VV CHAT WEB APP

Full Stack Messaging Service

System Design Document

Version: 1.0.0

Date: 03/09/2024

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1. Introduction

1.1. Software Requirements Specification

The web application “VV CHAT” is intended to provide users “Messaging Service”. It initially needs to allow users to register for availing the services. Intuitively, the web app needs to authenticate the users and prompt them to first register and then login. The core functionality of the prototype is to allow sending and receiving of text messages between the users. Next requirement is providing Group Chat functionality. Throughout the service, it must give message updates in real time. The user interface should be clean and intuitive. The data behind the interface needs to be implemented using best practices. In addition to that, data needs to be restored back whenever user requests. Efficient and Optimized code implementation is appreciable. Additional requirements suggested are providing users with the feature of Audio & Video calling and including AI services (such as User-friendly chatbots) to enhance User Experience.

1.2. Dev Dependencies Documentation

This section explains about the technologies, dependencies and libraries used during the Design, Develop and Deployment of the application.

1) **Next.js** => To build responsive frontend UI components. With respect to easy deployment in the Vercel platform, I have chosen this tech stack.
2) **Nodejs** => To build back-end RESTful API services. Effectively utilized the concurrent requests handling feature of nodejs. Chosen this tech stack because of its high performance and lesser loading time when linked with nextjs components.

3) **NoSQL** => Not only SQL database picked because of its dynamic schemas ability to include unstructured and semi-structured datatypes.
4) **MongoDB** => Open source, non-relational database management system with easy horizontal scale-out with sharding.
5) **Mongoose** => MongoDB object modeling tool installed & imported to handle data validation, schema management. Used in establishing the link between the backend and database.
6) **BcryptJS** => Installed & Imported to make use of Bcrypt hashing algorithm for the encryption of passwords.
7) **Tailwind CSS** => open-source CSS framework that provides customizable styling. Installed in order to setup an organized code structure, segregating styling logic into one side and rest business logic on the other. By this act, later any UI/UX design modifications can be completed in an efficient manner.
8) **react-hook-form** => Installed & Imported to build responsive user login & register forms. This library enhanced user authentication and authorization functionalities.
9) **react-hot-toast** => Lightweight yet powerful library for creating visually appealing user alerts. Easy to use, well documented library.
10) **react-dom** => Package from React that provides DOM-specific methods, so that web application gets easy page navigations and user customization.
11) **pusher-js** => Made use of third-party software to avail real-time communication between the server and the client.

12) **next-cloudinary** => Installed & Imported high-performance image delivery and uploading library from Next.js which is powered by Cloudinary. Controls web application's image chatting and user profile picture upload functionalities.
13) **next-auth** => A complete open-source authentication solution for Next.js applications. Used this dependency to design OAuth authentication for availing token-based user login sessions.
14) **date-fns** => Date utility library used in the application to display the time of arrival of chat message.
15) **@emotion/react** => Package designed for writing responsive css styles in JavaScript.
16) **@emotion/styled** => Installed & Imported this package to allow end user to change the styles of a component based on the props. Used this in the web application Login button and Register button.
17) **@mui/icons-material** => React Material Icons installed to add icons of username, email and password on web app's Login and Register pages.
18) **ESLint** => plugin to ensure proper patterns and test all the configurations.

2. System Overview

2.1. System Description

The VV CHAT App (VV abbreviation stands for the developer's name – Vishnu Vardhan) is a messaging service prototype which is a real-time web application that allows users to send and receive messages. Apart from that feature, the web app also allows users to upload profile pictures. In the list of chats and contacts, provides ability to search for a required entity. Gives a responsive user interface by dynamically changing the UI components of the application. Users alerts and notifications displayed with low latency. Optimized user registration and authentication provided by the app. Mobile UI is handled efficiently, user can experience dynamic UI/UX when mobile layouts are changed. Clean & Optimized code handles retrieval of user profile details, storing them in backend database. Whenever user initiates a new chat, all the messages are stored in the backend for future retrievals. The VV Chat App apart from text messages, also allows users to share pictures through the chat. In future, enables users to upload video files too.

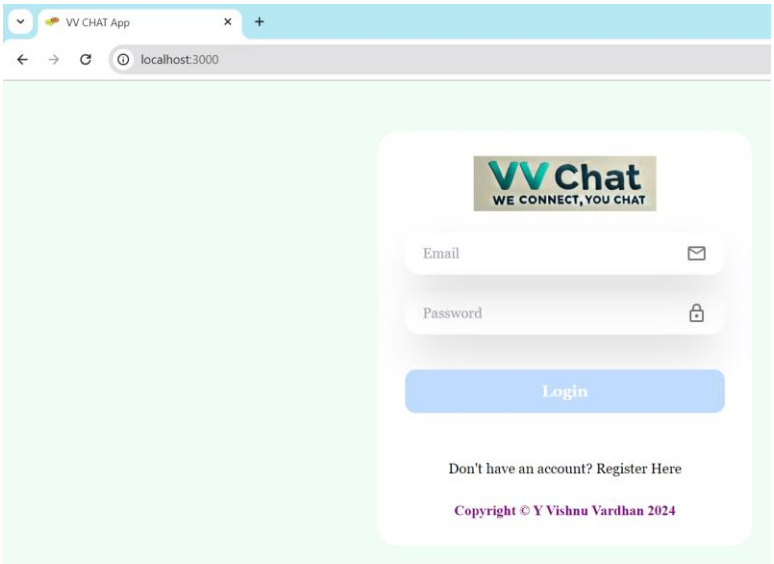


Figure 01

2.2. System Context

The Next.js web application – VV CHAT interacts with various services in order to deliver the system requirements efficiently. As Next.js UI components in terms of reliability go hand in hand with Node.js backend routes, web app developed REST APIs using nodejs programming language. VV CHAT preferred NoSQL database because, of its dynamic schemas ability. Messaging service quite often has usage of unstructured and semi-structured datatypes, which is achievable only through NoSQL. Among several NoSQL database providers, VV CHAT picked MongoDB Atlas cloud database service for storing the data. Since MongoDB is a flexible and customizable database that stores data in documents instead of traditional tables and rows, I believed CRUD operations of DBMS get executed in an optimized manner with very low latency. Specifically chosen MongoDB Atlas service, as it automates many administrative tasks which makes my job free and moreover gives me time to concentrate more on database schemas and relations. Furthermore, it also provides additional security and scalability features which will be helpful for my future implementations. VV CHAT implemented user authentication by importing NextAuth.js open-source authentication library. Any user after getting registered in our web app, will be authenticated successfully from the login page which takes forward to the Home page of VV CHAT. Strong authentications incorporated to stop users visiting inner layers of UI such as Contacts page, Profile page. Apart from that, the web application imported several other packages and dependencies to develop various functionalities such as Tailwind CSS, Pusher, Cloudinary so on. Reasons to pick those third-party tools are mentioned in Dev Dependencies Documentation.

3. Architecture Design

3.1. High-Level Architecture

VV CHAT Web application built frontend using Next,js. Since it is the React framework for the Web, has high scalability and efficient Route handling techniques. As it integrates with Node.js to give a strong backend, I used Node.js JavaScript runtime environment for executing the application on the server. The overall application performs various REST API calls in order to provide end-users single user chatting, group chatting, profile picture upload, start a new conversation and so on.

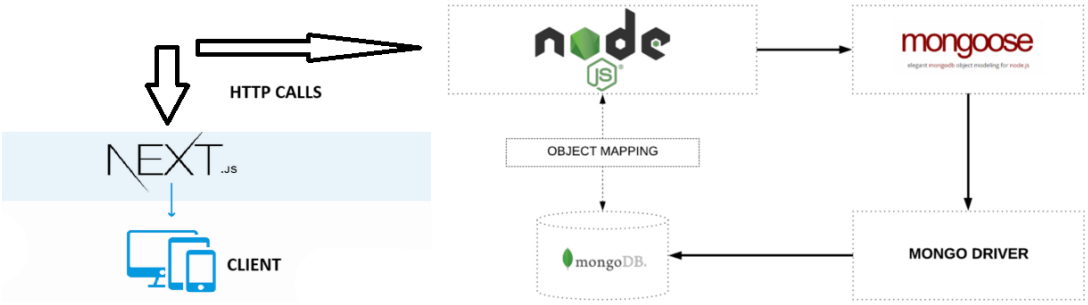


Figure 02

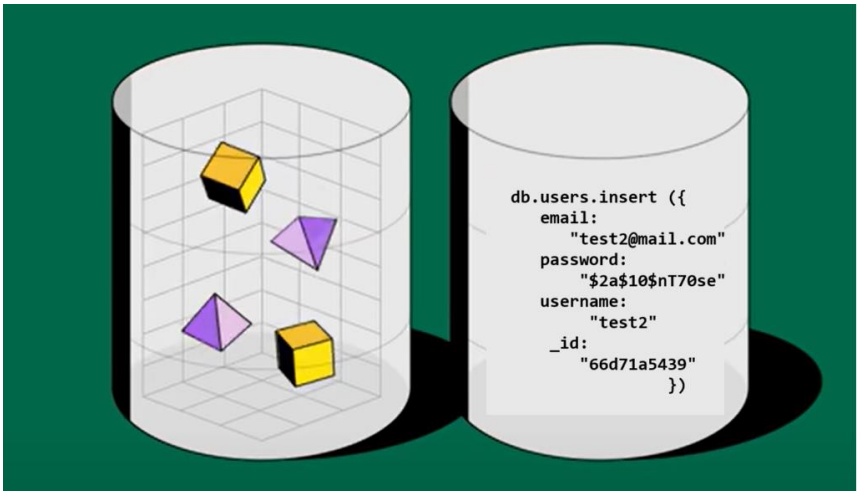


Figure 03

3.2. Component Diagram

First of all, the web application broadly differentiates Login & Register pages and rest of the pages (like Home page, Contact page, Chats page etc.) into 2 different components.

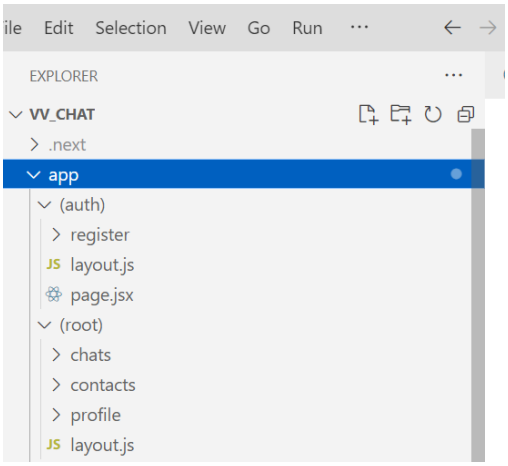


Figure 04

Dealing with initial Login and Register pages, considering code optimization I implemented both the pages using single component (Form.jsx). By importing "react-hook-form", developing user validations task became easy. Applying ternary operator,

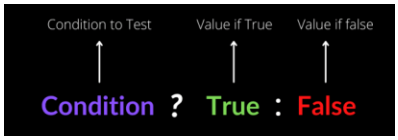


Figure 05

I have developed a responsive form when a user visits either Login page or Register page.

```
134                <button className="button" type="submit">
135                  {type === "register" ? "Register" : "Login"}
136                </button>
137              </form>
138
139              {type === "register" ? (
140                <Link href="/" className="link">
141                  <p className="text-center">Already registered? Log In</p>
142                </Link>
143              ) : (
144                <Link href="/register" className="link">
145                  <p className="text-center">Don't have an account? Register Here</p>
146                </Link>
147              )}
```

Figure 06

Coming to the Home page UI, using Nextjs File-based Routing feature, I divided the root directory into 3 different children:

chats

contacts

profile

Furthermore, chats directory is query-downed (chatId]) to get specific user chatting page.

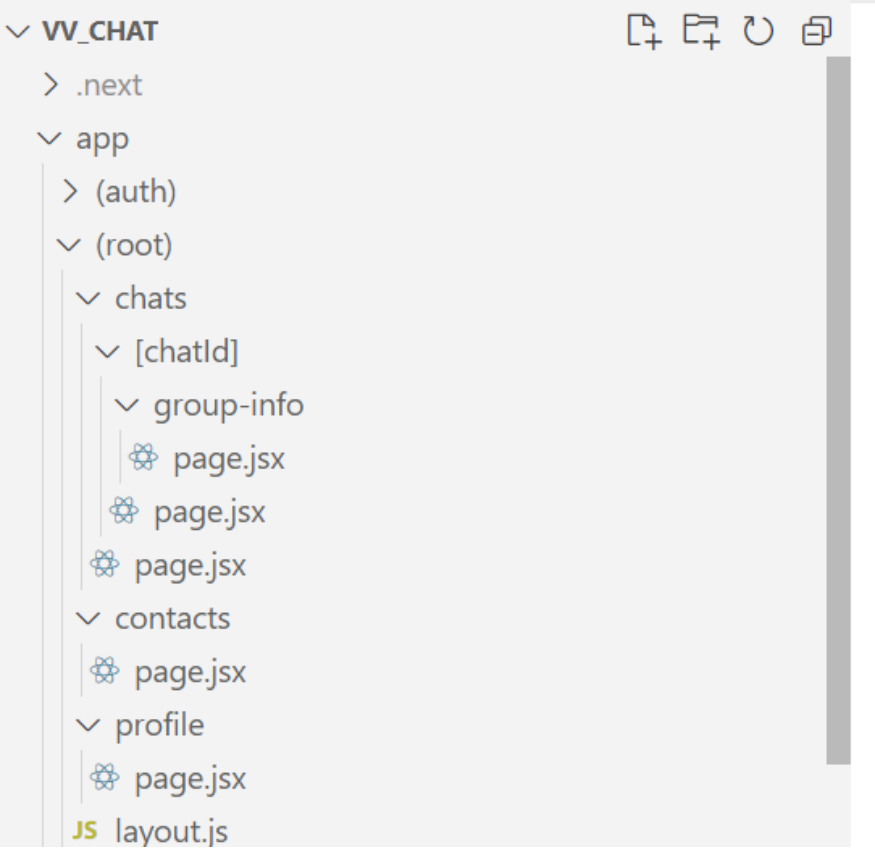


Figure 07

One more optimization technique adopted in styling the UI pages is, engulfing all the component's, section's and HTML tag's CSS logic into single file (globals.css).

```
# globals.css 9+ ×
app > # globals.css > ...
40   }
41
42   .link {
43     @apply text-base-medium cursor-pointer hover:bg-red-50;
44   }
45
46   /* Main Container */
47   .main-container {
48     @apply h-screen flex justify-between gap-5 px-10 py-3 max-lg:gap-8;
49   }
50
51   /* Top Bar */
52   .topbar {
53     @apply top-0 sticky px-20 py-5 flex items-center justify-between bg-blue-2;
54   }
55
56   .menu {
57     @apply flex items-center gap-8 max-sm:hidden;
58   }
59
60   .profilePhoto {
61     @apply w-11 h-11 rounded-full object-cover object-center;
62   }
63
64   /* Bottom Bar */
65   .bottom-bar {
66     @apply  w-full flex justify-between items-center px-5 py-9 bg-blue-2 sm:hidden
67   }
```

Figure 08

Describing the REST APIs implementation, I broadly classified the main api directory into 4 different modules.

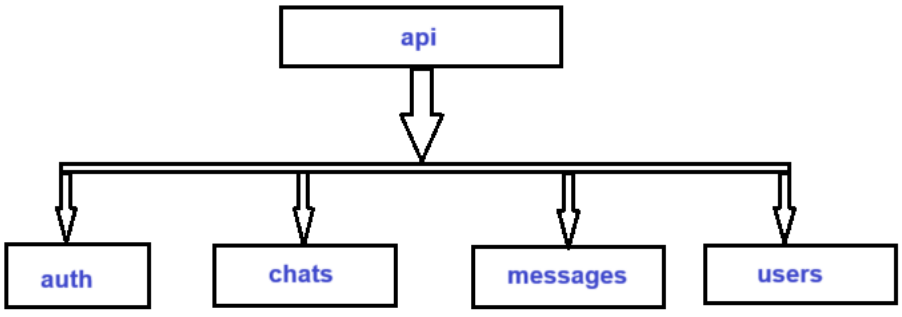


Figure 09

Each and every nodejs file present in the above modules will send GET/POST requests via establishing a connection to the database. This is achieved by installing and importing "mongoose". Mongoose is an Object Data Modeling (ODM) library for MongoDB and Node.js. It manages relationships between data, provides schema validation, and is used to translate between objects in code and the representation of those objects in MongoDB.

