ideal for remote teams, online classrooms, or anyone seeking to brainstorm and collaborate visually. Users can contribute to the board from anywhere with an internet connection, making it a versatile and efficient way to collaborate and share ideas. It is like having a shared whiteboard accessible to everyone, enhancing teamwork and creativity. Virtual whiteboards represent an innovative leap in collaborative technology, merging the spontaneity and intuitiveness of traditional whiteboard brainstorming with the global connectivity of the digital age. These platforms digitize the experience of using a physical whiteboard, allowing for real- time collaboration among users, regardless of their geographical locations [1]. This technology not only captures the essence of idea-sharing and teamwork but also enhances it with features that are not possible with physical whiteboards. A collaborative virtual whiteboard is a digital platform that mimics a whiteboard but offers a plethora of advantages. It provides a shared workspace accessible from any device with an internet connection. Multiple users can work on the board simultaneously, adding notes, drawings, images, and other visual elements in real-time. The use of whiteboards has been found to be a beneficial

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Received Date: July 17, 2024
Accepted Date: August 20, 2024
Published Date: August 30, 2024

Citation: Robinsh Raj, Meghali Waghmode, Pragati Pawar, Isha Yerawar. Creative Collaboration on a Digital Canvas. International Journal of Electrical and Communication Engineering Technology. 2024; 2(2): 29–36p.

medium to communicate spontaneous handwritten ideas and concepts. Several workplace field studies have shown the importance of physical whiteboards that are a locale for discussion and collaboration. However, physical whiteboards are only visible locally in one place. Their information is not easily available for remote sites. Hence, real-time multi-user physical whiteboard collaboration is limited locally to people in the same room [2]. Multiple users can add, edit, and manipulate content on the whiteboard simultaneously. This allows for a dynamic and interactive flow of ideas, fostering teamwork and engagement. Unlike physical whiteboards, collaborative virtual whiteboards offer an infinitely scalable workspace. This eliminates the constraints of physical space and allows for complex and sprawling ideas to be captured and visualized. It often allows users to track changes made to the board over time. This enables revisiting previous versions, collaborating asynchronously, and maintaining a record of the creative process. It facilitates dynamic brainstorming sessions with features like anonymous contributions, voting systems, and visual organization tools. It enables geographically dispersed teams to work together seamlessly on projects, fostering communication and innovation. Real-time collaboration and visual representation of ideas can streamline workflows and improve project management. It can be used to capture meeting notes, document decisions, and create visual representations of complex processes.

BACKGROUND STUDIES

The use of whiteboards has been found to be a beneficial medium to communicate spontaneous handwritten ideas and concepts. Several workplace field studies have shown the importance of physical whiteboards that are a locale for discussion and collaboration. However, physical whiteboards are only visible locally in one place. Their information is not easily available for remote sites. Especially, strokes written on the whiteboard with ink cannot be erased or edited by remote users. Hence, real-time multi-user physical whiteboard collaboration is limited locally to people in the same room. With the development of ink stroke data capturing devices and the explosive usage of the Internet, a networked whiteboard collaboration system is called for [3, 4]. The content of a whiteboard is made up of strokes written by users. A stroke is defined as a continuous curve created when the pen (or PC mouse) is down on the whiteboard and ends when the pen (or PC mouse) is lifted from the whiteboard. These strokes are captured and rendered as a sequence of points. For a typical whiteboard stroke-capturing device, the entities that make up a stroke are temporally sampled point coordinates [5]. The stroke is then rendered on the display as a curve that passes through those sampled points. The simplest rendering of the stroke is thus connecting subsequent sampled points with straight lines. In our discussion in this study, we will focus on the content of a whiteboard as a collection of strokes, each of which is composed of a sequence of sampled points (referred as stroke data points) connected by straight lines. Traditionally, stroke data was not treated as stream data type [6–10].

However, a streaming stroke data mechanism is especially essential in the low bandwidth environment (e.g., regular telephone modem) to reduce the download waiting time and enhance the media quality. Even in high bandwidth environments (e.g., LAN, cable modem or ADSL), streaming technology has been shown essential for better quality of service (QoS) and increasing the network bandwidth. A whiteboard collaboration system requires to stream efficiently stroke data across all participants. This study will present a multi-resolution representation of the stroke media that is ready for efficient streaming. When a group of people gets together in one room to work on an agenda, we refer to this scenario as an ideal collaboration. Whiteboard is designed specifically for the best online experience. It breaks past the physical limits of a traditional whiteboard and sprinkles in the brainstorming potential that a flexible cloud network empowers. Freehand drawing is possible and works great, but does not seem to be the largest focus. Whiteboard is designed for instant access and the ease of use, allowing users to jump online without logging in or downloading any apps, invite guests or coworkers, and quickly share ideas or draw visual explanations. With less of a focus on the longevity and direct replacement of office whiteboards. Add on notes allow users to write down ideas or comments to spur collaboration and supply feedback without alerting the original idea, a solid function. Because the White Board is meant to be an infinite canvas, navigation is made easy with unique mouse

