VISVESVARAYA TECHNOLOGICAL UNIVERSITY

“Jnana Sangama”, Belagavi, Karnataka, INDIA

A Mini Project Report
on

SyncSketch: A Real-time Collaborative Drawing App

Submitted in partial fulfilment of the requirement for the award of the degree of

Bachelor of Engineering
in
Computer Science and Engineering

Submitted By

Asfiya Firdouse	**1GA21CS032**
Bindu Madhavi V	**1GA21CS040**

Under the Guidance of

Dr. Jyothi R
Professor

Department of Computer Science and Engineering
Accredited by NBA (2022-2025)

GLOBAL ACADEMY OF TECHNOLOGY

(Autonomous Institute, Affliated to VTU, Belagavi)
Rajarajeshwarinagar, Bengaluru - 560 098
2023 – 2024

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CERTIFICATE

Certified that the Mini Project Entitled **"SyncSketch: A Real-time Collaborative Drawing App"** carried out by **Asfiya Firdouse**, bearing **USN 1GA21CS032, Bindu Madhavi V**, bearing **USN 1GA21CS040,** bonafide students of Global Academy of Technology, in partial fulfilment for the award of the **BACHELOR OF ENGINEERING** in **Computer Science and Engineering** from Visvesvaraya Technological University, Belagavi during the year 2023 – 2024 . It is certified that all the corrections/suggestions indicated for Internal Assessment have been incorporated in the Report submitted to the department. The Partial Project report has been approved as it satisfies the academic requirements in respect of the mini project work prescribed for the said Degree.

Dr. Jyothi R
Professor
Dept. of CSE
GAT, Bengaluru.

Dr. Kumaraswamy S
Professor & Head
Dept. of CSE
GAT, Bengaluru.

Dr. Rana Pratap Reddy
Principal
GAT, Bengaluru.

External Viva

Name of the Examiners

Signature with date

1.

2.

GLOBAL ACADEMY OF TECHNOLOGY

(Autonomous Institute, Affliated to VTU, Belagavi)
Rajarajeshwarinagar, Bengaluru - 560 098

DECLARATION

We, **Asfiya Firdouse**, bearing **USN 1GA21CS032, Bindu Madhavi V**, bearing **USN 1GA21CS040**, students of Sixth Semester B.E, Department of Computer Science and Engineering, Global Academy of Technology, Rajarajeshwarinagar Bengaluru, declare that the Mini Project Work entitled "**SyncSketch: A Real-time Collaborative Drawing App**" has been carried out by us and submitted in partial fulfillment of the course requirements for the award of degree in **Bachelor of Engineering** in **Computer Science and Engineering** from **Visvesvaraya Technological University, Belagavi** during the academic year **2023-2024**.

1.Asfiya Firdouse	1GA21CS032	Signature
2.Bindu Madhavi V	1GA21CS040	Signature

Place: Bengaluru
Date:

ABSTRACT

Collaborative drawing can provide an opportunity to use perceptive thinking as a stimulus for drawing. Users get to try different approaches to depict a single image. Front-end development companies often seek innovative ways to engage users and provide the best experiences. Existing systems like VR are complex for beginners to understand and extended VR sessions can lead to physical discomfort for the users. One such solution is creating a real-time collaborative drawing app using WebSockets. SyncSketch is developed for beginners who want to share their artistic ideas with fellow users in a simpler manner. This app will allow users to draw on a shared canvas and see updates from other users instantaneously. The app is built with ReactJS, Express and NodeJS offering robust foundation for intuitive interaction. Operational Transformation is used as the base algorithm to develop this project where every drawing action is considered as an operation which ensures that the final drawing is identical on all clients, regardless of the order in which the operations are received.

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ASFIYA FIRDOUSE	**1GA21CS032**
BINDU MADHAVI V	**1GA21CS040**

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CHAPTER 1

INTRODUCTION

1.1 Introduction to Project

Web development refers to the creating, building and maintaining of websites/web apps. It involves a blend of creativity and technical expertise to bring ideas to life. The word Web Development is made up of two words, i.e., **Web** and **Development**.

Our project belongs to the domain of Web Development focusing on,

- **Frontend technologies** - User interacts directly with the website. It is also referred to as the ‘client side’ of the application.
- **Backend technologies** –It is the portion of software that does not come in direct contact with the users. It is used to store and arrange data. It is also referred to as the ‘server side’ of the application.

SyncSketch is perfect for brainstorming, creating shared art projects, or simply having fun. Our app breaks down geographical barriers, allowing you to co-create with other users simultaneously. It also allows users to choose from different options to present their thinking.

1.2 Problem Definition

Traditional methods such as physical whiteboards or asynchronous digital tools hinder effective collaboration by imposing geographical and temporal limitations. Perceptive thinking can be used as a stimulus for drawing where users get to try different approaches to depict a single image. A focus on unique visual representations might prioritize aesthetic appeal over functional or user-centric design considerations. So we came up with an idea of developing a user-friendly drawing application that fosters a sense of co-creation and shared artistic experience for beginners.

1.3 Existing System

Existing systems like Virtual Reality (VR) inclusive drawing apps are complex for beginners to understand and extended sessions can lead to physical discomfort for the users. VR environments have unique user interfaces that differ significantly from traditional computer interfaces, requiring users to learn new navigation and interaction methods. These systems often require users to master new input methods like controllers or head movements, which can be daunting for those unfamiliar with technology.