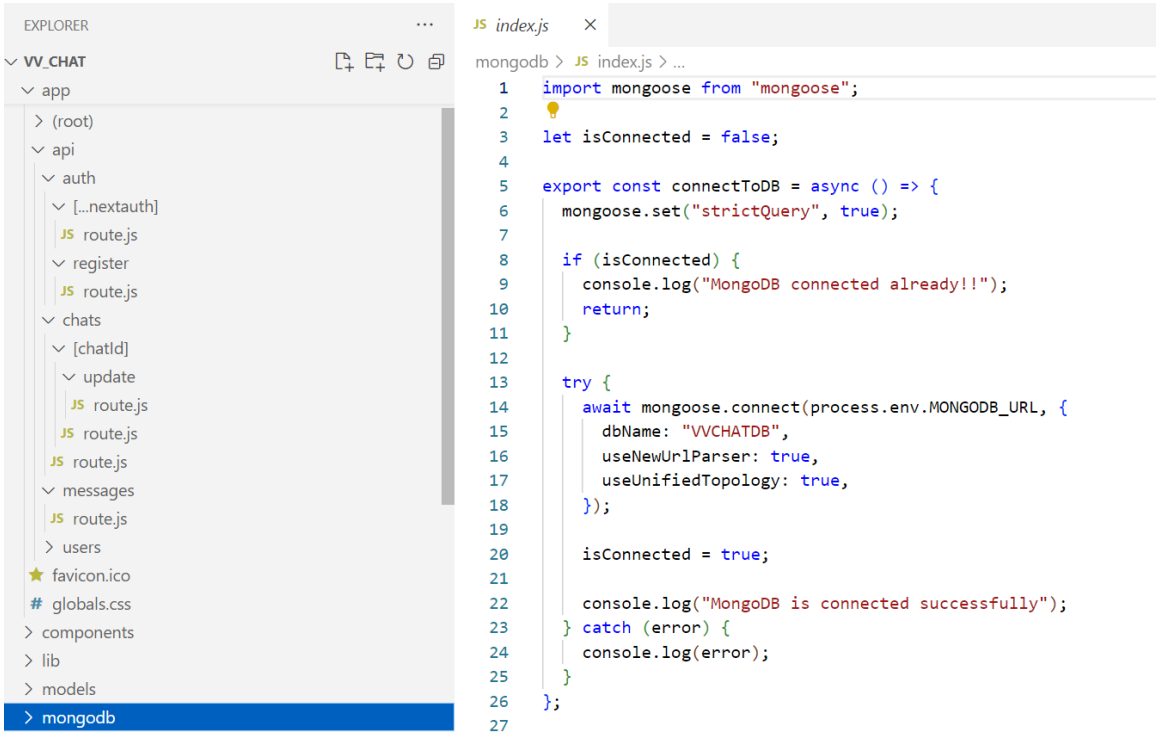


Figure 10

Coming to protection of client and server side rendered pages as well as API routes, I implemented next-auth middleware pattern. By this, my web app allows to run a code before a request is completed. Through this functionality, I secured chats page, contacts page and profile page from intruders. As soon as these pages are called without prior login, the user redirects to the login page via callbacks.

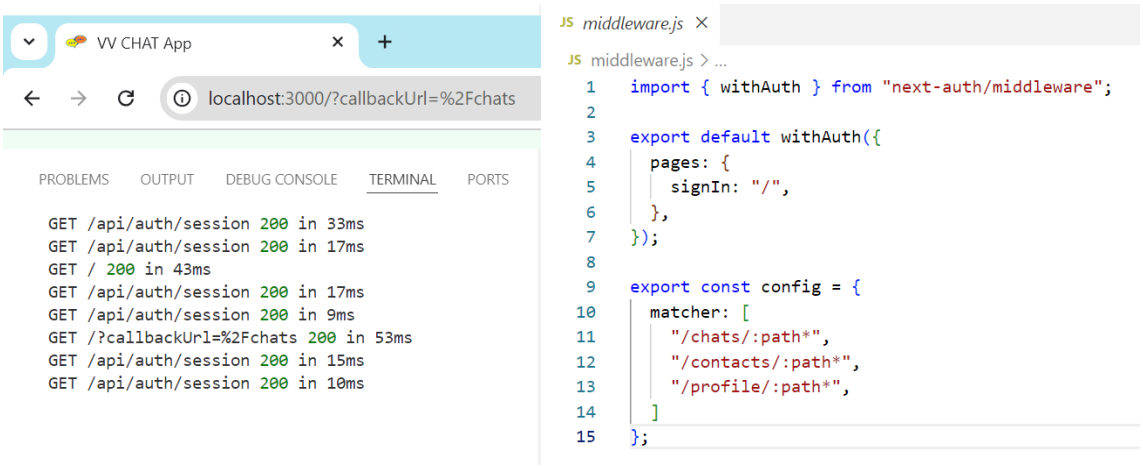


Figure 11

3.3. Technologies Used

The technology stack used to Design, Develop & Deploy the VV CHAT Web Application is:

Nextjs = For developing Front end components.

React Hook Form = For developing super lightweight and responsive user forms.

Nodejs = For building backend framework and REST API calls.

MongoDB = For storing data and to exhibit persistent data.

Tailwind CSS = For clean and consistent UI by availing utility-first styling principles.

Cloudinary = To manage user profile picture upload and photo messages functionality.

Vercel = Cloud infrastructure to deploy the web application.

In addition to those, for development of other functionalities, I installed multiple open-source tools and modules using Node Package Manager (npm).

Below figure depicts overall packages along with their version numbers used in the development.

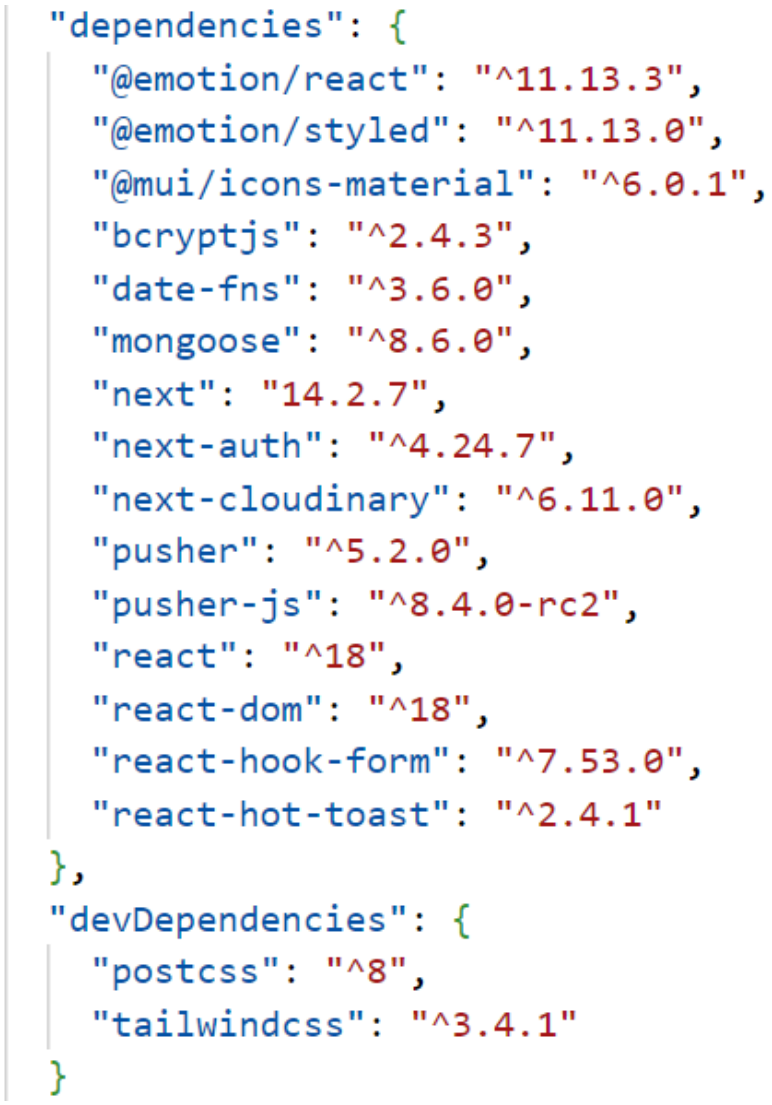


Figure 12

4. Detailed Design

4.1. Frontend Design

VV CHAT Web Application frontend consists of multiple UI components. Considering the Atomic Design practices, I created a separate directory containing all the components and imported them into the root folder whenever needed.

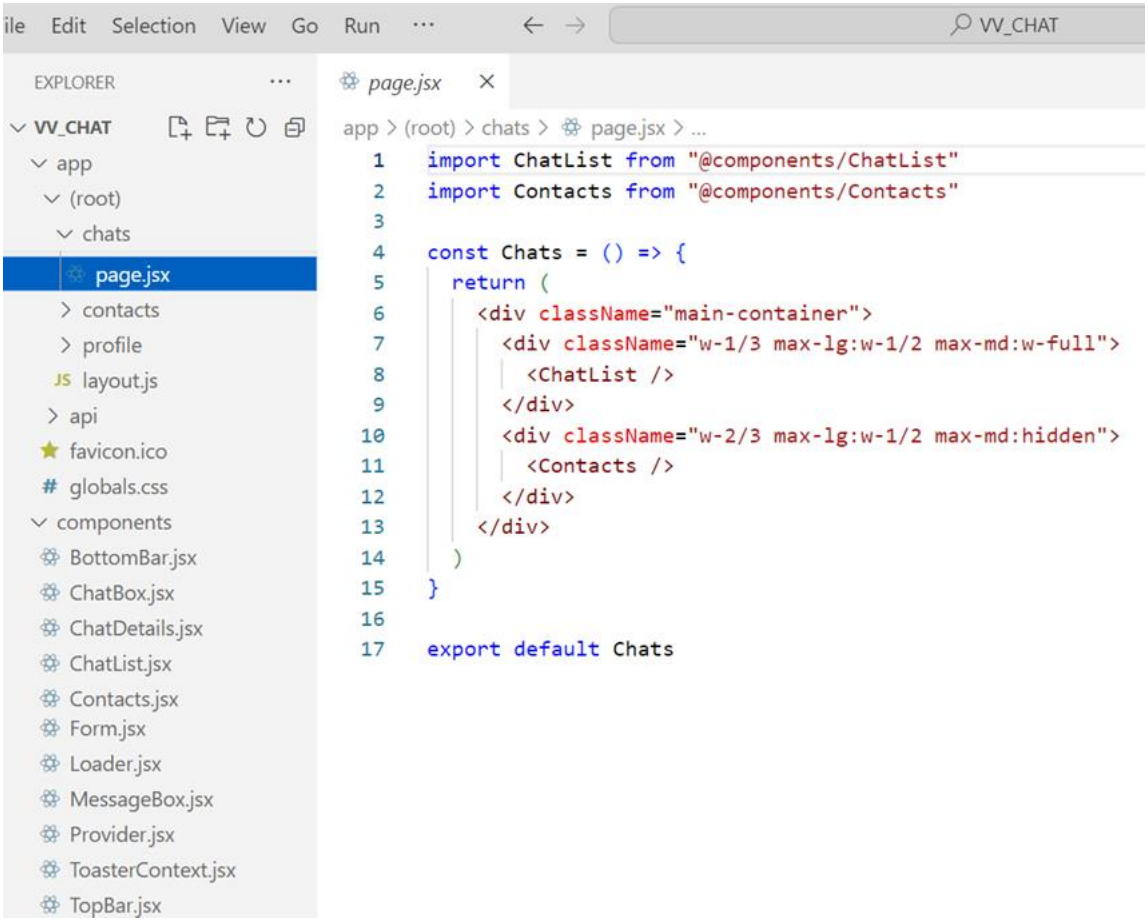


Figure 13

In figure 13, you can see chats component present in the root folder utilized ChatList and Contacts components by importing them into the page.jsx of chats component. Changing the logic in ChatList.jsx and Contacts.jsx components will affect all the pages who imported these.

Each and every jsx extension file inside Components directory will be rendering from the root folder. Here's the description of each file:

TopBar.jsx

This component displays the top section of the Home page. Includes addition of web application's logo, hyperlinks which navigate users to Chat section, Contacts section. Logout button and User Icon to update profile name and upload new profile picture.

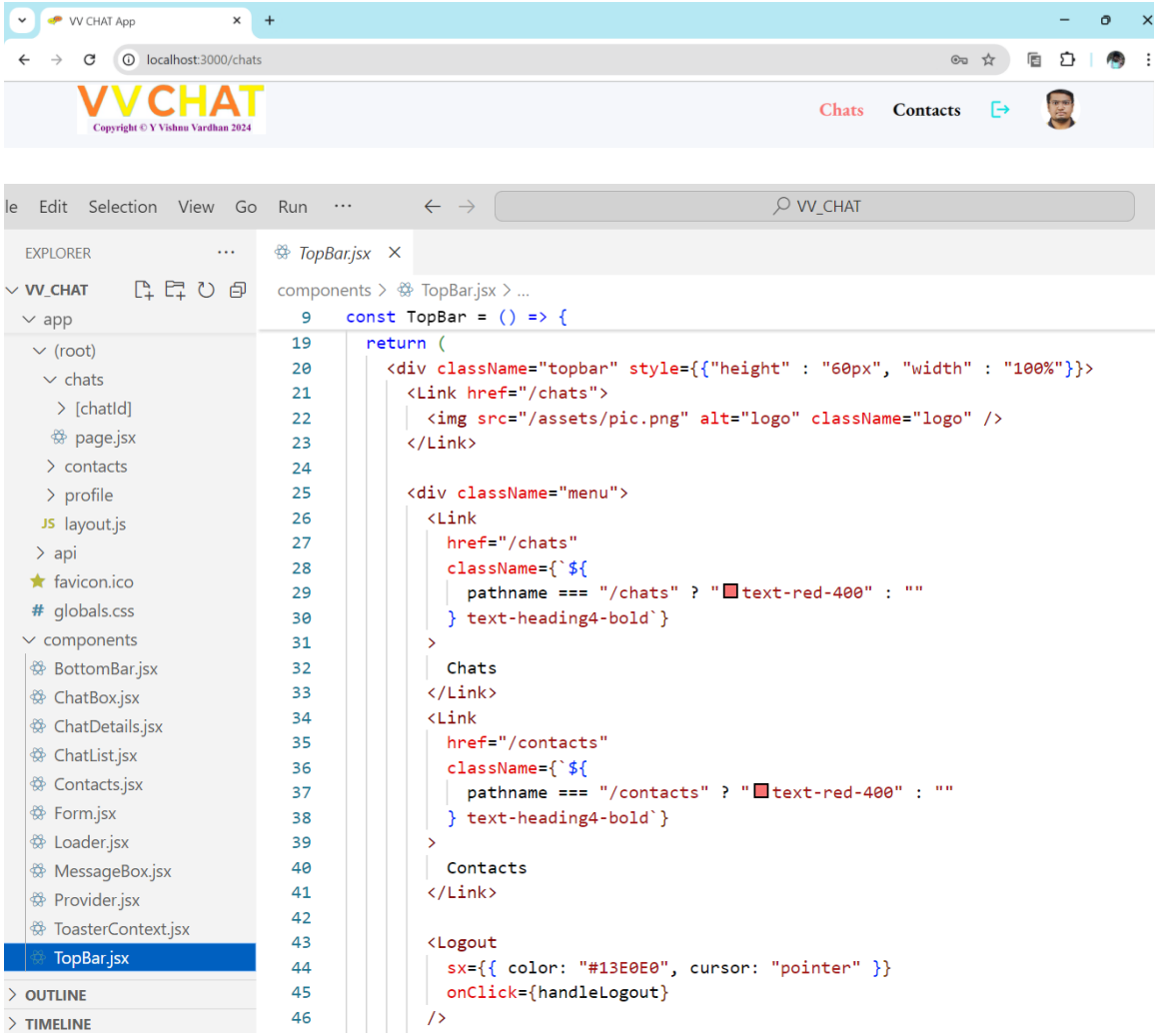


Figure 14

BottomBar.jsx

This component is a responsive component which upon changes in the screen dimensions will appear at the bottom of the Home page. Includes hyperlinks which navigate users to Chat section, Contacts section. Logout button and User Icon to update profile name and upload new profile picture.

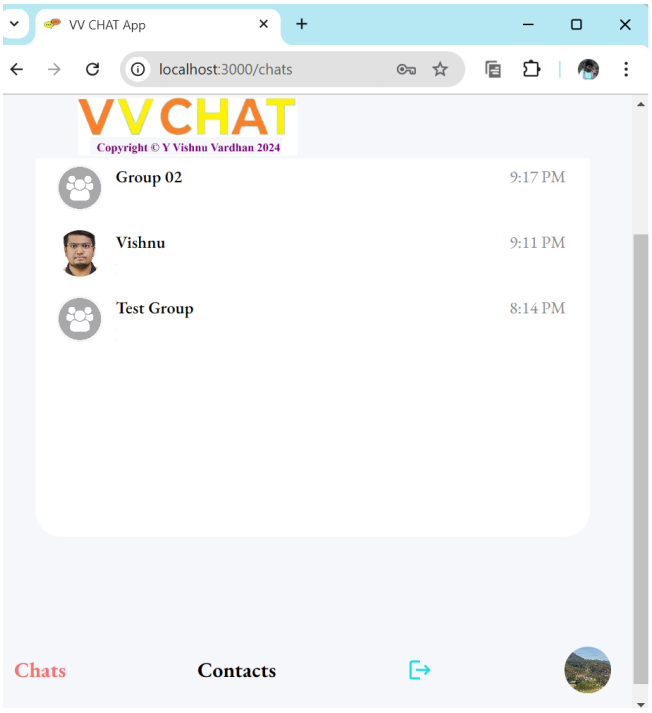


Figure 15

Form.jsx

This component makes use of “react-hook-form" library for generating clean and clear forms. I imported "@mui/icons-material” Material UI which is an open-source React component library for depicting icons for Username, Email and Password. Responsive logic written which displays content based on whether it’s Login page or it’s Register page.