controls. As COVID-19 is continuing to impact people around the world, thousands of schools and teachers are using Whiteboard as a key tool to provide the best remote learning experience and to help students stay engaged during remote learning. With everyone staying and working from home these days, due to the COVID-19 lockdowns, the number of online meetings and video conferences have skyrocketed [11]. Many schools and design companies require systems that allow for collaborative sessions. A major problem with the available online whiteboards is that most of the boards are locked behind a money vault or most of the features of the whiteboard are needed to be purchased, which makes it difficult for small organizations to afford the board, hence making it difficult for virtual interactions and idea sharing. Our whiteboard strives to solve these problems. Taking the magical simplicity of an analog whiteboard and adding interactive, collaborative technology, our Whiteboard gives the whole class a new space to engage, ideate, and create in real time. It will be a free to use online whiteboard that anyone can use without paying huge sums of money. In this study, we will present an immersive whiteboards collaborative system. The most crucial element of our system is the shared whiteboards. The whiteboard is both a physical platform for our input/output interfaces and a virtual screen for sharing common multimedia. It is the whiteboards that allow users to seamlessly navigate and interact in the immersive environment. The screen also permits users to communicate through natural handwritten sketches. The virtual whiteboard in the immersive environment can correspond to the physical whiteboard in our setup. It is this whiteboard correspondence that allows the user to physically write on the immersive whiteboard. In addition to drawing on the shared virtual board, the immersive whiteboard in our setup permits users to control the application menus, insert multimedia objects into the world, and navigate around the virtual environment. The shared whiteboards in the immersive environment provide the best medium for users to freely discuss handwritten and spontaneous ideas. On a conventional whiteboard, participants are expected to draw and see other people's drawings on the same surface. It offers a natural interface for both input and display. In our immersive whiteboard system, the whiteboard acts as a 2D stroke input, menu input, 3D objects etc. [12].

Note that the whiteboard collaborative system described here is recommended for a truly immersive collaboration system. However, not every client is required to have all the components to participate in the conference. For instance, the whiteboard can be used by itself without the avatar environment and vice versa. Also, a PDA device can participate in the collaboration and function as a whiteboard without projector. Furthermore, the Whiteboard Collaborative System breaks down geographical barriers, opening doors to remote collaboration that transcends time zones and physical borders. Its applications span across various sectors, including business, education, design, healthcare, and research, providing a versatile solution that caters to diverse needs and scenarios. As the digital landscape evolves, this system stands as a testament to the power of technology in enhancing human interaction.

APPROACH AND DESIGN

Online whiteboard applications begin with an infinite canvas. This means there is no border to how big your whiteboard can be. You can do freehand drawing with several pen tools like in Paint programs. The best whiteboard software can automatically straighten your lines. They can also recognize your shapes and transform them. Widgets are very common tools of online whiteboards. These can be little icons that help guide the viewers. For example: arrows, sticky notes or notes, stickers, highlights and more. Notes are very important for online whiteboards. They allow team members to communicate with each other in exact places on the whiteboards. Notes can be saved as conversations or resolved. You can also add media to online whiteboards. Most obvious are images and photos. But sometimes you can add video and audio tracks, or even upload other documents. These can be played or accessed by clicking directly inside the whiteboard. May whiteboard platforms allow a variety of plugins and integrations too for added functionality. These could be to publish whiteboards to web pages like WordPress, or to include voice and video chatting with apps like Skype [13].

- The code for the whiteboard was written using the Visual Studio Code.
- Languages used for writing the code:
    - HTML: To provide structure.

- JavaScript: To provide functionality.
- CSS: to provide design.

- Node.js was used as an asynchronous event driven by JavaScript runtime.
- Canvas API had been used in the whiteboard to draw on the blank canvas.
- Npm was integrated with Visual Studio Code.
- Event Listeners were added for the user to draw on board.
- Express will be used to provide the server.