1.4 Proposed System

SyncSketch is a collaborative drawing app designed for beginners who wish to co-create with other users seamlessly on a user friendly platform involving fewer complexities. It is built using the following techstack,

- The front-end of the application is developed using **HTML5 and JavaScript** for setting up the canvas and interactivity. **ReactJS** is mainly used to create the UI.
- The back-end is developed using **ExpressJS** and **NodeJS** for server setup.
- The primary technology used in this project will be **WebSockets** for real-time communication between the client and the server.
- The working of the app is tested using **VScode**.
- The application is hosted on **Vercel.**

1.5 Objectives of the Project Work

The main objectives of the project is to,

- Develop a real-time drawing app called SyncSketch which will allow users to draw on a shared canvas and see updates from other users instantaneously.
- Allow users to connect irrespective of their geographical locations.
- Provide an opportunity to implement communication and a user-friendly application thereby enhancing creativity and user experience.

1.6 Scope of the Project Work

Users can simultaneously draw on a shared canvas, and changes are reflected instantly for all participants. The application will be accessible from any device with internet connectivity. The application will have an intuitive design for easy navigation and will provide a set of basic drawing like colours and shapes. Users can create drawings as per needed.

1.7 Project Report Outline

The project report is structured in the following manner,

- **Introduction -** This section provides an overview of the project and its domain.
- **Literature Review -** This section reviews existing literature on drawing ideation in remote co-design, digital drawing tools used to depict prompts and digital play in early years.
- **Methodology -** This section describes the methodology employed in developing SyncSketch.
- **Results -** This section presents the outcomes of the project.
- **Discussion -** This section discusses the implications of the project findings, limitations of the system and potential avenues for future research.
- **Conclusion -** This section summarizes the project's contributions and offers concluding remarks.
- **References -** This section lists the sources cited in the project report.

CHAPTER 2

LITERATURE SURVEY

2.1 System Study

[1] **Visual thinking in virtual environments: evaluating multidisciplinary interaction through drawing ideation in real-time remote co-design by Close A et al. (2024)** - This study investigated remote sketching ideation across three systems: virtual reality (VR), tablet drawing, and uploading paper drawings.

[2] **Paper or Tablet? The Impact of Digital Tools on Sketching During Engineering Design Concept Generation by Das M et al. (2023)** – This study posed three RQs. Four mixed gender treatment groups used each set of tools to sketch two different design prompts. The order in which they used the tools and the order of the prompts were switched to have an equal number of people in each of the four treatment categories.

[3] **Digital play in the early years: A systematic review by Chu, C et al. (2024)** – This study aimed to provide insight into the extant literature which explored young children's digital play following the release of the Apple iPad in 2020.

2.2 Review of Literature

[1] The aim was to evaluate how drawing tools influence strategies and design artifacts. 3D VR drawings were compared to two forms of 2D drawing—tablet drawing and paper drawing and upload. The paper also compared the approaches of people across three areas of study/profession—industrial design, visual art, and engineering. Participants would make a shipping container greenhouse for a cold climate, as this is focused on forms, relationships, limited materials, human interaction and active elements such as growing plants. In this study, physical drawing excelled in expressiveness and line control, while VR demonstrated potential for general creative expression and visualization. The tablet method proved effective in enhancing mutual understanding among participants, underlining the impact of existing skills on collaboration perceptions.

[2] An experiment was conducted involving 40 participants who generated concepts by sketching ideas for two engineering design prompts, one on paper with a pen and one on a

tablet (iPad) using a stylus (Apple Pencil). All participants completed both prompts in order to ensure that they did both tablet and paper sketching. Subsequently, the sketches were analyzed for quantity, quality, and understandability. This work investigated the influence of the sketching tool used on sketching outcomes during engineering concept generation such as sketch quantity and quality. Additionally, it explores whether or not there are any gender differences in sketch quantity or quality during brainstorming for engineering problems. Prompts given to the participants were milk frother and a peanut sheller. This study only explores a few limited areas within the sketching experience namely quality, quantity, and understandability.

[3] This systematic review aimed to provide insight into the extant literature which explored young children's digital play following the release of the Apple iPad in 2020. Specifically, this review sought to identify the characteristic knowledge base of digital play for young children in the available literature. This paper has highlighted three key findings that represent the characteristic knowledge base of the digital play literature following the release of the Apple iPad. These include that: 1) digital play is only possible when children are afforded by access to working or non-working technologies; 2) there appears to be six distinctive features of digital play including learning and development, situated, interactive, enjoyable and entertaining, meaningful, and gendered; and 3) there remains concerns about the effects of digital play on young children particularly in relation to physical activity and addiction.