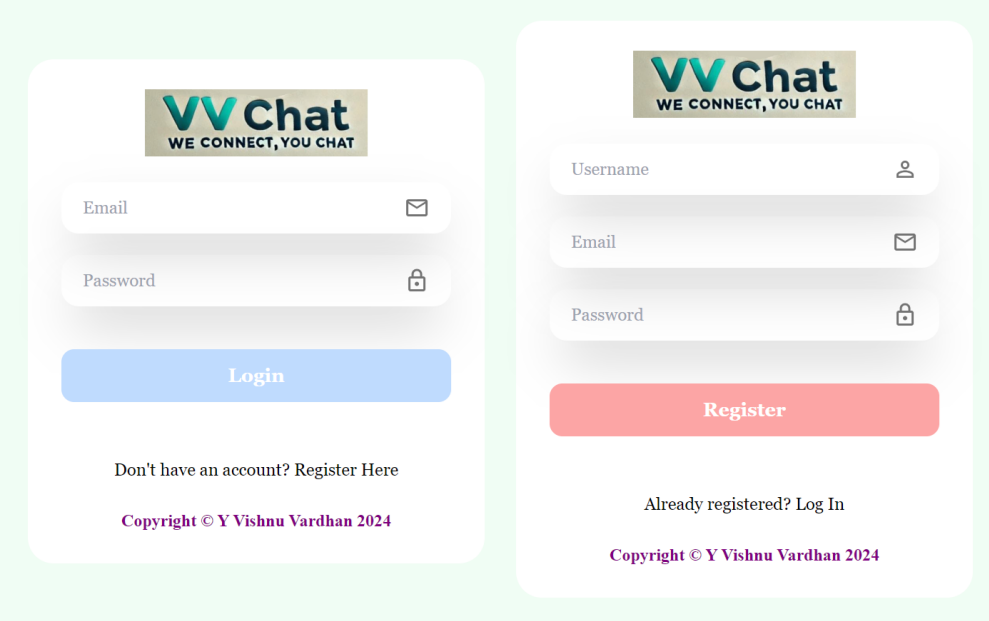


Figure 16

ToasterContext.jsx

This component is responsible for generating notification pop-ups. Need to import “Toaster” from "react-hot-toast" library.

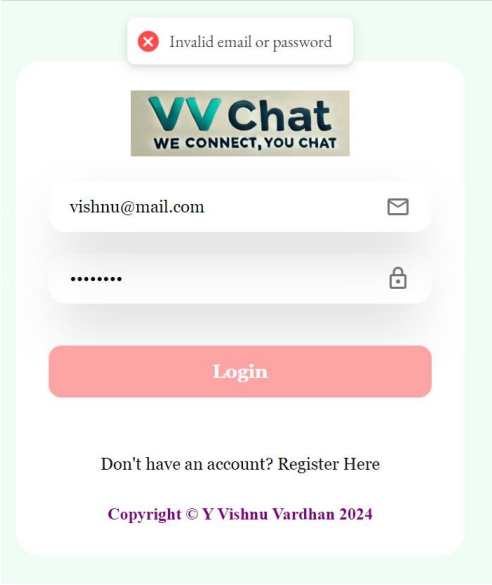


Figure 17

Provider.jsx

This component uses “useSession” React Hook from "next-auth/react" library which is responsible in checking whether user signed in or not. All root’s children are wrapped inside it.

Provider.jsx

components > Provider.jsx > default

```
1   "use client"
2
3   import { SessionProvider } from "next-auth/react"
4
5   const Provider = ({ children, session }) => {
6     return (
7       <SessionProvider session={session}>
8         {children}
9       </SessionProvider>
10    )
11  }
12
13  export default Provider
```

Figure 18

Loader.jsx

This component displays blue color loading icon whenever requested page takes time to render onto the screen.

Figure 19

MessageBox.jsx

This is one of the main component which takes care of the chatting functionality. Based on the sender of the message, this component alters the message box color. This feature implicating the source of the message gives a better user experience.

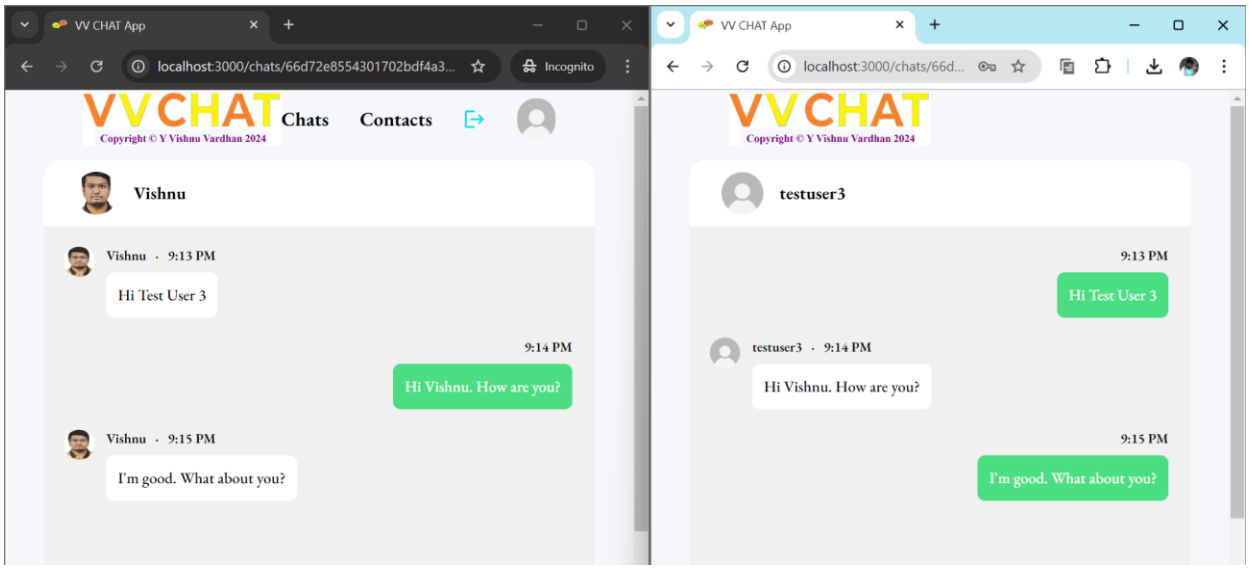


Figure 20

Contacts.jsx

Another important component which controls major functionalities like Checking or Unchecking the Users in order to start a new message conversation thread. Responsive Group Chat logic has been implemented in this component.

When more than one user is selected, then UI displays Group Chat dialog which gives user option to add group name and displays members of the group.

Additionally, this component is responsible for searching a specific contact.

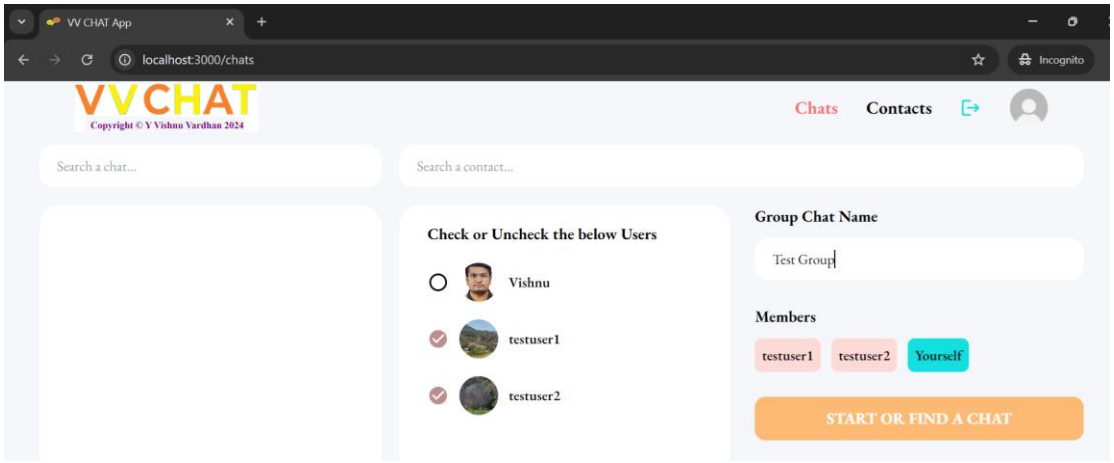


Figure 21

ChatList.jsx

This component gives users the chance to search for a particular chat from the Chats list. In addition to that using Pusher API Service which uses Web sockets, user will experience real time updates regarding new chat creation, new message conversation and chat updates.

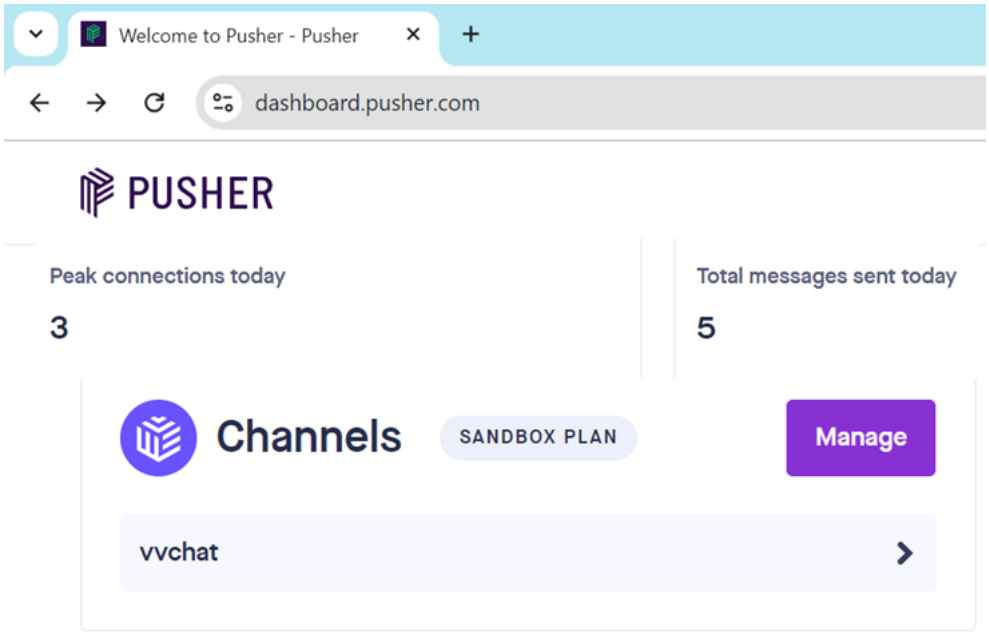


Figure 22

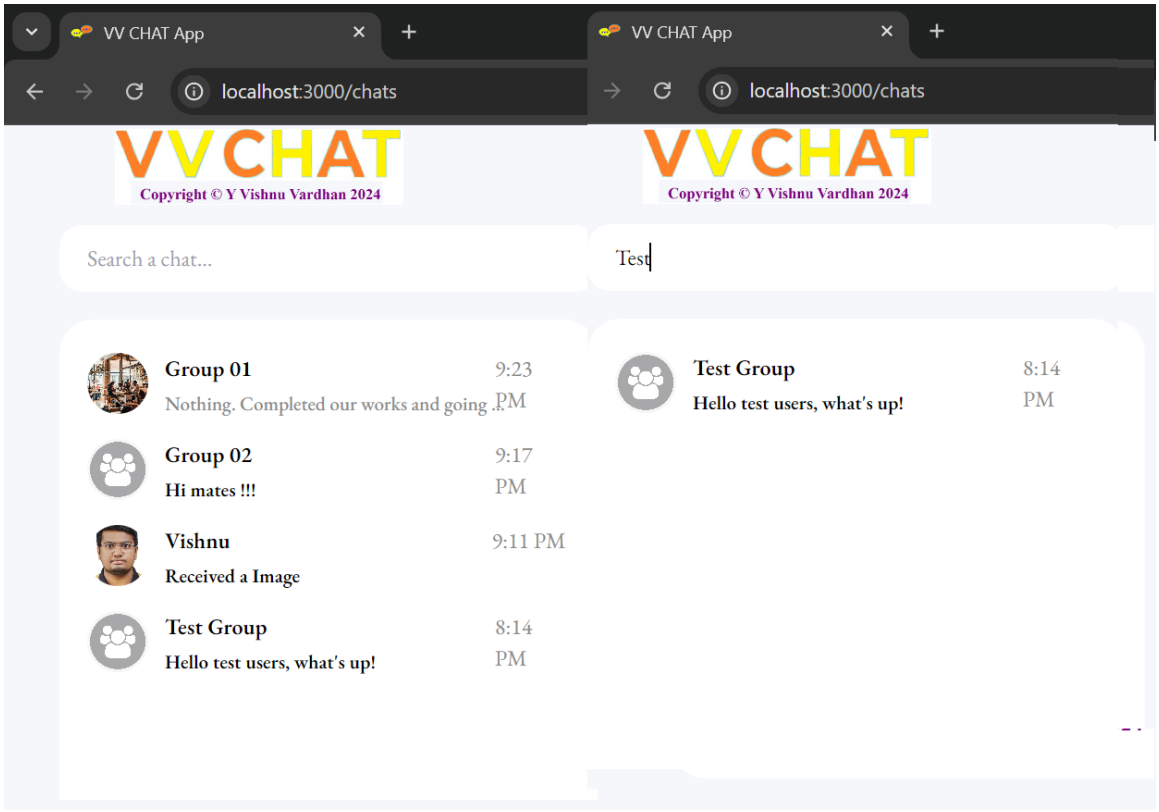


Figure 23

ChatDetails.jsx

This component catch holds vital feature of the web application i.e the chat dialog to type the message and send to the receiver. Apart from that, users can upload an image as a message. This functionality is achieved by making use of the Next Cloudinary Library. This provides a secure and comprehensive API for easy upload of media files. Currently, application allows only image files upload with limit of one at a time.

Moreover, user experiences scrolling down of the screen to the bottom whenever new message arrived.

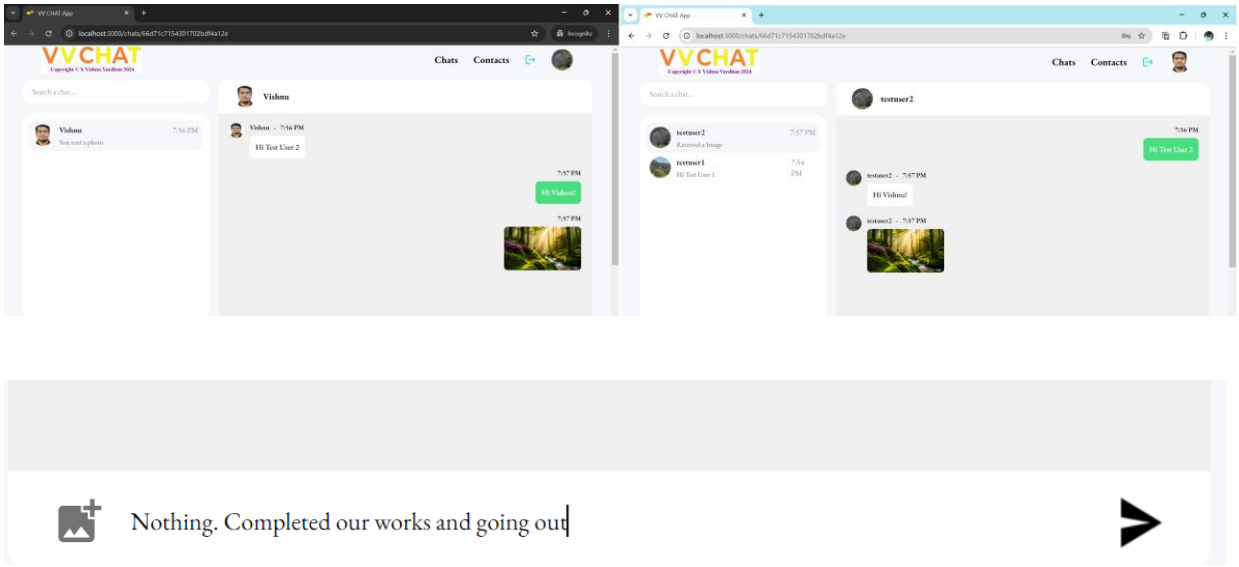


Figure 24

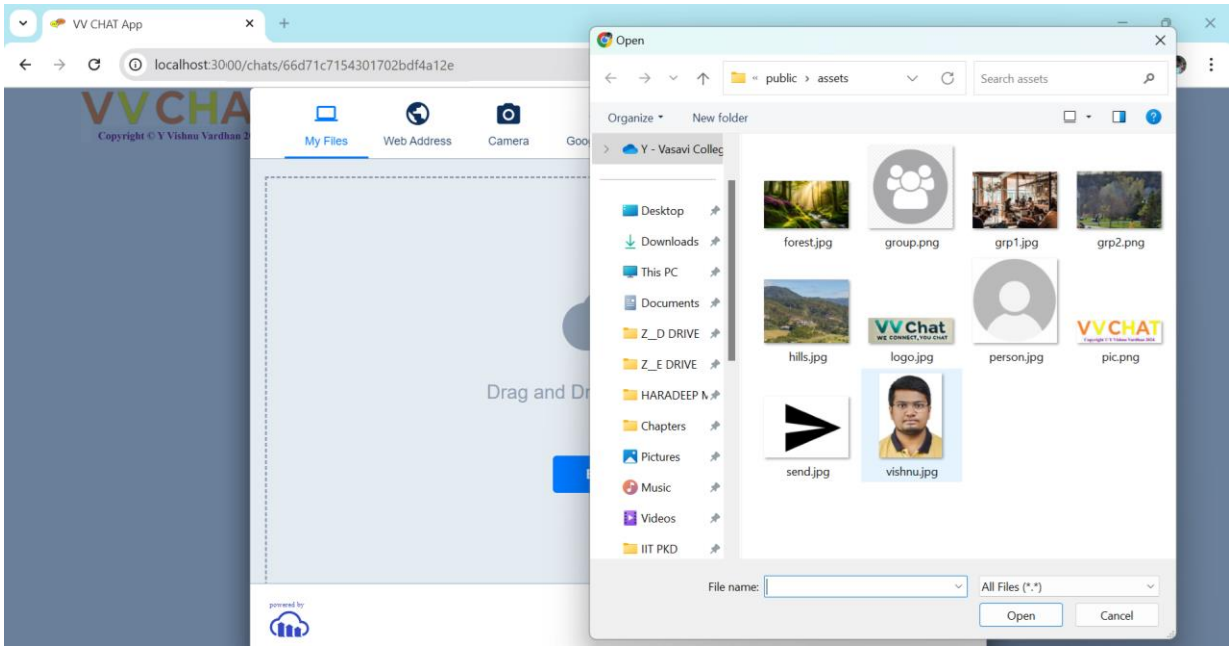


Figure 25

ChatBox.jsx

This component stacks up the chat conversations which were initiated by the user. Based on whether it's a group chat or single user chat, by default profile photo gets displayed. Users also gets bold text notifications whenever new message arrived. Using "data-fns" JavaScript date utility library, user get to know the time at which message arrived.