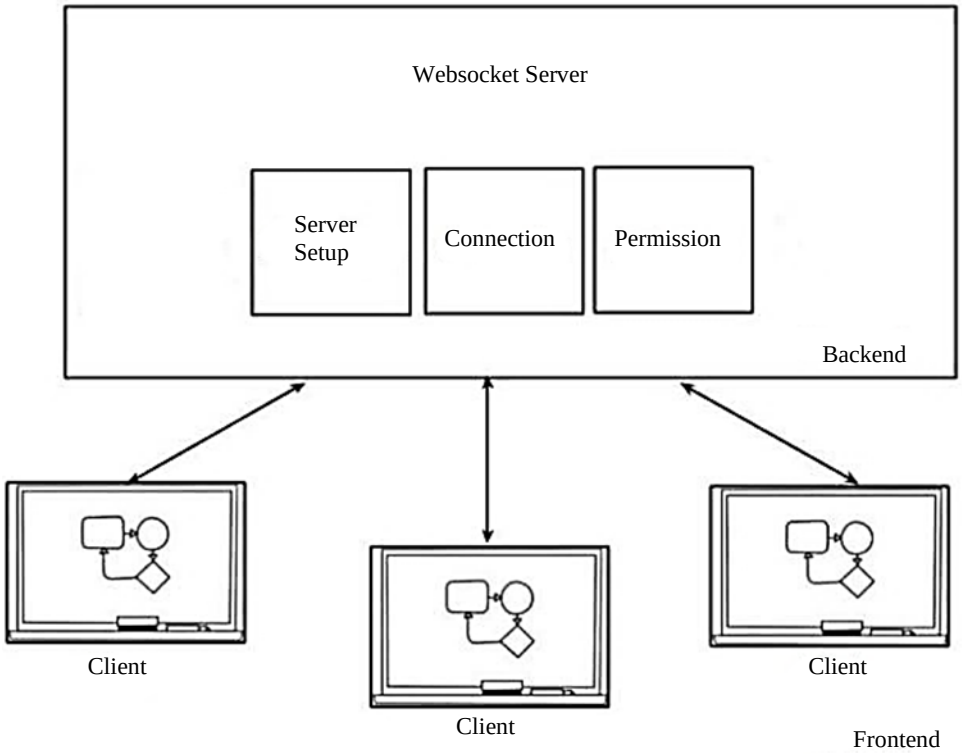

Figure 1. Approach and design.

The shared whiteboards in the immersive environment provide the best medium for users to freely discuss handwritten and spontaneous ideas as shown in Figure 1. On a conventional whiteboard, participants are expected to draw and see other people's drawings on the same surface. It offers a natural interface for both input and display. In our immersive whiteboard system. We developed a ink stroke data capturing devices, system architecture of a networked collaboration system. It consists of two virtually physical whiteboards connected via the Internet. The virtual ink strokes are captured by means of low-cost devices. Low-cost projectors can then be used to display the strokes on the whiteboards [14]. Consequently, we can virtualize the physical whiteboard, and enable remote collaboration for discussion, design, and editing in a network environment. The meeting management server network will coordinate the meeting and communicate with client to establish the environment for some software components. The first component is the immersive environment in which the users share their presence and the objects on their agenda are exchanged [15]. A 3D environment can be modeled as a set of graph nodes. Each node in the graph can represent either a multimedia object or a transformation operation on the multimedia objects residing in its children's nodes. Multimedia objects can only be leafing nodes in the graph, and a transformation node should always have its children's nodes. Each individual multimedia object can be modeled as a set of data points in the 3D coordinate space. The Design and Drawing show that interactive whiteboard applications can be developed by utilizing web technologies consisting of HTML and CSS3, and Node.js. The results of interactive web-based whiteboard application development demonstrate a solution to help improve electronic learning services. This ICT application approach offers several advantages, especially for electronic learning as it saves costs, time,

and resources. The main share whiteboard feature can facilitate virtual classrooms, where learners do not have to physically come to the learning location.

Interactivity that characterizes the application is represented through the facilities provided. A teacher can interact (write or draw) directly with an interactive whiteboard via a browser connected to a computer network. This activity is done directly through the mouse input device. On the other hand, learners can see in real-time, teaching activities on the whiteboard through their respective browsers that are also connected to the Internet network. To ensure that the product is in conformity with the initial specification, a series of black-box testing was then conducted. The aspects assessed include the main function, performance, user experience, ease of use, and portability. The test results show that the product is in conformity with the initial specifications. The test results also show that interactive whiteboard application is able to adapt and adjust to the screen size of the browser to get the best view [16, 17]. Utilization of such ICT applications has great potential to support education services, especially electronic learning. However, geographical constraints can be overcome with a web-based application development solution.