2.3 Comparison of Literature

TITLE	METHODOLOGY	OUTCOMES	SETBACKS
[1] Visual thinking in virtual environments: evaluating multidisciplinary interaction through drawing ideation in real-time	This study investigated remote sketching ideation across three systems: virtual reality (VR), tablet drawing, and uploading paper	Physical drawing - line control and expressiveness. VR - potential for creativity and visualization. Tablet – enhanced	Different sized rooms (VR), and lack of precision (Tablet). Discomfort either with technology or with a medium that is not indicative of

remote co-design **(2024)**	drawings.	mutual understanding among participants via collaboration.	current skills.
[2] Paper or Tablet? The Impact of Digital Tools on Sketching During Engineering Design Concept Generation **(2023)**	Posed **three RQs**. Study of four mixed gender treatment groups who used each set of tools to sketch two different design prompts. The order in which they used the tools and the order of the prompts was switched to have an equal number of people in each of the four treatment categories.	No differences in sketch quantity. Differences in sketch quality. **Manual sketches were more refined than tablet sketches.** No differences in gender.	**Similarity in prompts** can be considered. **Tablet features** might be a factor for 2nd RQ.
[3] Digital play in the early years: A systematic review (2024)	Aimed to provide insight into the extant literature which explored young children's digital play following the release of the Apple iPad in 2020.	Six distinctive features of digital play - learning and development, situated, interactive, entertaining, meaningful, and gendered.	Most of the studies included were conducted in Western contexts - United States and Australia.

CHAPTER 3

SYSTEM REQUIREMENTS SPECIFICATION

3.1 Functional Requirements

The functional requirements for a system describe what the system should do. These requirements depend on the type of software being developed, the general approach taken by the organization when writing requirements. The functional system requirements describe the system function in detail, its inputs and outputs, exceptions and so on.

Functional requirements are as follows,

- **User management** - A simple UI to allow users to generate a room code and join a room using that code.
- **Canvas creation and tool selection** - A shared canvas allowing users to draw using different shapes and choose colors from the color palette.
- **Clear canvas** - Options to undo or redo the operation and ability to clear the canvas at once.
- **Collaboration** - Show joined users in real-time and allow room chat integration.

3.2 Non-Functional Requirements

Non-functional requirements, as the name suggests, are requirements that are not directly concerned with the specific functions delivered by the system. They may relate to emergent system properties such as reliability, response time and store occupancy. Alternatively, they may define constraints on the system such as capabilities of I/O devices and the data representations used in system interfaces.

The non-functional requirements are as follows,

- **Response time –** The app must respond quickly to user actions.
- **Scalability –** The app must be able to handle increasing numbers of users and concurrent sessions.
- **Throughput –** The app must efficiently handle data transfer and processing.

- **Load handling** – The app must effectively manage high traffic and peak usage periods.

3.3 Hardware Requirements

Hardware requirements refer to the specific physical components or devices needed for a software application or system to function correctly. These specifications outline the minimum and recommended configuration for optimal performance.

The hardware requirements are as follows,

- **Processor -** Modern processor capable of handling real-time interactions.
- **Memory -** Sufficient RAM for smooth application performance.
- **Display –** High resolution display for optimal visual experience.
- **Input devices -** Mouse, stylus, or touch screen for drawing input.
- **Network interface -** Reliable internet connection for collaboration and seamless experience.

3.4 Software Requirements

Software requirements are essentially a detailed description of what a software system should do. They outline the functions, features and constraints that the software must meet to satisfy the needs of its users.

The software requirements are as follows,

- **Operating System** - Choose a compatible operating system such as Linux, Windows or Mac.
- **Programming Language** - Let JavaScript be chosen as the preferred language.
- **Integrated Development Environment (IDE)** – Use VScode to test the working of the application.
- **Frameworks** – Utilize ReactJS for frontend development and ExpressJS + NodeJS for backend development. Use WebSockets for client-server communication.
- **Deployment** – Utilize Vercel to deploy the app for free of cost.

CHAPTER 4

SYSTEM DESIGN

4.1 Design Overview

SyncSketch aims for a simple, intuitive interface centered on a large, shared canvas for users to create and join a room. Users will have easy access to a set of basic drawing tools and color palette. The app prioritizes real-time updates, smooth collaboration and versatility. The app includes options to undo, redo and clear the drawing. The users options on the left when clicked, is expanded as a sidebar that displays the list of users while the chats option will allow users to exchange messages in real-time. Users can download the drawings on to their local machine. Overall, the visual design will emphasize clarity and consistency, with a focus on creating a positive and engaging environment for collaborative drawing.

4.2 System Architecture

System architecture is essentially a blueprint that outlines the structure, behavior and components of a system. It's a conceptual model that defines how different parts of a system interact with each other.

The system architecture of SyncSketch is as follows,

- **User Interface (UI) -** Represents the user's web browser where they see and interact with the canvas, displays a list of active users, allows room-chat integration and options to create/join rooms.
- **Websocket Connection -**This two-way communication channel allows real-time data exchange between the UI and the server. In other words, it sends drawing updates and room actions to the server. It also receives updates from the server and applies them to the local canvas.
- **Server-side Logic -** This handles application logic, manages rooms and users, and broadcasts updates to all users in a room.