For a new chat, UI persuades by displaying "Start a New Conversation" message.

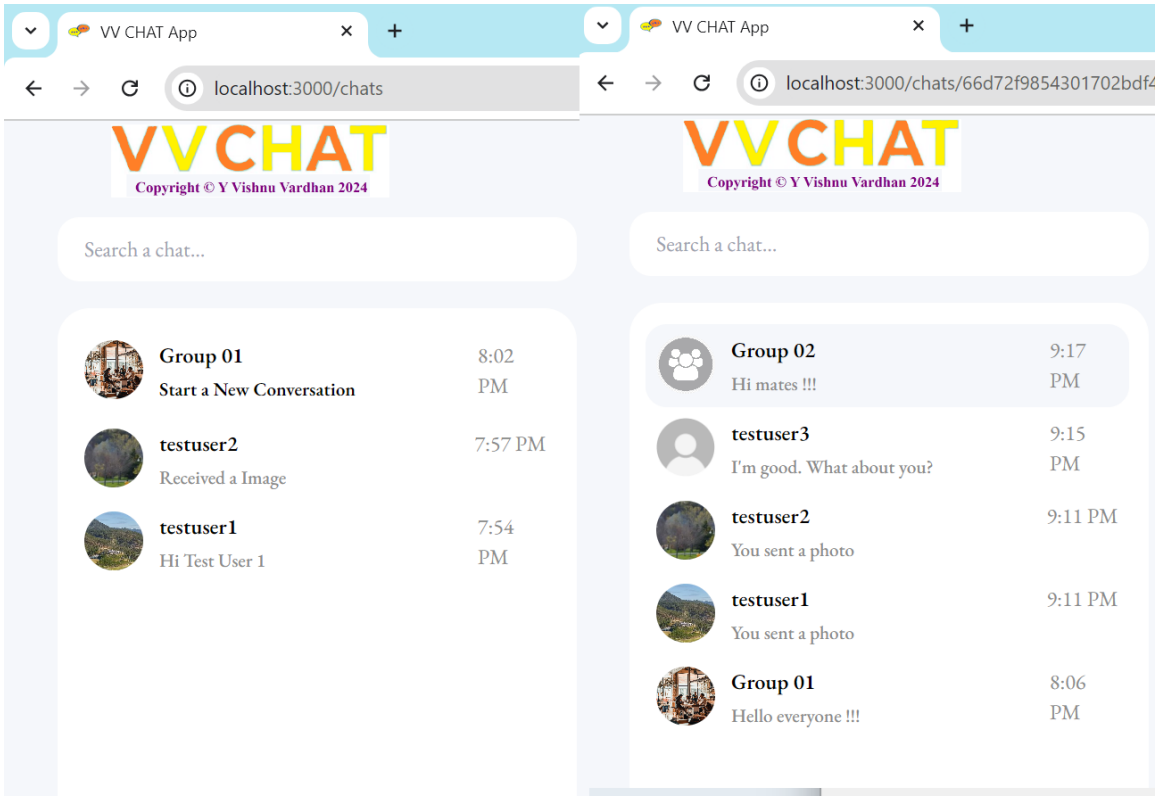


Figure 26

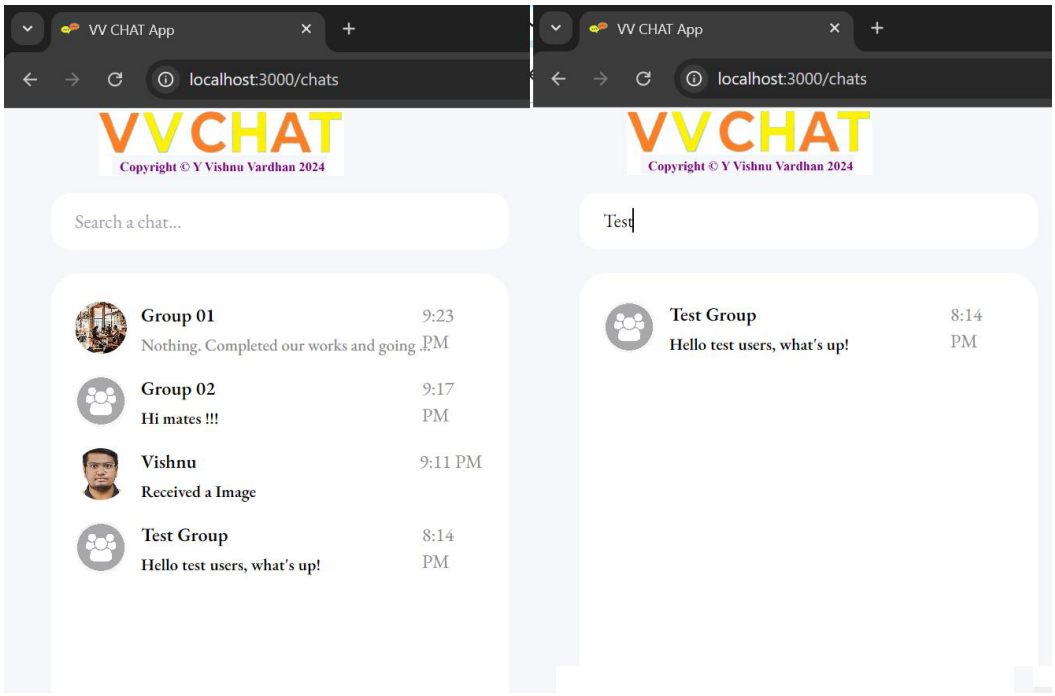


Figure 27

4.2. Backend Design

Nodejs framework due to its event-driven, non-blocking nature is being used to build various APIs. Broadly calls are segregated into 4 modules namely auth, chats, messages and users. I made use of RESTful APIs throughout the web application by calling standard HTTP GET/POST methods to perform the CRUD operations. Data transferred or retrieved in the form of JSON object.

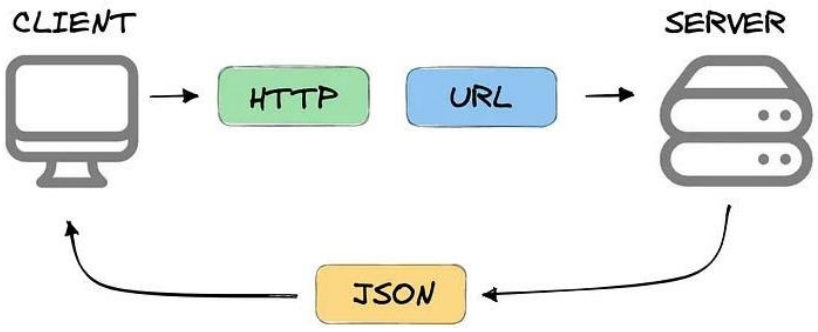


Figure 28

List of Backend API Calls

api/auth/register/route.js

I utilized “hash” function imported from “bcryptjs” library, to encrypt user entered password in order to store it in MongoDB. As Bcrypt hashing algorithm is implemented, users can experience a highly secure and protected web application prototype.

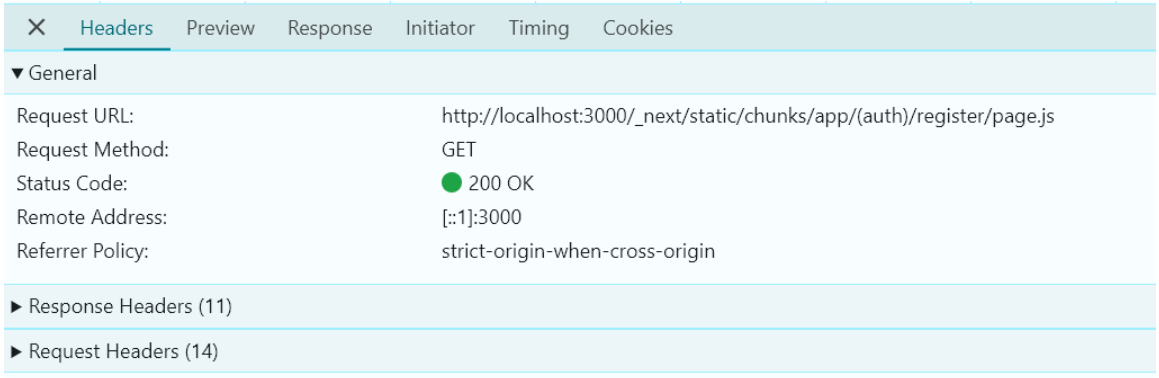


Figure 29

This Javascript file also sends request to the database to check whether user is already registered, if yes prompts the user about the existence of the account.

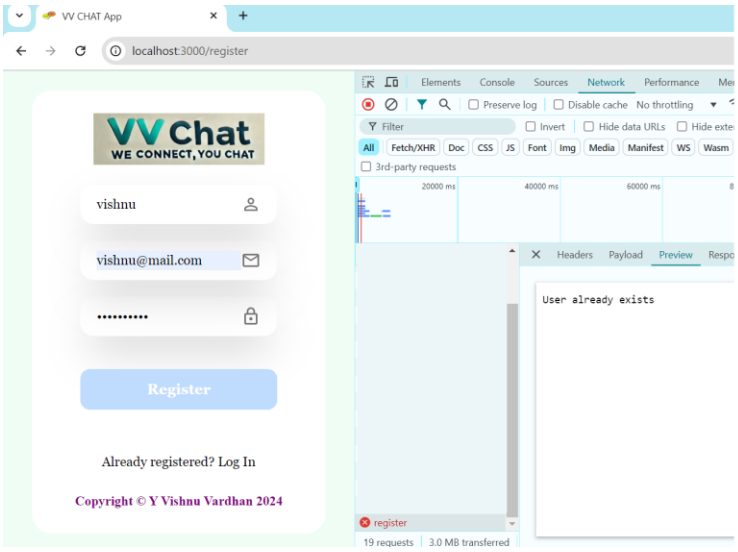


Figure 30

api/auth/[…nextauth]/route.js

Following NextAuth.js format, added the backend logic for Login page in this file path. Using “Toaster” from "react-hot-toast" library, added user alerts whenever invalid email or password is entered.

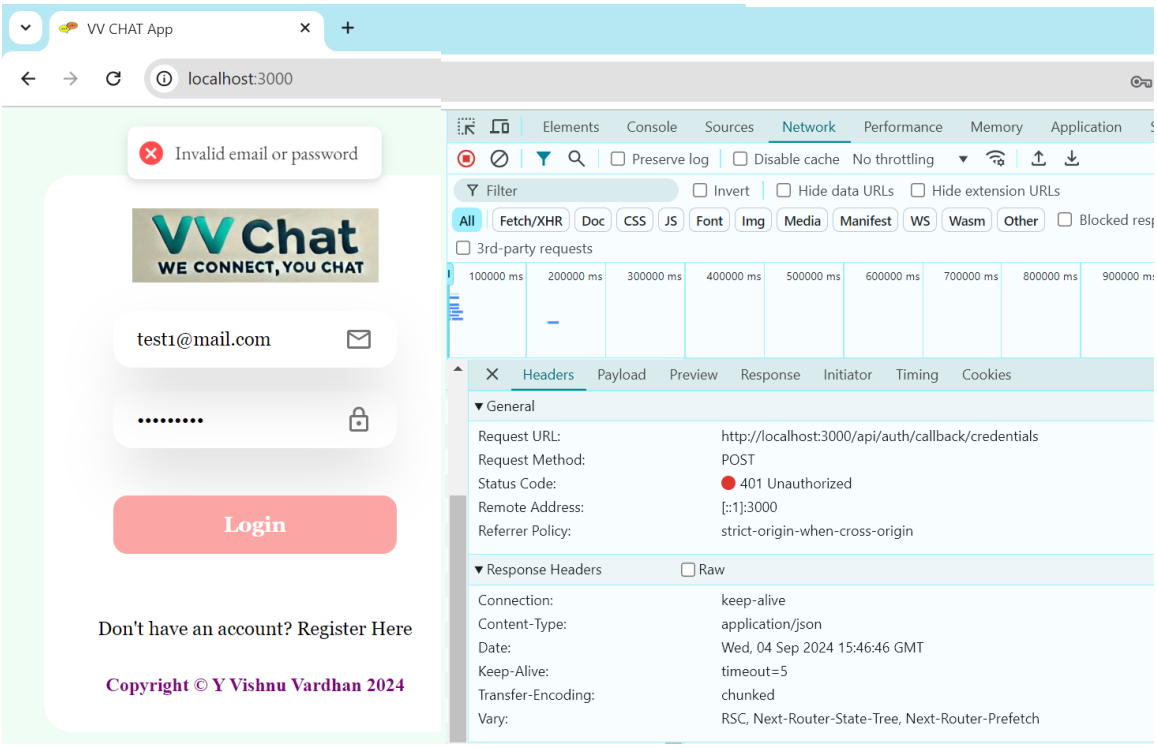


Figure 31

Through prior database connection, this file calls GET request to retrieve the registered user’s credentials and compares with the entered ones. If mismatch occur, instantly the UI alerts the user.

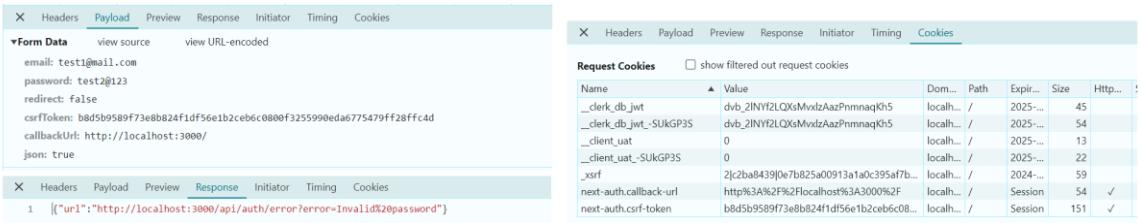


Figure 32

api/chats/route.js

This JavaScript file is responsible for starting a new chat or opening an existing chat.