RESULTS AND DISCUSSION

Creating a Collaborative Virtual Whiteboard using React JS and HTML Canvas represents a significant stride in facilitating interactive and cooperative environments for both educational and professional settings [18]. This section delves into the outcomes of developing such a system, alongside a discussion of its implications, challenges, and potential future enhancements. The developed system offers a real-time collaborative platform where users can:

- Draw, sketch, and write on a shared virtual whiteboard from remote locations.
- Interact with the whiteboard content simultaneously with multiple users, thanks to WebSocket technology for real-time communication.
- Utilize various drawing tools and colors, enhancing the expressiveness and clarity of ideas shared on the whiteboard.
- Save the current state of the whiteboard for future reference or to continue the session later.

Performance evaluations and user feedback indicate that the system is:

- *Responsive and Intuitive:* Minimal lag was observed in real-time interactions, closely mimicking the immediacy of physical whiteboards.
- *User-friendly:* Participants appreciated the straightforward interface, making it accessible even to users with limited technical expertise.
- *Effective for Collaboration:* The system facilitated a productive collaborative environment, enabling efficient sharing and development of ideas.
- *Synchronizing Real-time Data:* Ensuring that all participants view the same content in real-time required meticulous management of WebSocket connections and data broadcasting.
- *User Interaction Experience:* Balancing simplicity with functionality was crucial. Offering a comprehensive set of tools without overwhelming the user interface a design challenge.
- *Latency Issues:* Some users experienced latency, dependent on their internet connection, which could affect the fluidity of real-time collaboration.
- *Advanced Toolset:* Incorporating more sophisticated drawing tools, shapes, and possibly the ability to add images and documents could enrich the whiteboard's functionality.
- *Undo/Redo Functionality:* This feature would allow users to correct mistakes easily, further aligning the digital experience with the flexibility of physical whiteboards.
- *Access Control and Permissions:* Implementing roles and permissions would enable more structured sessions, where moderators can control the flow of the session and contributions.
- *Integration Capabilities:* Allowing the virtual whiteboard to integrate seamlessly with other tools and platforms could enhance its utility in various professional and educational workflows.