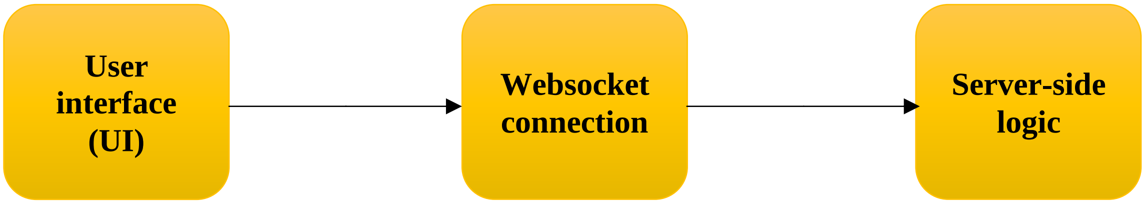


Fig 4.1 System Architecture

4.3 Data Flow Diagrams

4.3.1 Data Flow Diagram - Level 0

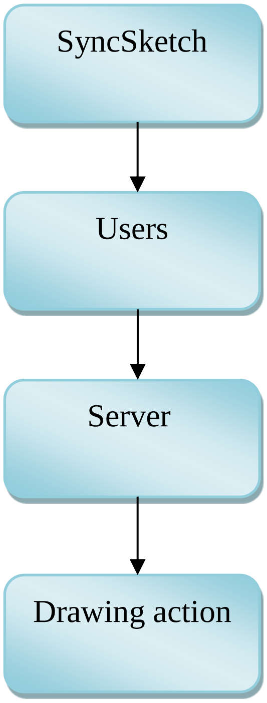


Figure 4.2 DFD-Level 0

Figure 4.2 depicts that users connect to our application with the help of server and then proceed to perform desired drawing actions.

4.3.2 Data Flow Diagram - Level 1

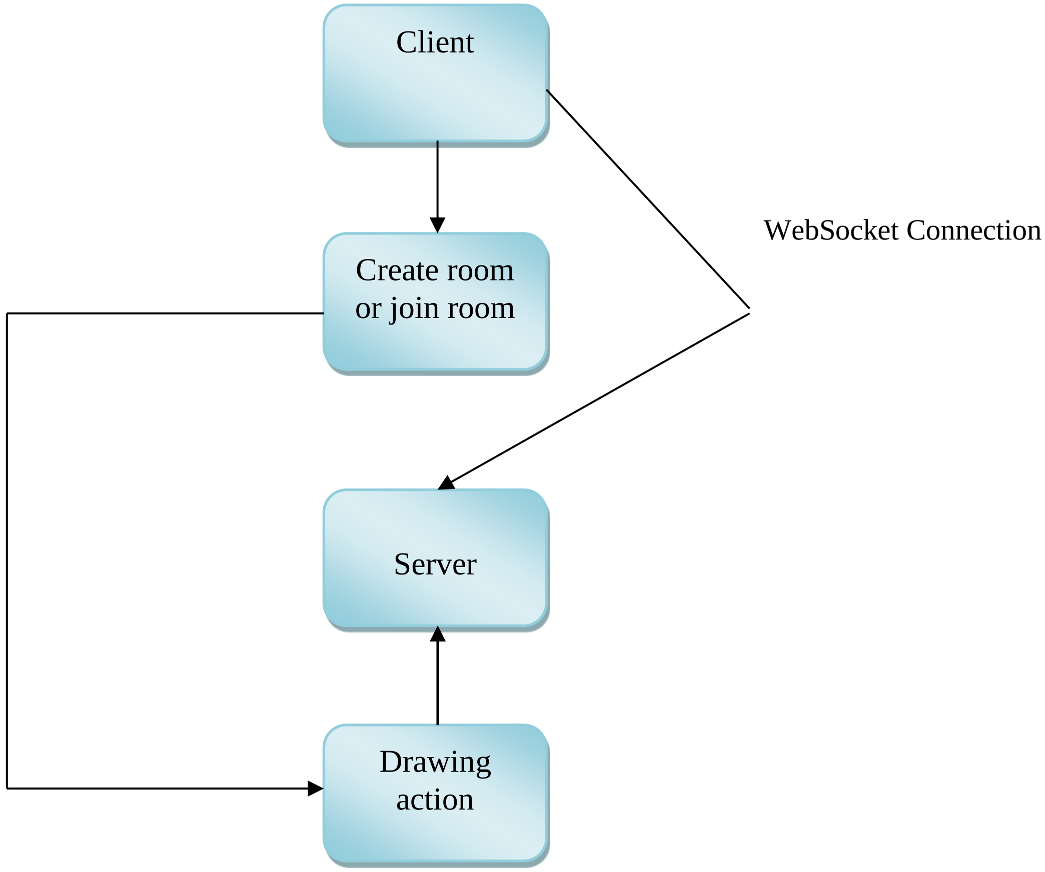


Figure 4.3 DFD-Level 1

Figure 4.3 depicts the following,

- A user creates or joins a room on the client side.
- The client sends a room creation/join request to the server.
- The server creates a new room or adds the user to an existing room.
- The client establishes a WebSocket connection with the server.
- Drawing actions performed by a user are sent to the server via WebSocket.
- The server broadcasts the drawing update to all users in the room.
- Clients receive the update and apply it to their local canvas.

CHAPTER 5

IMPLEMENTATION

Implementation is the process of converting a new system design into an operational one. It is the key stage in achieving a successful new system. It must therefore be carefully planned and controlled. The implementation of a system is done after the development effort is completed.