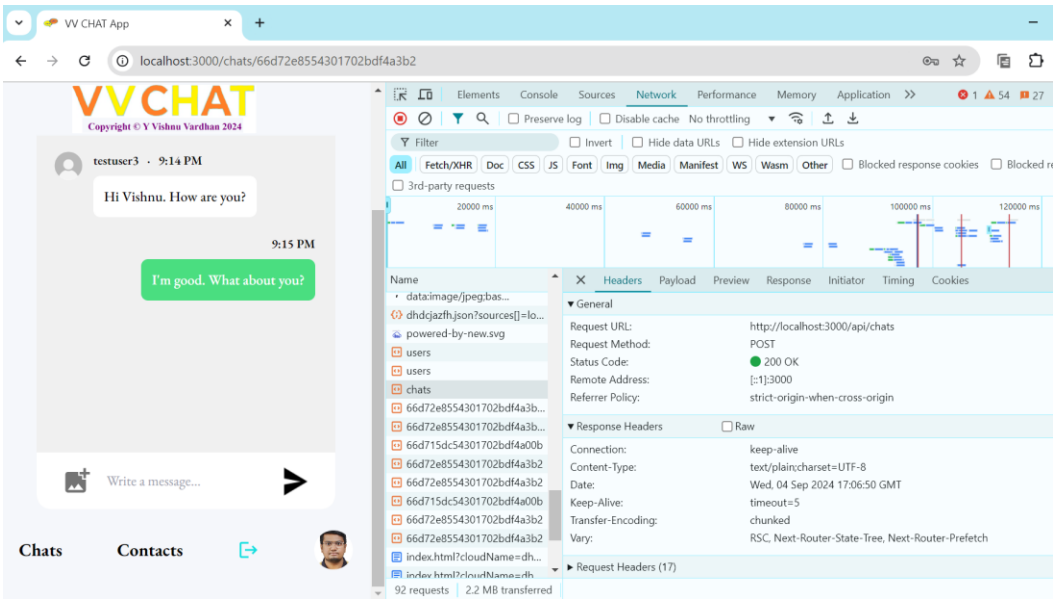


Figure 33

POST request is sent whenever, user tries to open a chat by selecting usernames from the Contacts page. In the above figure, since testuser3 chat is selected, in the response of the POST request, we will be able to see the “chatId” of testuser3 as member and all the messages already sent as “messageIds”.

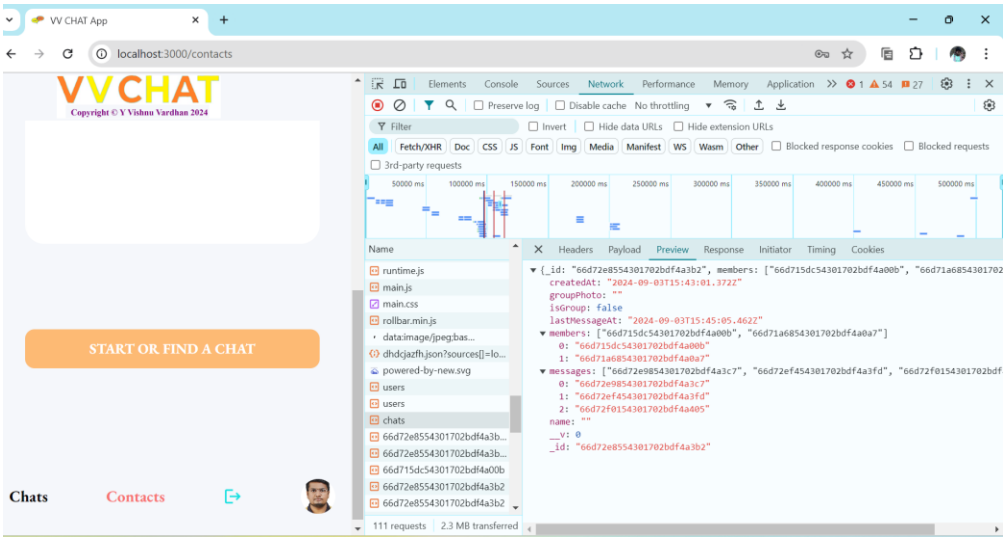


Figure 34

api/chats/[chatId]/route.js

This JavaScript file handles GET and POST requests of chatting messages. Makes use of all the tables present in the database and by mongoose driven connectToDB function, it will ensure to perform addition and modification of database tuples. To display the past chatted messages, this file calls GET request which has unique [chatId] in the endpoint.

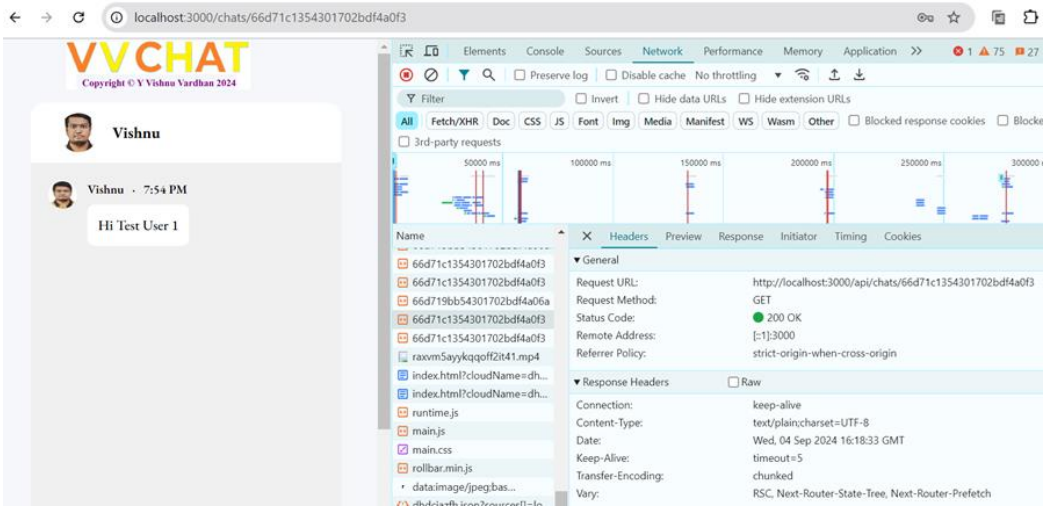


Figure 35

Upon successful 200 OK Response, whenever user opens a previous chat box, as a JSON object this request will fetch all the details of both sender & receiver.

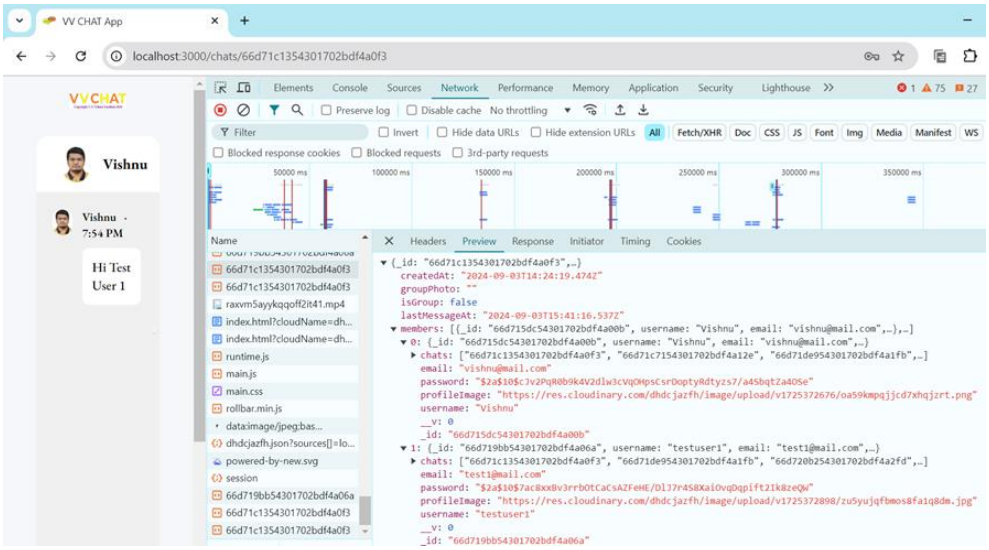


Figure 36

When a new message is sent to the receiver, then POST request is called which will add a new message record into the database. Every individual message gets a unique messageId which is later used by GET request in retrieving the past messages information.

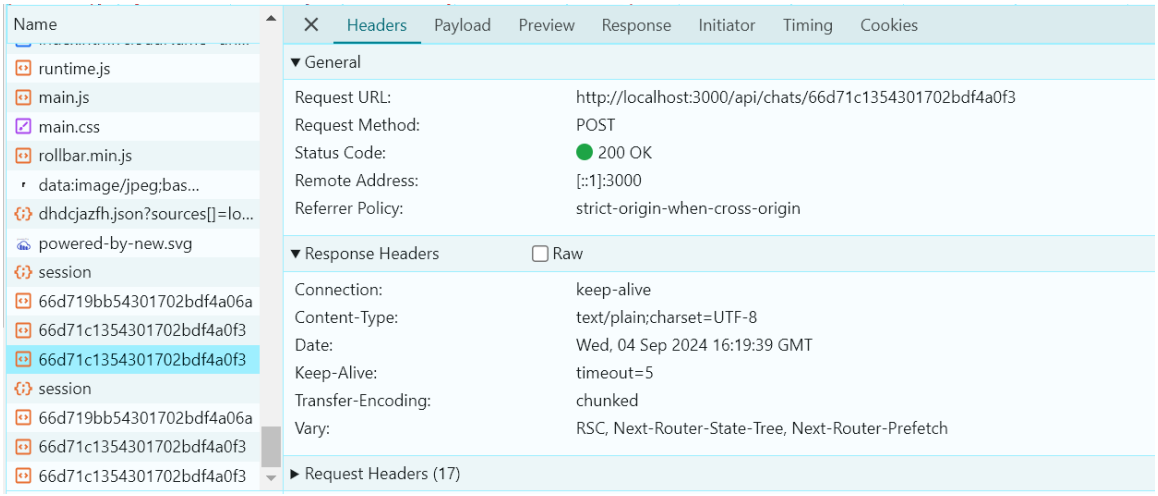


Figure 37

Upon successful delivery of the message from the receiver, whenever the user views the sent message, this file notifies that all the messages were seen by the current user.

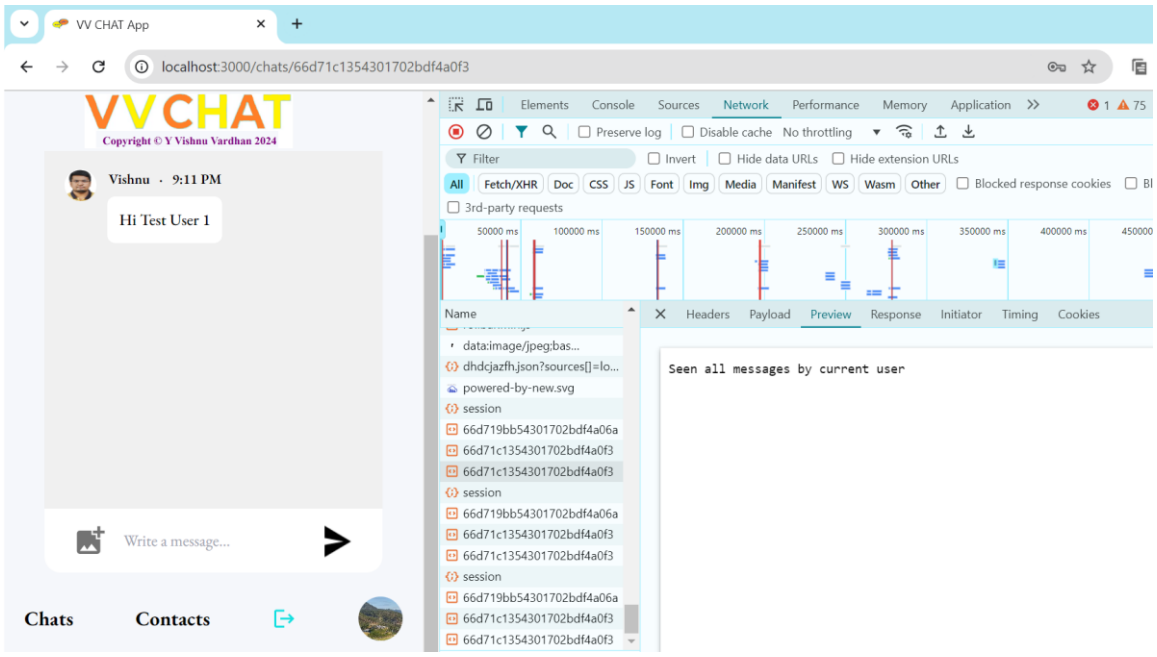


Figure 38

api/chats/[chatId]/update/route.js

This file initiates POST request which takes Group chat new name and new profile picture as body. Upon successful response generation it will update the UI accordingly. If error is generated, it catches and logs 500 status Response with error message as “Failed to update group chat info”.

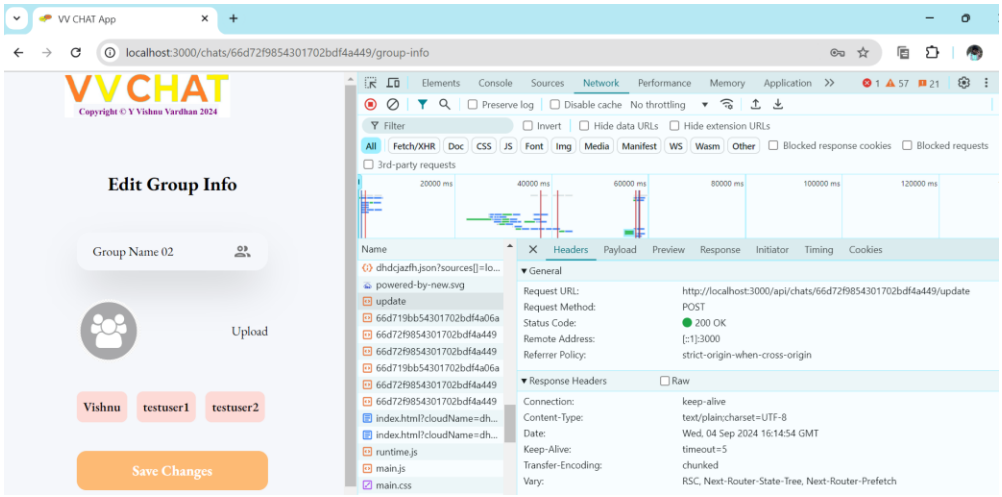


Figure 39

api/messages/route.js

This file also initiates POST request which handles addition of new record in Messages database table. Below figure illustrates, when user send “Hi” message, that text is sent along with unique “_id” and “createdAt” timestamp.

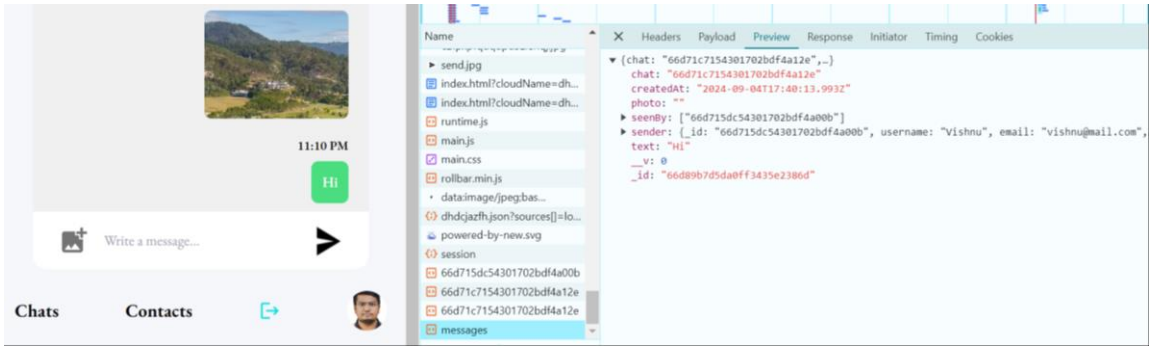


Figure 40

As soon as a new message is shared by clicking the send icon, a POST request is called including the “chatId”, “currentUserId” and “text” as Payload.

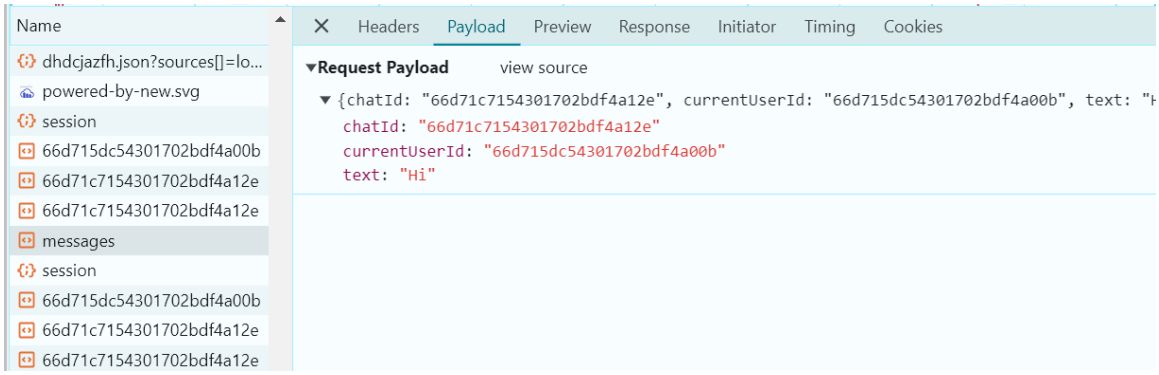


Figure 41

Upon successful delivery of the message, 200 OK Response is achieved.