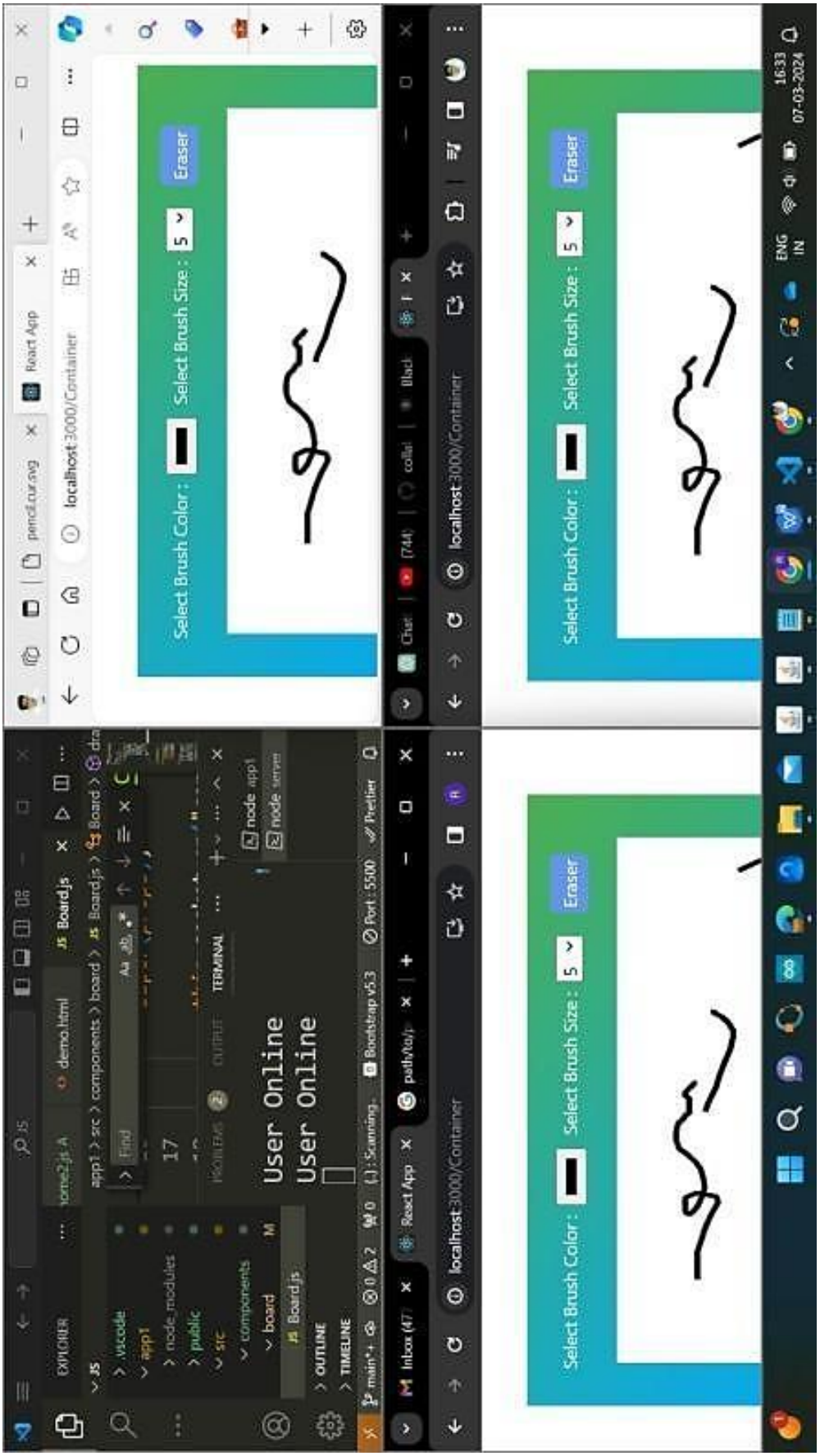

Figure 2. Result of the website page.

A virtual whiteboard is a collaborative tool that allows users to draw, write, and interact with digital content in real-time as shown in Figure 2. It has become increasingly popular in various settings, including remote work, online education, and virtual meetings. Firstly, in smaller groups, the participants collaborated more frequently by consecutively working on the same ideas in short cycles, while in bigger groups, the students worked at the beginning of a creativity session mostly isolated and in parallel and afterwards compared their results with the rest of the team. Secondly, the participants only used a fraction of the available whiteboard space, which had a negative influence on the ideation process. We have created an application by using HTML, CSS, JAVASCRIPT, REACT, and BOOTSTRAP. We had created a login page and Dashboard in which we centralized view of relevant information, features, or tools.

CONCLUSION

Collaborative Virtual Whiteboards (CVWs) represent a dynamic and transformative technology that has the potential to revolutionize the way we collaborate, communicate, and learn in a digital world. These platforms offer a wide array of benefits, including enhanced remote collaboration, improved communication, and creative problem-solving. CVWs have found applications across various sectors, including education, business, healthcare, and creative industries, demonstrating their versatility and adaptability. This project represents a significant step towards redefining how individuals collaborate and share ideas in virtual spaces. By breaking down geographical barriers, this tool opens up new possibilities for remote teamwork and creativity. The project not only addresses current collaboration challenges but also lays the foundation for future enhancements, ensuring its relevance in an ever-changing technological landscape. As we navigate the digital age, the Collaborative Virtual Whiteboard will stand as a testament to the innovative solutions that can emerge when technology and collaboration converge. Concluding the project on a Collaborative Virtual Whiteboard built with React JS and HTML Canvas, it is clear that this innovative tool stands as a testament to the power of modern web technologies in facilitating real-time, interactive collaboration across distances. The application not only serves as a medium for spontaneous idea sharing and creative brainstorming but also represents a significant leap in how teams communicate, design, and conceptualize projects in a digital environment.

Real-time Collaboration

The application allows multiple users to engage with the whiteboard simultaneously, making remote teamwork seamless and efficient. This feature is pivotal for teams spread across various locations, ensuring that everyone can contribute their ideas and feedback instantaneously.

Intuitive Interface

Leveraging React JS, we have created an intuitive and user-friendly interface that closely mimics the natural experience of using a physical whiteboard. This ease of use encourages adoption and lowers the learning curve for new users.

Advanced Drawing Capabilities

By utilizing HTML Canvas, your virtual whiteboard offers advanced drawing and annotation capabilities, enabling users to express their ideas vividly and in detail. This level of expressiveness is crucial for creative processes and complex project planning.

The Collaborative Virtual Whiteboard is a powerful example of how technology can bridge gaps, foster innovation, and streamline the collaborative process. It reflects a deep understanding of team dynamics and the needs of modern workplaces. As the digital landscape evolves, the project stands ready to adapt and grow, continuing to serve as an indispensable tool for teams worldwide.

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