5.1 Steps for Implementation

The steps for implementation are as follows,

- **Set Up the Environment -** Install NodeJS and Node Package Manager (npm). Install yarn globally using the command, *npm i -g yarn* in the terminal or command prompt.
- **Install Dependencies -** Install all the necessary packages using the command, *yarn*. Use *yarn* both in backend and frontend folder assuming the existence of a react app.
- **Set Up the Client -** Create a React app for the client-side.
- **Set Up the Server -** Create a basic Express server with WebSocket by using Socket.IO.
- **Application –** Implement the necessary code needed to stir up the app.
- **Run the application -** Start the server in the backend folder using *yarn start* and start the client in the frontend folder using *yarn dev*.
- **Deploy the application –** Use Vercel to host the app and make it available online.

5.2 Implementation Issues

The implementation phase of software development is concerned with translating design specifications into source code. The primary goal of implementation is to write source code and internal documentation so that conformance of the code to its specifications can be easily verified and so that debugging testing and modification are eased. This goal can be achieved by making the source code as clear and straightforward as possible. Simplicity clarity and elegance are the hallmarks of good programs and these characteristics have been implemented in each program module.

The goals of implementation are as follows.

- Minimize development time and integrate all core functionalities.
- Ensure that the application performs well with minimal latency and quick responsiveness.
- Handle increasing number of users and data.
- Ensure compatibility across different devices and platforms.

5.3 Algorithms

5.3.1 Operational Transformation (OT)

- Handles the complexities of merging multiple users' drawing actions in real-time, ensuring consistency across all clients.
- Each drawing action is an operation.
- When a user performs an action, it's transformed into an operation and sent to all other users.
- Upon receiving an operation, each client applies it to its local copy of the drawing.
- Ensures that the final drawing is identical on all clients, regardless of the order in which the operations are received.

5.3.2 WebSockets

- Provides a persistent connection between clients and the server for efficient real-time data exchange.
- The client initiates a WebSocket connection by sending an upgrade request to the server.
- If the server accepts the request, a WebSocket connection is established.
- Both the client and server can send data to each other at any time.
- Either the client or server can initiate the closure of the WebSocket connection.

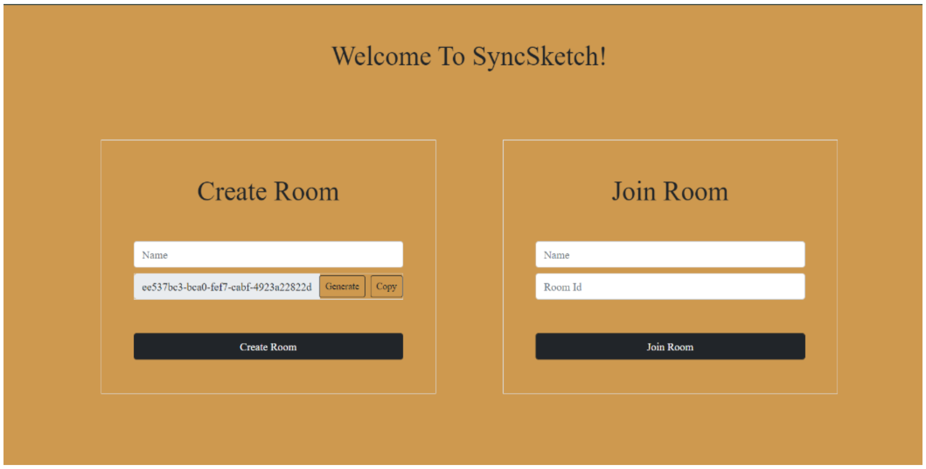
CHAPTER 6

RESULTS

This section describes the screens of **SyncSketch**. The snapshots are shown below in an incremental approach.

Snapshot 1 – Homepage

This is the look of the homepage when the user stirs up the application.

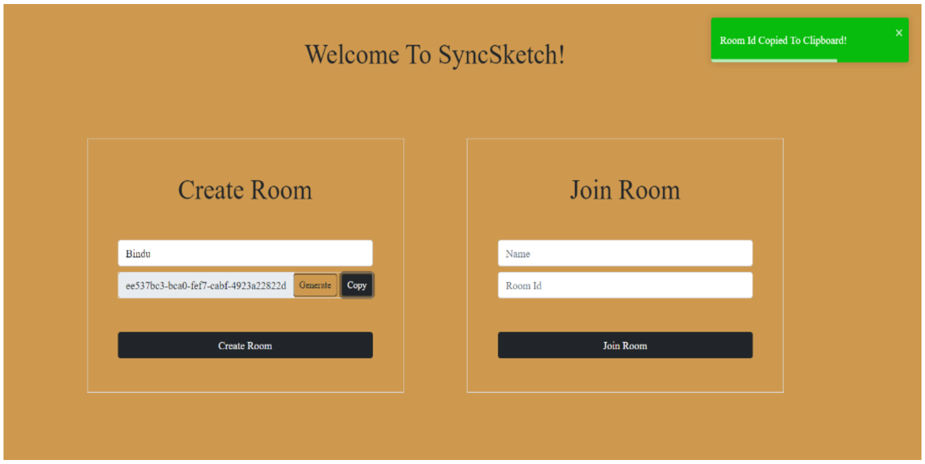


ee537bc3-bca0-fef7-cabf-4923a22822d

Figure 6.1 Snapshot of Homepage

Snapshot 2 - Copying room id

When the host copies the room id, it is reflected on the homepage.



Room Id Copied To Clipboard!