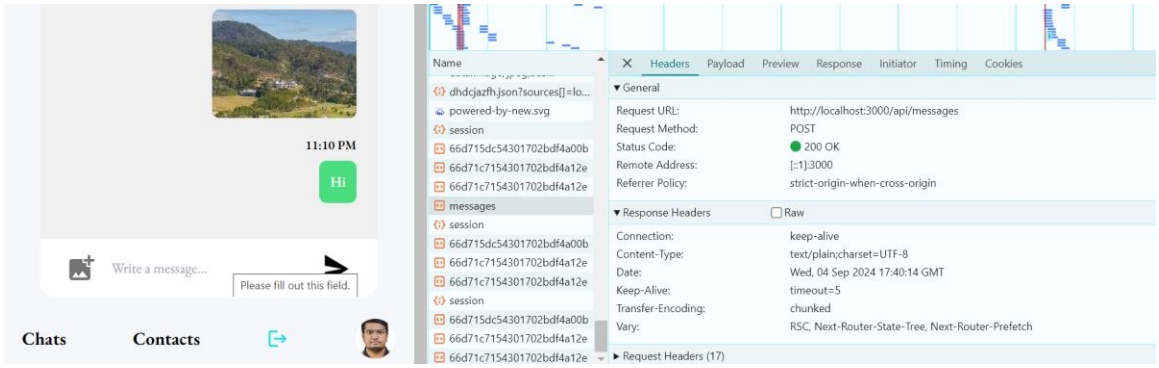


Figure 42

api/users/route.js

This file contains a GET request which retrieves details of all the users. Whenever new user registers in our web application, a new record is appended to the database. Hence, the response of this request will get all the “_id” of users.

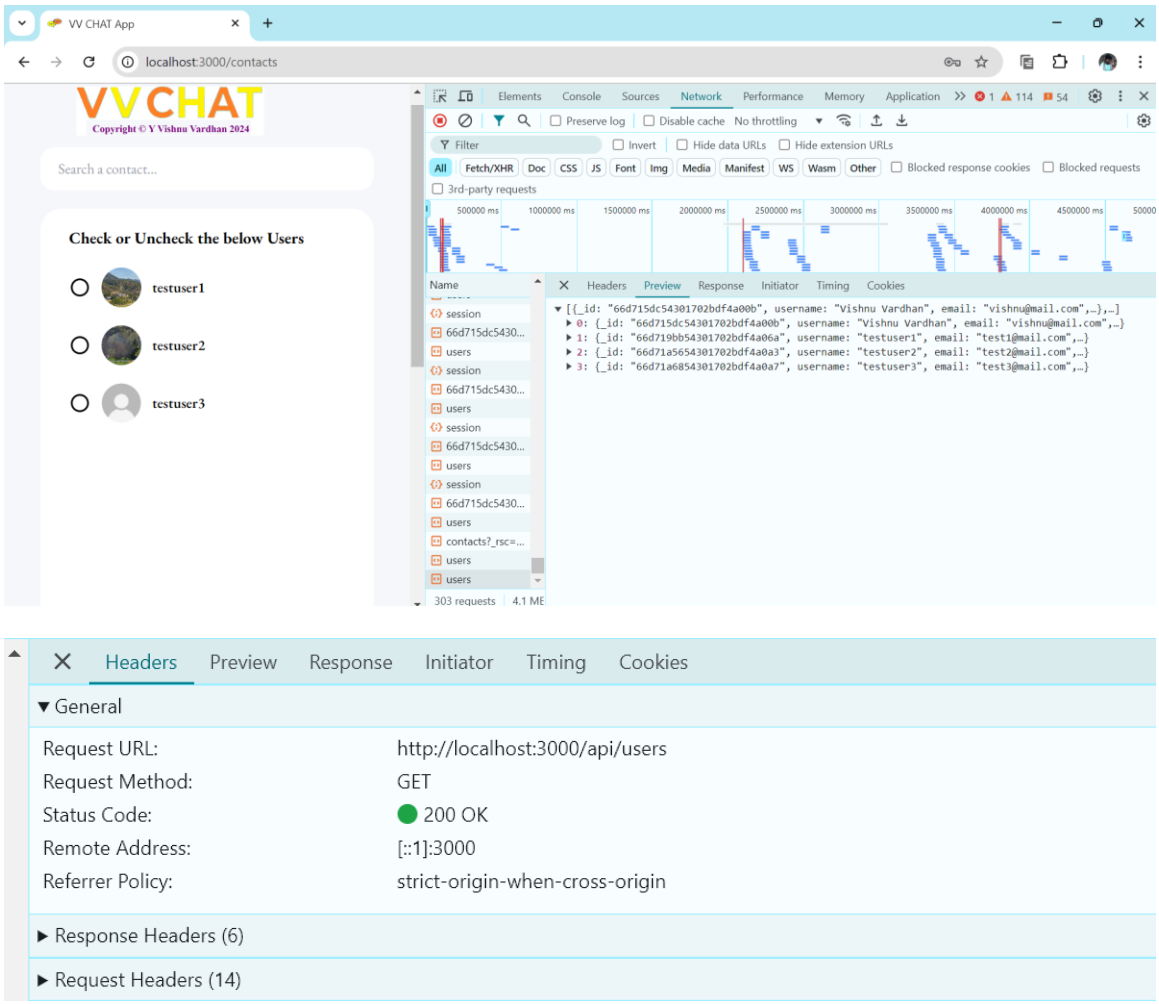
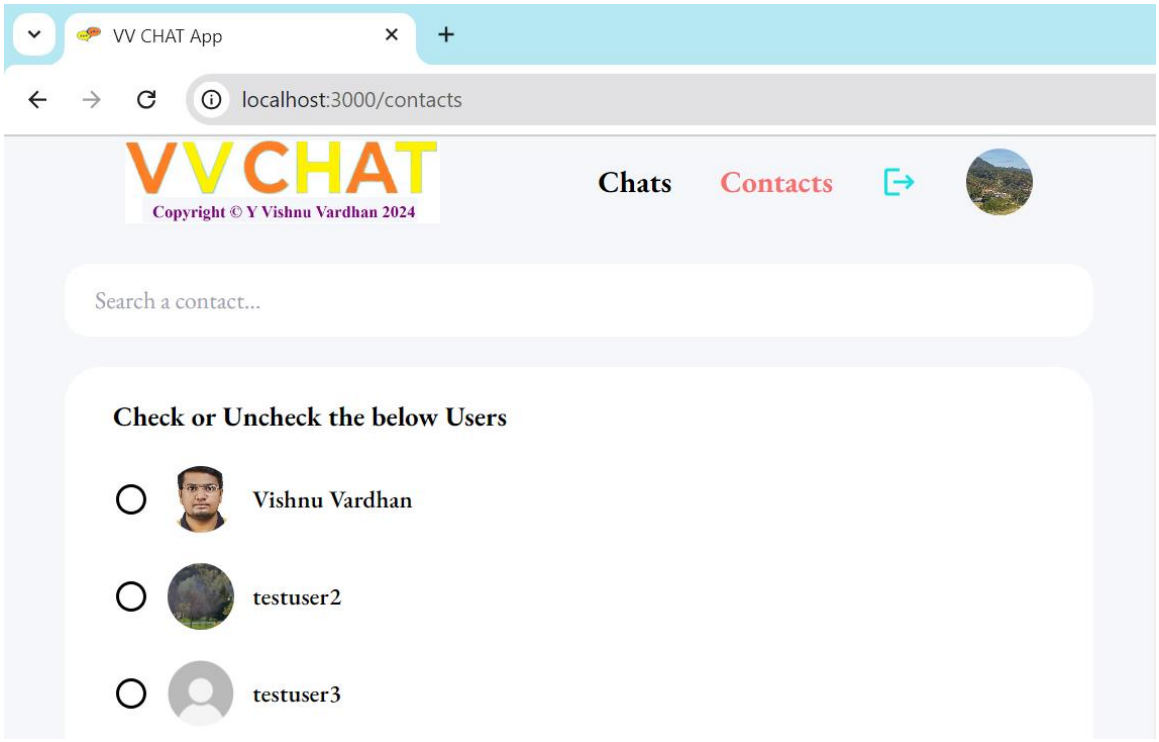


Figure 43

api/users/searchContact/[query]/route.js

This file contains GET request which helps users to search for a particular contact, so that user can continue to start a new chat or continue existing chat.

Below figure depicts among various users, through this endpoint how username is filter out.


VV CHAT App
localhost:3000/contacts
VV CHAT
Copyright © Y Vishnu Vardhan 2024
Chats
Contacts
Search a contact...
Check or Uncheck the below Users
Vishnu Vardhan
testuser2
testuser3

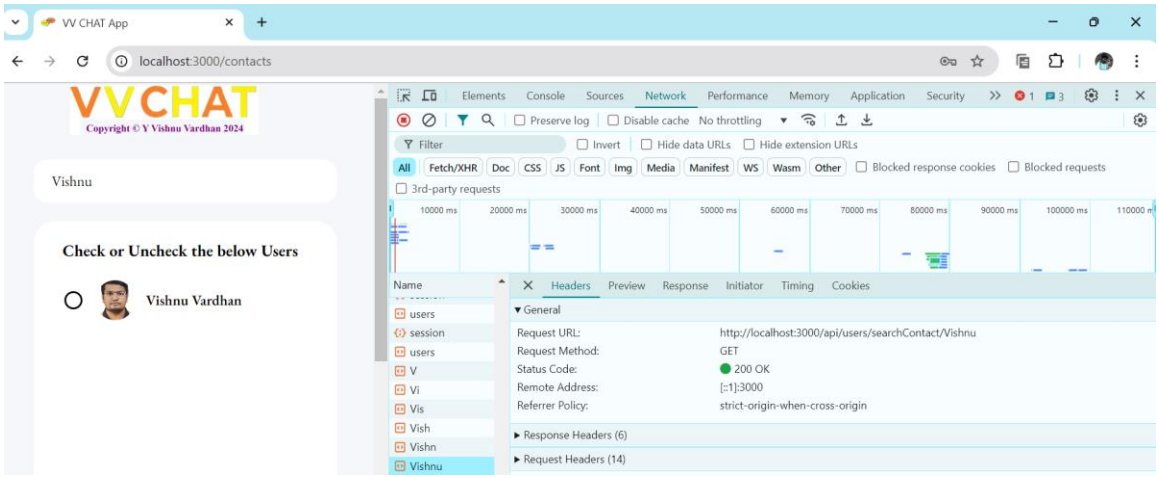

VV CHAT App
localhost:3000/contacts
VV CHAT
Copyright © Y Vishnu Vardhan 2024
Vishnu
Check or Uncheck the below Users
Vishnu Vardhan
Elements
Console
Sources
Network
Performance
Memory
Application
Security
Request URL: http://localhost:3000/api/users/searchContact/Vishnu
Request Method: GET
Status Code: 200 OK
Remote Address: [::1]:3000
Referrer Policy: strict-origin-when-cross-origin

Figure 44

api/users/[userId]/route.js

This file contains a GET request which retrieves all chats of the current user. To do that, this component gets interacted with all the 3 tables (Chat, Message, User) of the database.

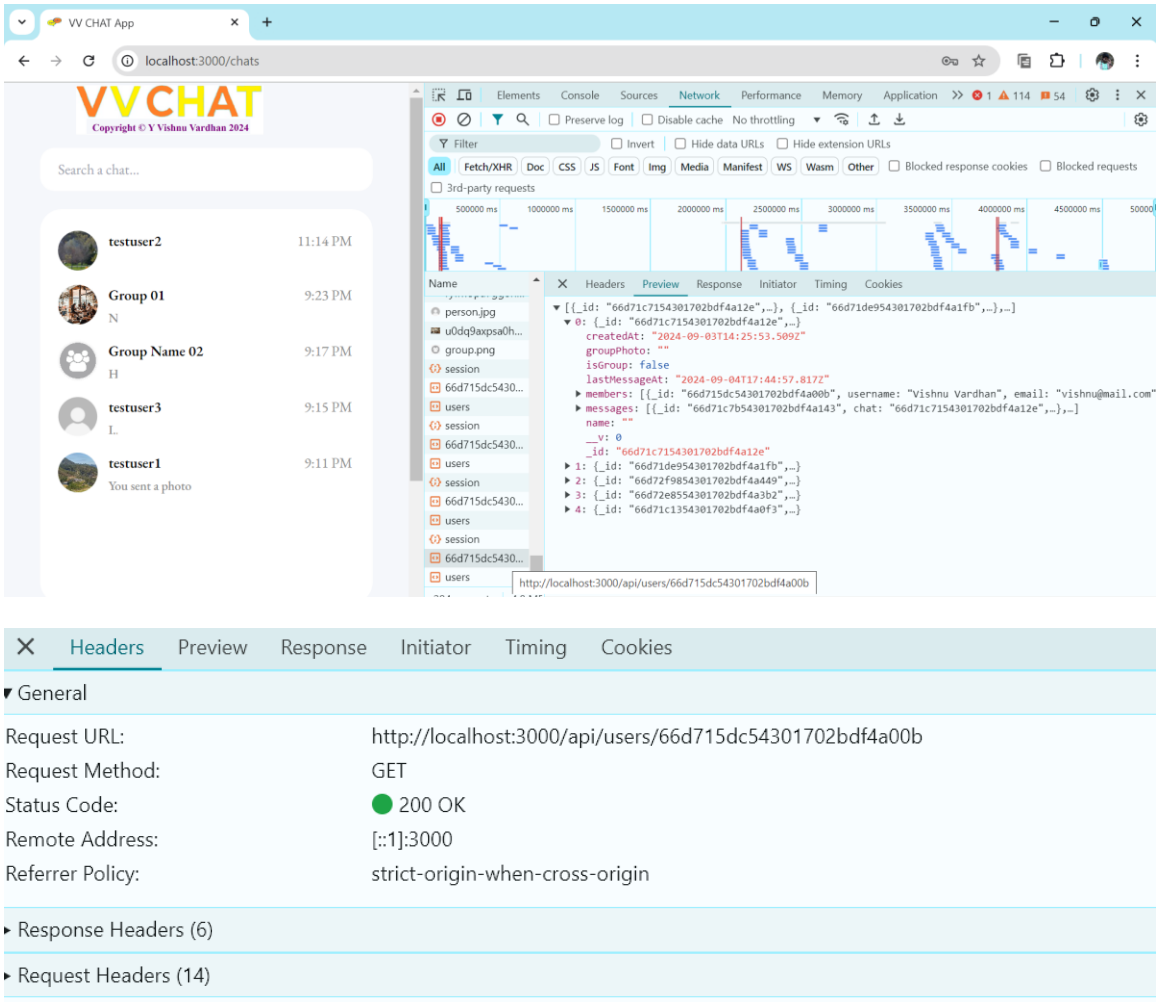


Figure 45

api/users/[userId]/update/route.js

This backend component will handle user modification of username or profile picture.

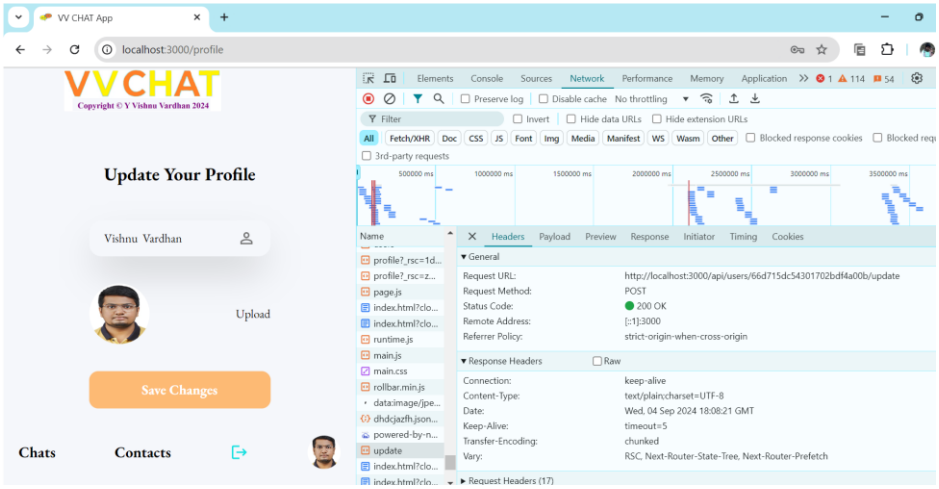


Figure 46

A POST request is sent giving the new username entered or new profile picture uploaded as payload. Upon successful updation, we achieve 200 OK Response.