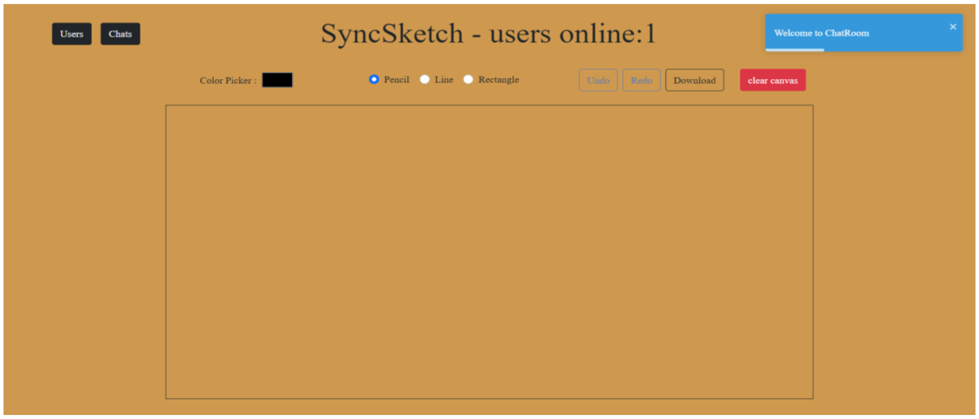
Bindu

ee537bc3-bca0-fef7-cabf-4923a22822d

Figure 6.2 Snapshot of Copying room id

Snapshot 3 – Room page

This is the page when the host creates a room.

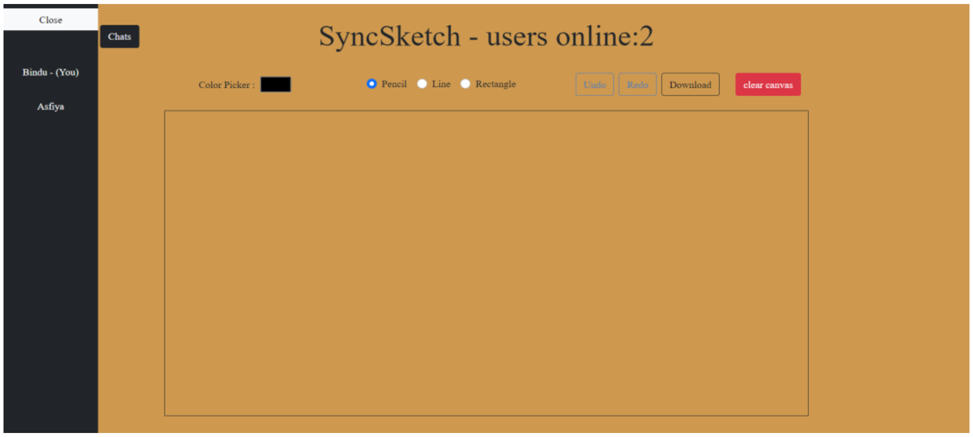


Welcome to ChatRoom

Figure 6.3 Snapshot of Room page

Snapshot 4 – Sidebar

This picture shows the list of users with the help of a sidebar.



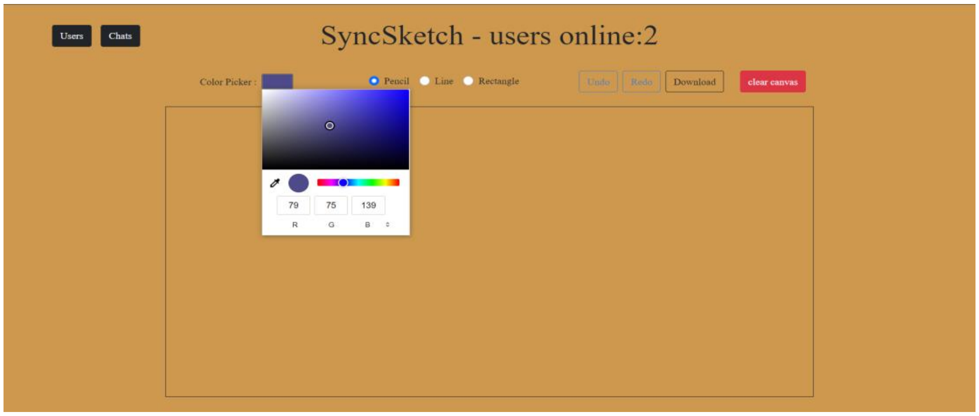
Bindu - (You)

Asfiya

Figure 6.4 Snapshot of Sidebar

Snapshot 5 – Color palette

This picture shows the host choosing a color from the color palette



R	G	B
79	75	139

Figure 6.5 Snapshot of Color palette

Snapshot 6 – Drawing action

This picture shows the host choosing tools like pencil, line and a rectangle.