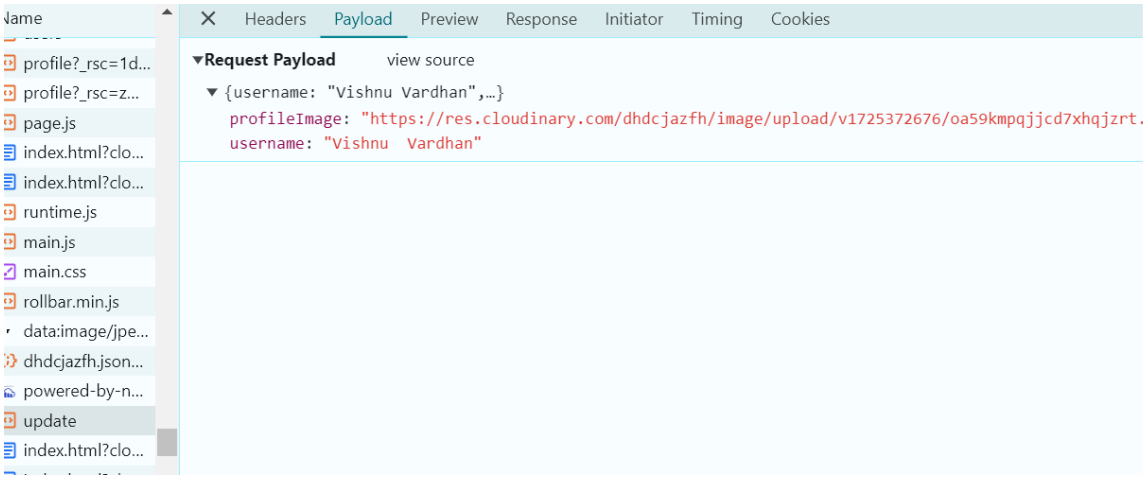


Figure 47

Whenever a new picture is uploaded, then Cloudinary cloud-based service will upload the new image with a specific URL and shares it to the backend in order to store it as "profileImage" attribute. That attribute is sent via Payload to the POST request.

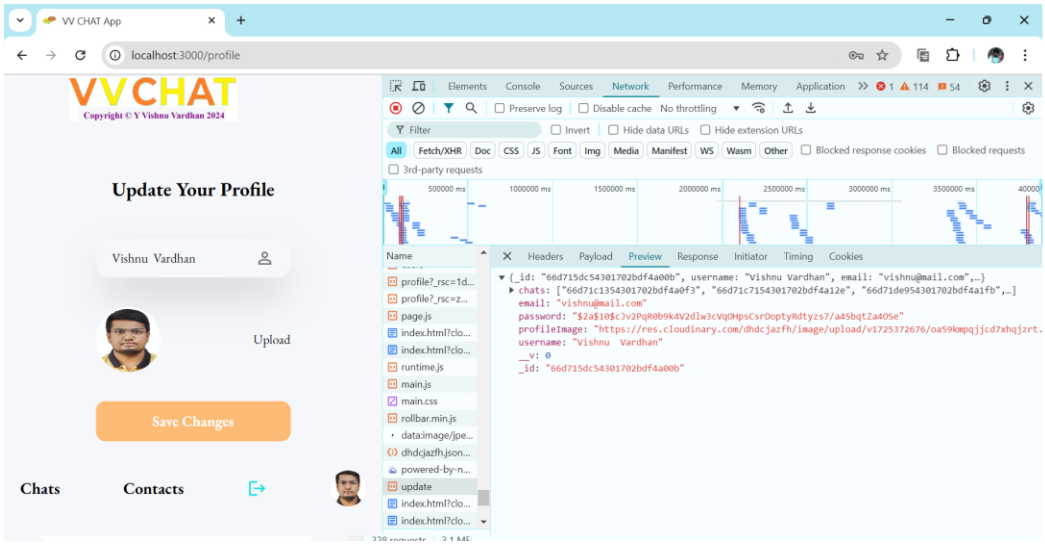


Figure 48

api/users/[userId]/searchChat/[query]/route.js

This file helps users in searching a particular chat from the web application home page. GET request is called with endpoint including current logged in "userId" and [query] path is filled with the text entered in the UI search bar.

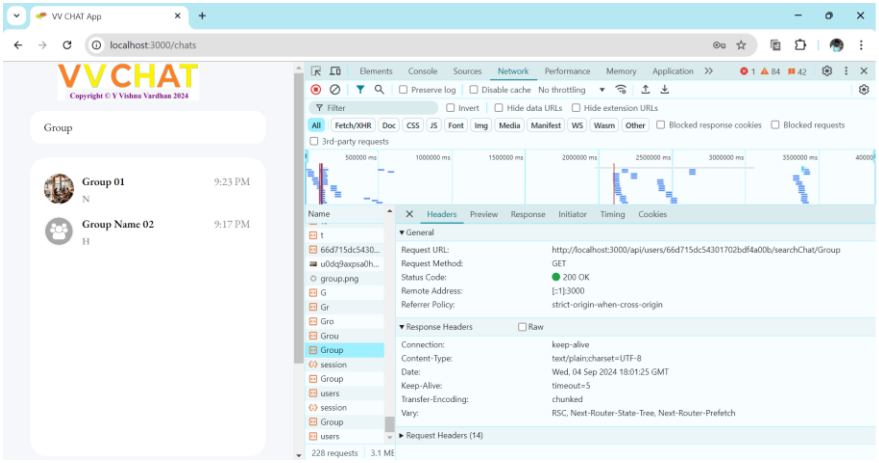


Figure 49

The response of the GET request contains the filtered ids of chats which got matched with the search bar text. In the below figure, we able to see when user searched chat entering “Group”, response retrieved has 2 chats with names “Group 01” & “Group Name 02”.

Figure 50

4.3. Database Design

MongoDB is used for storing the data of users who registered, into “users” table

Similarly when a chat is created between two users or when a group chat is started, all the details of it are stored into “chats” table.

To avail persistent data regarding chat messages, each and every message sent through chat will be stored into the database in “messages” table.

Database name in MongoDB Atlas: VVCHATDB

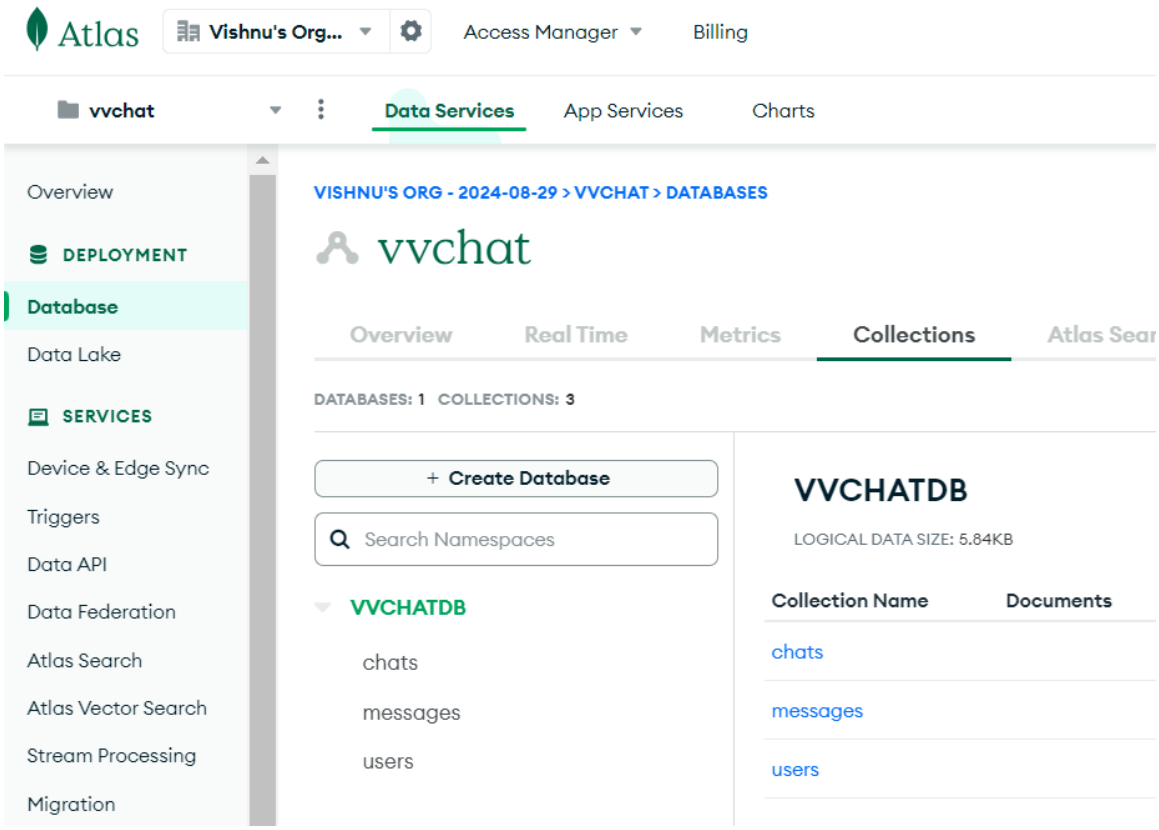


Figure 51

In order to define schemas for these tables, under “models” directory I have created 3 JavaScript extension files.

models/User.js **models/Message.js** **models/Chat.js**

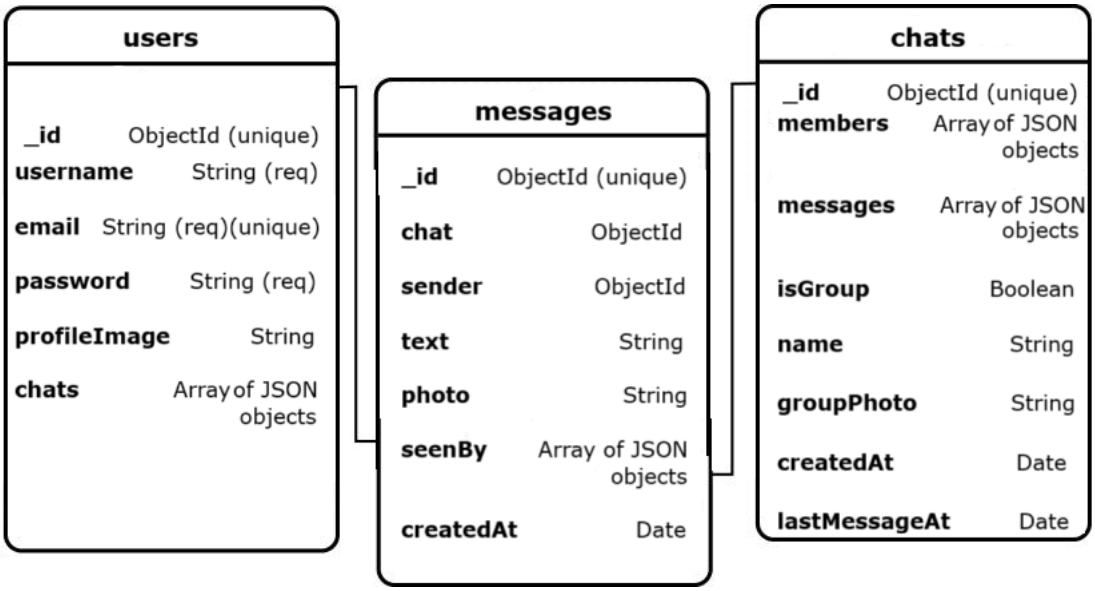


Figure 52

Below figures illustrate how data is stored in MongoDB.

Figure 53

Figure 54

Figure 55

For the VV CHAT Web Application, Cloudinary Software as a Service (SaaS) cloud computing model is used as a database for storing image files. Upon successful integration of cloud details into the development code, we were able to see each and every picture uploaded from the web app gets stored with a unique Public ID for future retrievals.

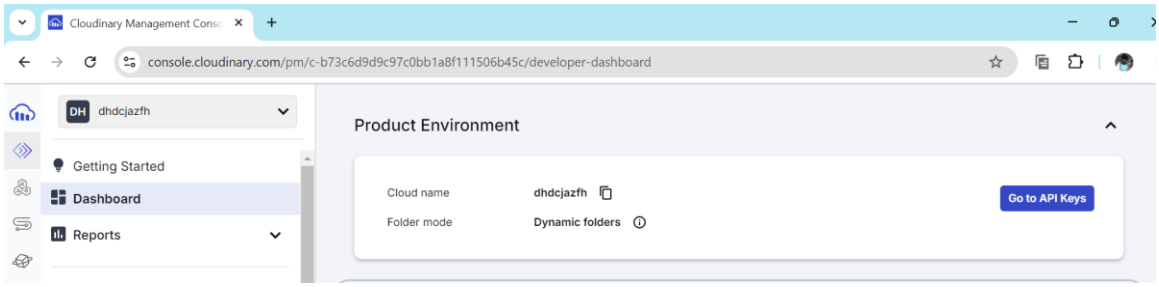


Figure 56

Below figure depicts, the Media Explorer of the Cloudinary where images sent via chatting and images uploaded as profile picture are stored.

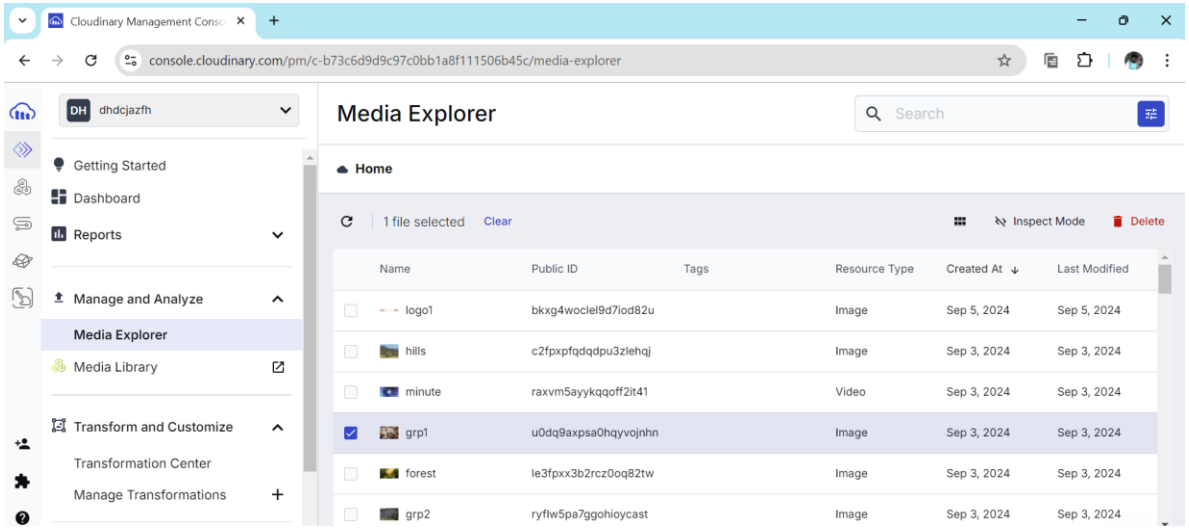


Figure 57

4.4. Security Design

The VV CHAT Web application handles sensitive data such as user passwords and message contents. In order to provide encryption, I implemented Bcrypt hashing algorithm by importing “hash” function from “bcryptjs” library. The algorithm uses salt rounds for creating hashes. It takes the plaintext password and a salt factor (optional) as input parameters and returns the hashed password asynchronously.

```
const hashedPassword = await hash(password, 10);

const newUser = await User.create({
  username,
  email,
  password: hashedPassword,
});

await newUser.save();
```

Figure 58

As the web app imported "next-auth version 4.24.7", it ensures user sessions by generating unique tokens.

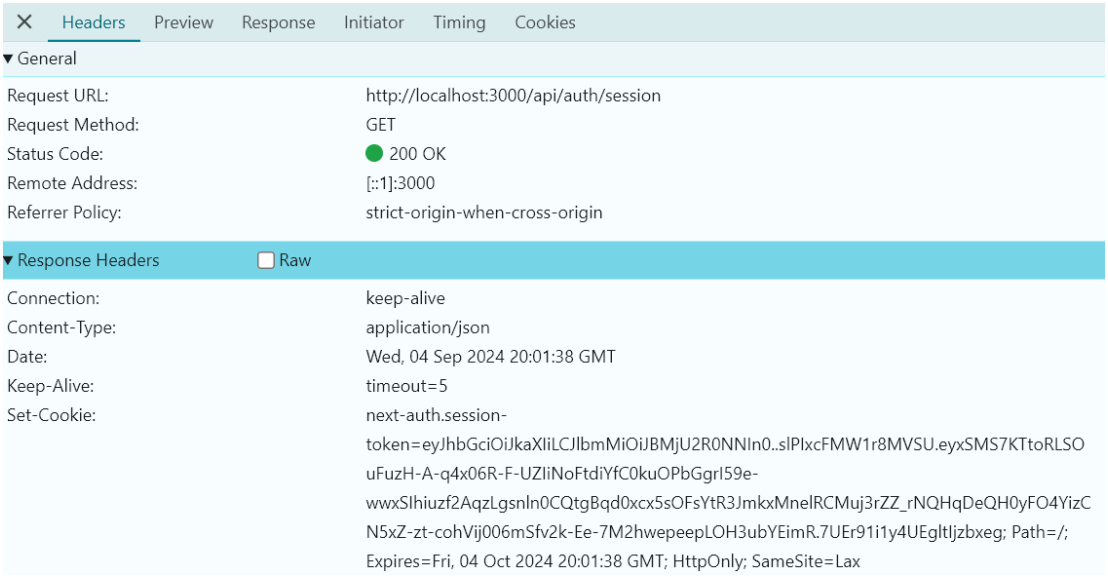


Figure 59

Special attention taken during the initial Login page of the web app to enhance user authentication and authorization. In the Form component, I imported “signIn” module from the Nextauth.js Client API library. As soon as the user logs into the web application, this generates a CSRF token to prevent any CSRF attacks.