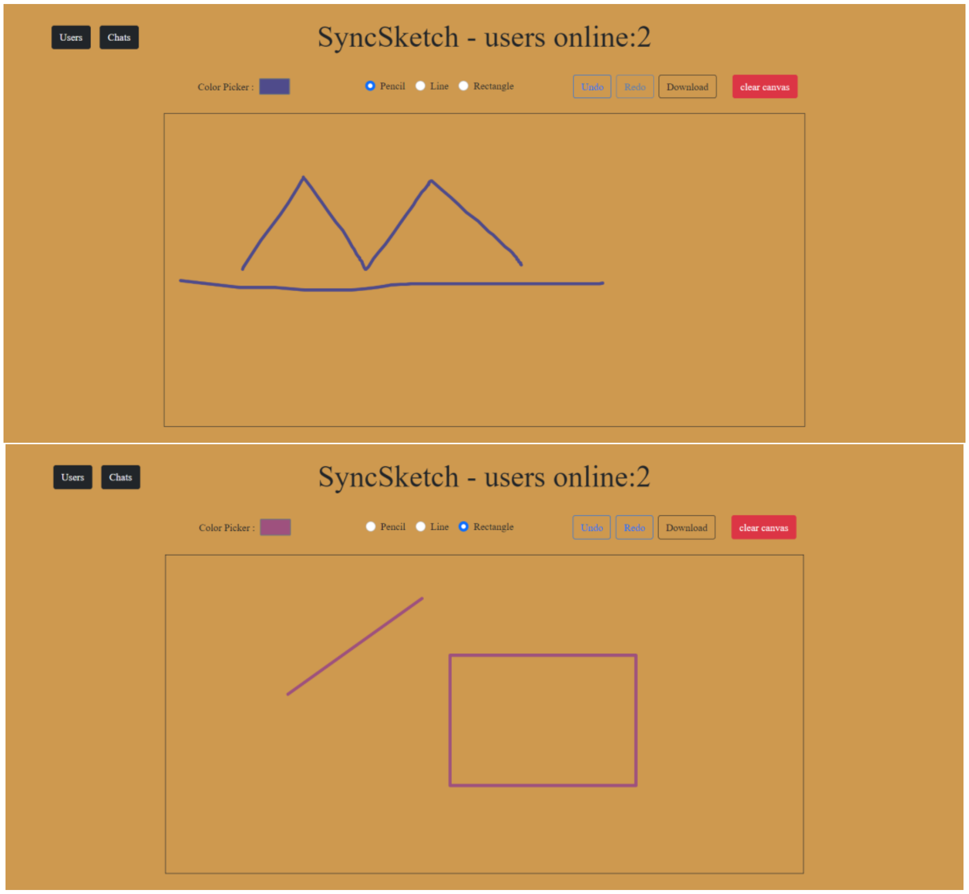

Users
Chats
SyncSketch - users online:2
Color Picker :
● Pencil ○ Line ○ Rectangle
Undo
Redo
Download
clear canvas
Users
Chats
SyncSketch - users online:2
Color Picker :
○ Pencil ○ Line ● Rectangle
Undo
Redo
Download
clear canvas

Figure 6.6 Snapshots of Drawing action

Snapshot 7 – Download drawing

This picture shows that the host can download the drawing.

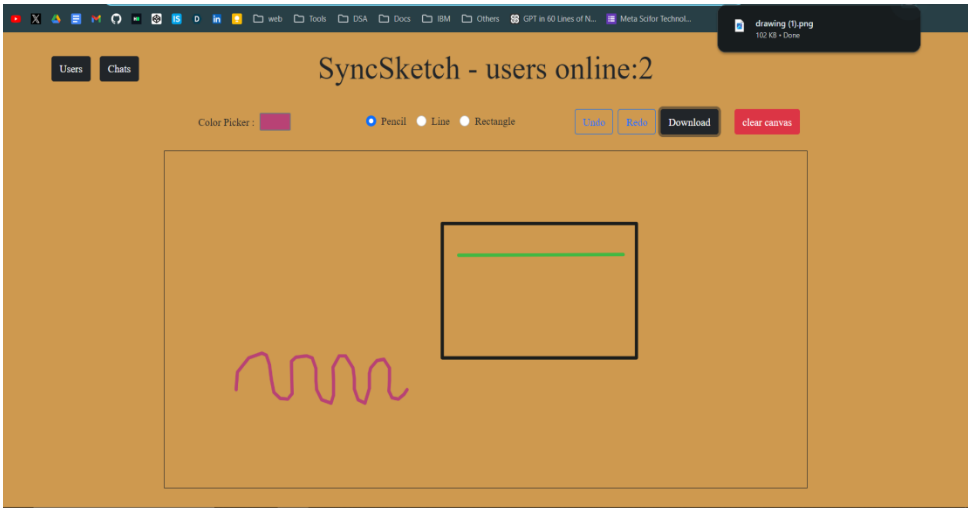
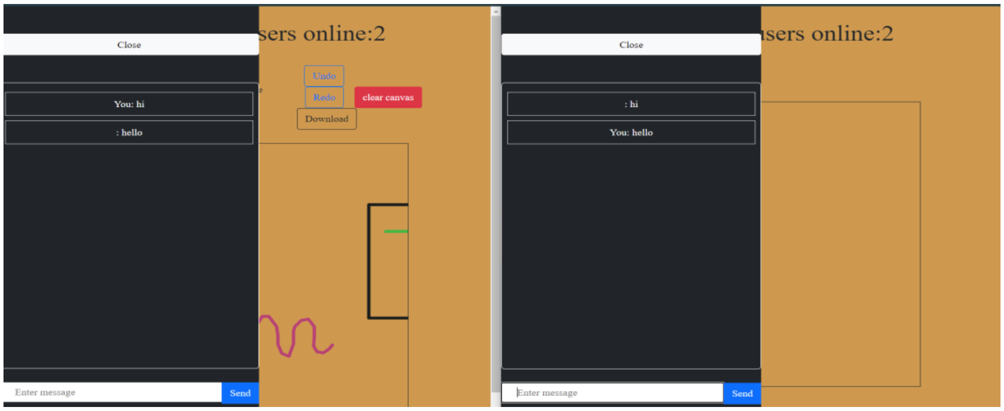


Figure 6.7 Snapshot of Download drawing

Snapshot 8 – Room-chat integration

This picture shows the message exchange between two users.



You: hi

: hello

: hi

You: hello

Figure 6.8 Snapshot of Room-chat integration

Snapshot 9 – Clear canvas

This picture shows that the host has cleared the canvas.

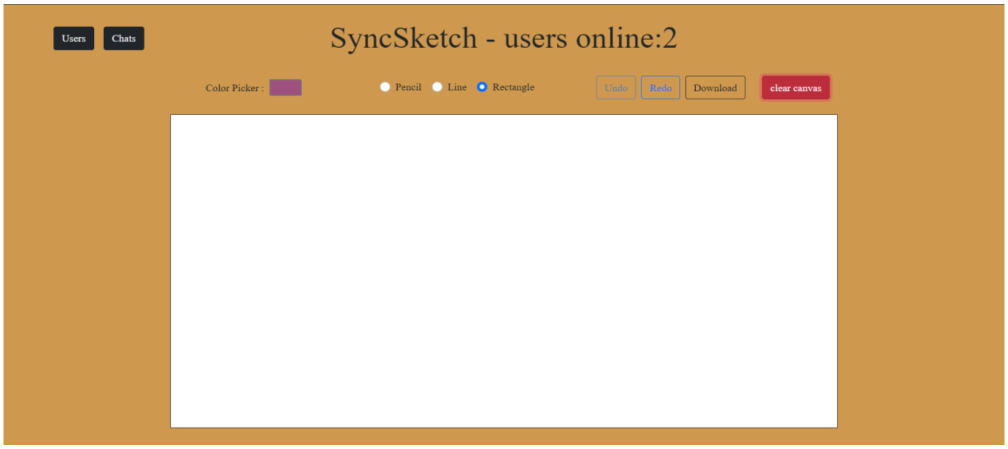
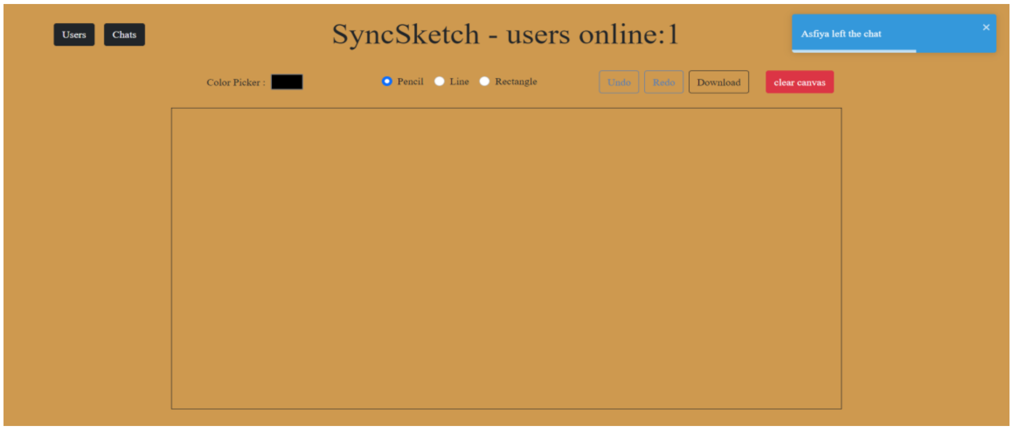


Figure 6.9 Snapshot of Clear canvas

Snapshot 10 – Leave room

This picture depicts the user leaving a room.



Asfiya left the chat

Figure 6.10 Snapshot of Leave room

CHAPTER 7

CONCLUSION

7.1 Major contributions

SyncSketch is a tool for real-time collaborative drawing offering a seamless experience for beginners and has depicted the following contributions,

- **Real-Time Collaboration** - SyncSketch allows multiple users to draw on a shared canvas simultaneously, with updates visible in real-time. This feature is crucial for collaborative projects, enabling seamless communication and feedback.
- **User-Friendly Interface** - Designed with beginners in mind, SyncSketch offers an intuitive interface that simplifies the drawing process. This makes the app accessible with simple UI, allowing users to generate a room code and join a room using that code.
- **Whiteboard Component** - A canvas allowing users to draw using different shapes and choose colors from the color palette with options to undo or redo the operation to clear the canvas and to download the drawings.

7.2 Future Enhancements

By continuing to innovate and expand its capabilities, SyncSketch can remain at the forefront of collaborative drawing technology in the following manner,

- Adding a shape palette instead of individual shapes and also brushes of varied sizes.
- Saving the drawing data in a database.
- Exporting the drawing in different formats.
- Transfer host controls to other users.
- Introducing advanced features tailored for professional artists, animators, and VFX professionals that can broaden the user base and increase the platform’s appeal.
- Incorporating user feedback to add new features and customization options can help meet the evolving needs of the creative community.

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