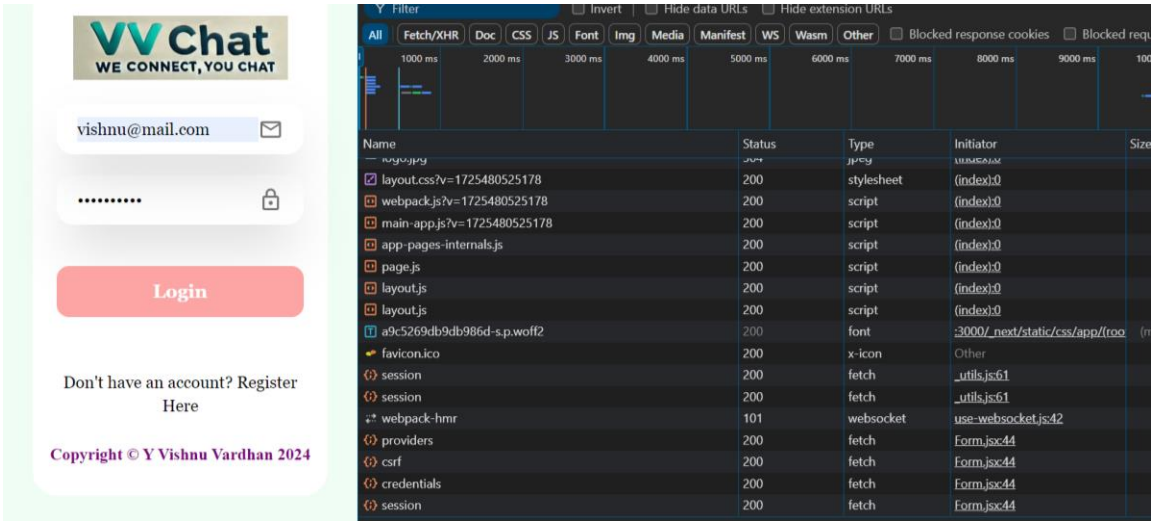


Figure 60

5. Non-Functional Requirements

5.1. Performance and Scalability

VV CHAT Web application was developed using optimized business logic codes by which future scalabilities are achievable. Backend API calls responses are retrieved with minimal latency. Until the response is acquired, UI guides the end users with loading icon. Since Atomic Design practice is used during development of the UI components, in future addition of new functionalities can be done in efficient manner and fast production is obtained. The fact that most of the files doing multiple jobs parallelly, I believe the data size of the complete project is appreciable during deployments and scaling.

5.2. Reliability and Availability

The VV CHAT Web Application is an UI responsive application, which gives users experience a good messaging service in any screen dimensions. Making use of various cascading styling libraries such as Tailwind CSS, React based @mui/icons-material and @emotion/styled make application more reliable.

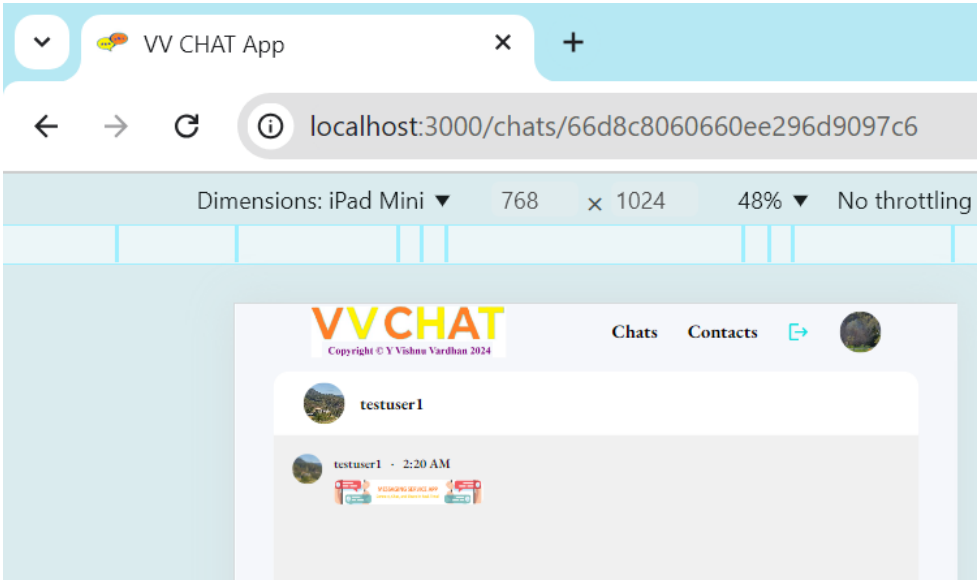


Figure 61

6. Deployment

I have chosen Vercel cloud platform as a service to deploy my VV CHAT web app. Since Vercel being the developer of Next.js, offers several features that make the deployment of Next.js project process easier and more efficient.

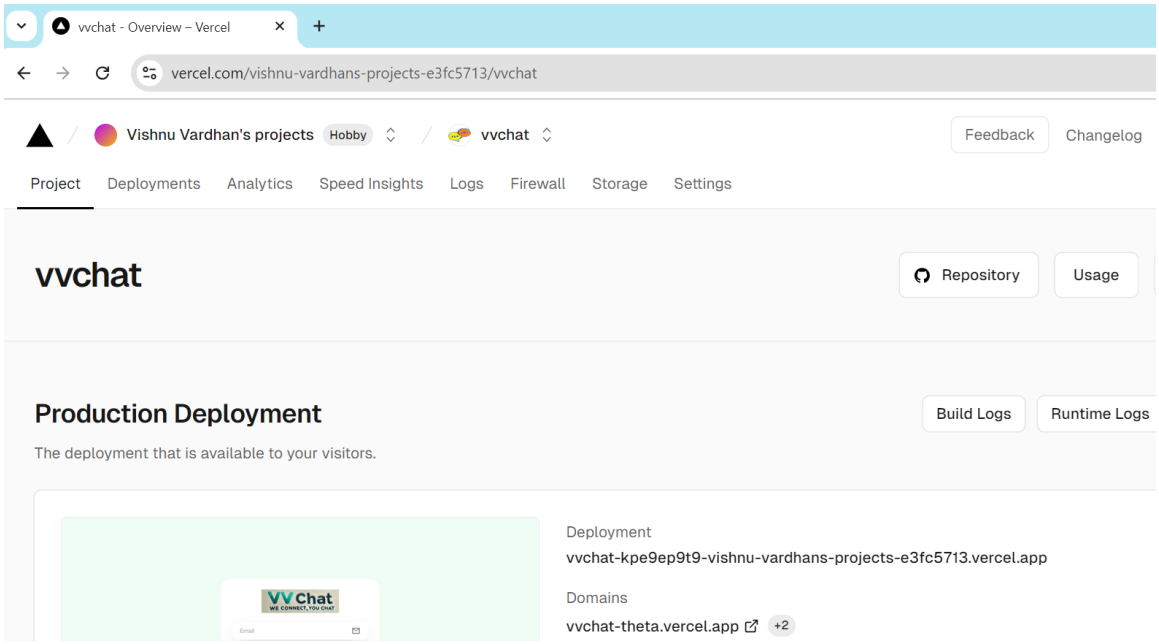


Figure 62

Link for the deployed web application: https://vvchat-theta.vercel.app/

For the access of local dependencies present in the business logic of the application, various third-party environment variables are updated in the Vercel dashboard. MongoDB database driver for accessing the database for information retrievals. Next-auth.js secret key to carry forward user authentications. Cloudinary Cluster name in order to access the image files uploaded through the web application. Lastly, Pusher credentials in order to facilitate real time message updates to the end users.

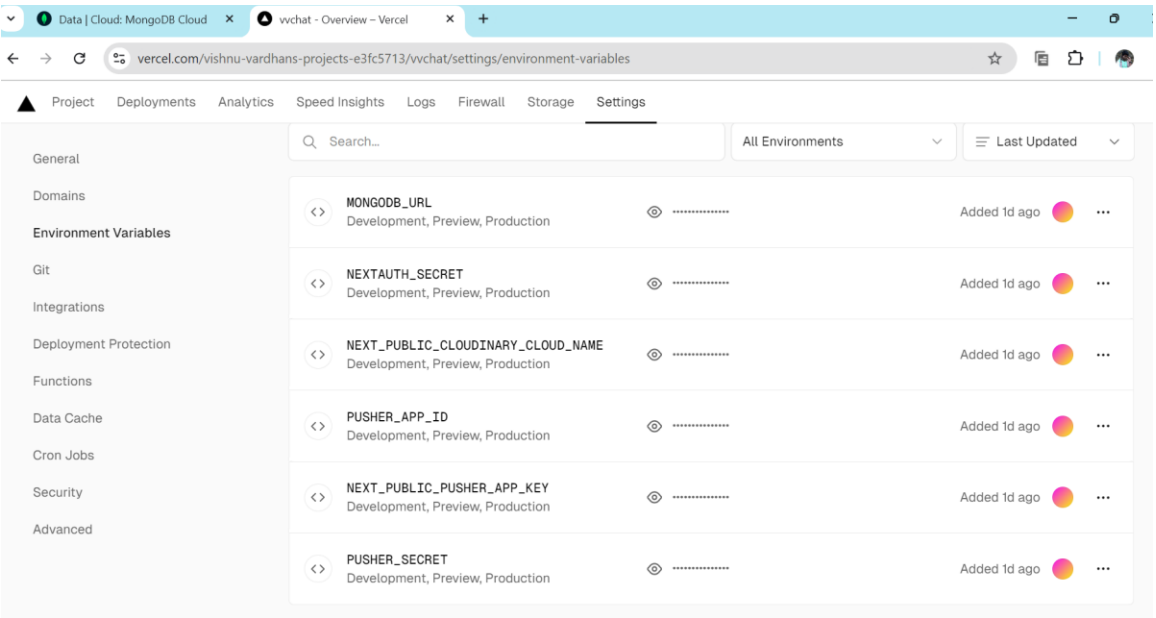


Figure 63

Upon successful connection establishment to my Git Repository, Vercel deployed my application onto a valid domain taking care of all sorts of integrations, Data cache, Logs and Source Protection, Git Fork Protection, and Vercel's authentication.

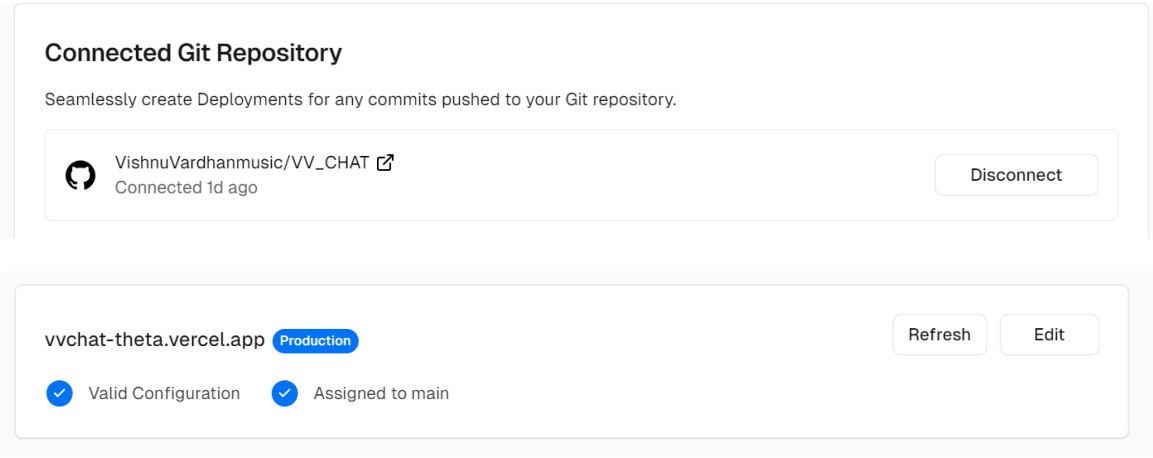


Figure 64

7. Error Handling and Logging

Throughout the development of backend components, I have made use of try-catch block mechanism to handle user driven errors.

route.js U

app > api > users > route.js > GET

```
1   import User from "@models/User"
2   import { connectToDB } from "@mongodb"
3
4   export const GET = async (req, res) => {
5     try {
6       await connectToDB()
7
8       const allUsers = await User.find()
9
10      return new Response(JSON.stringify(allUsers), { status: 200 })
11    } catch (err) {
12      console.log(err)
13      return new Response("Failed to get all the users", { status: 500 })
14    }
15  }
```

Figure 65

Based on the JSON Response, code firstly enters the try block where required business logic is written. If status other than 2xx (Success) is received, then the code enters the catch block where the error message, depending on whether to display it to the end user or console log at the backend will be done.

As a good practice, I figured out the error status for a few API calls and incorporated those in the error message. Rarely, 4xx client error and 5xx server error are encountered, which are efficiently handled by the web application.

Below figure illustrates, when user tries to register with already entered email. Then 400 Bad Request response is logged onto the console.

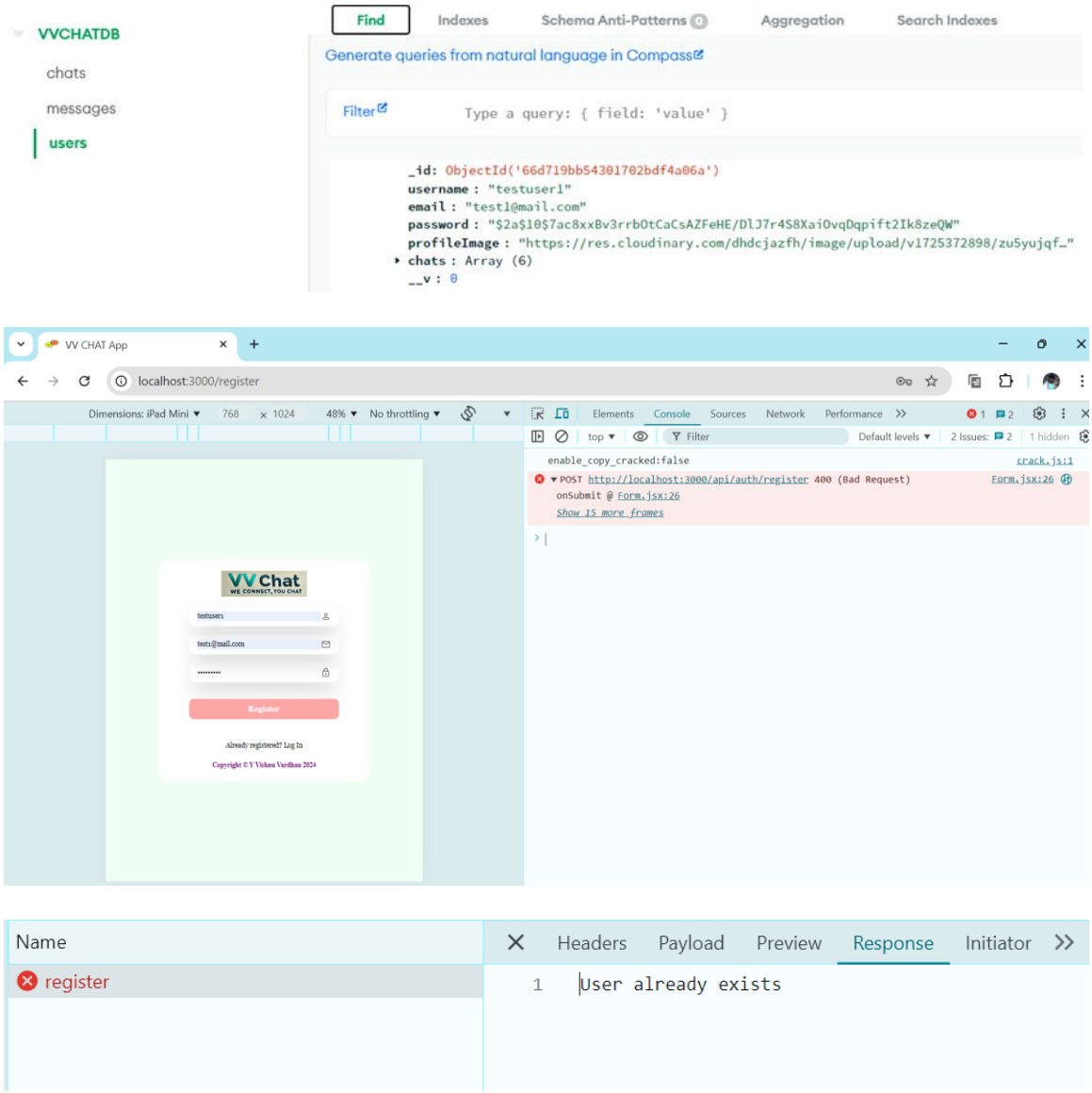


Figure 66

Logging Strategy is vital during the run of any full stack application. Since there will be numerous function calls rendering which need to be logged properly for analyzing any code breaks and business login failure cases, I console logged all appropriate messages which were considered during unit testing and end-to-end testing.

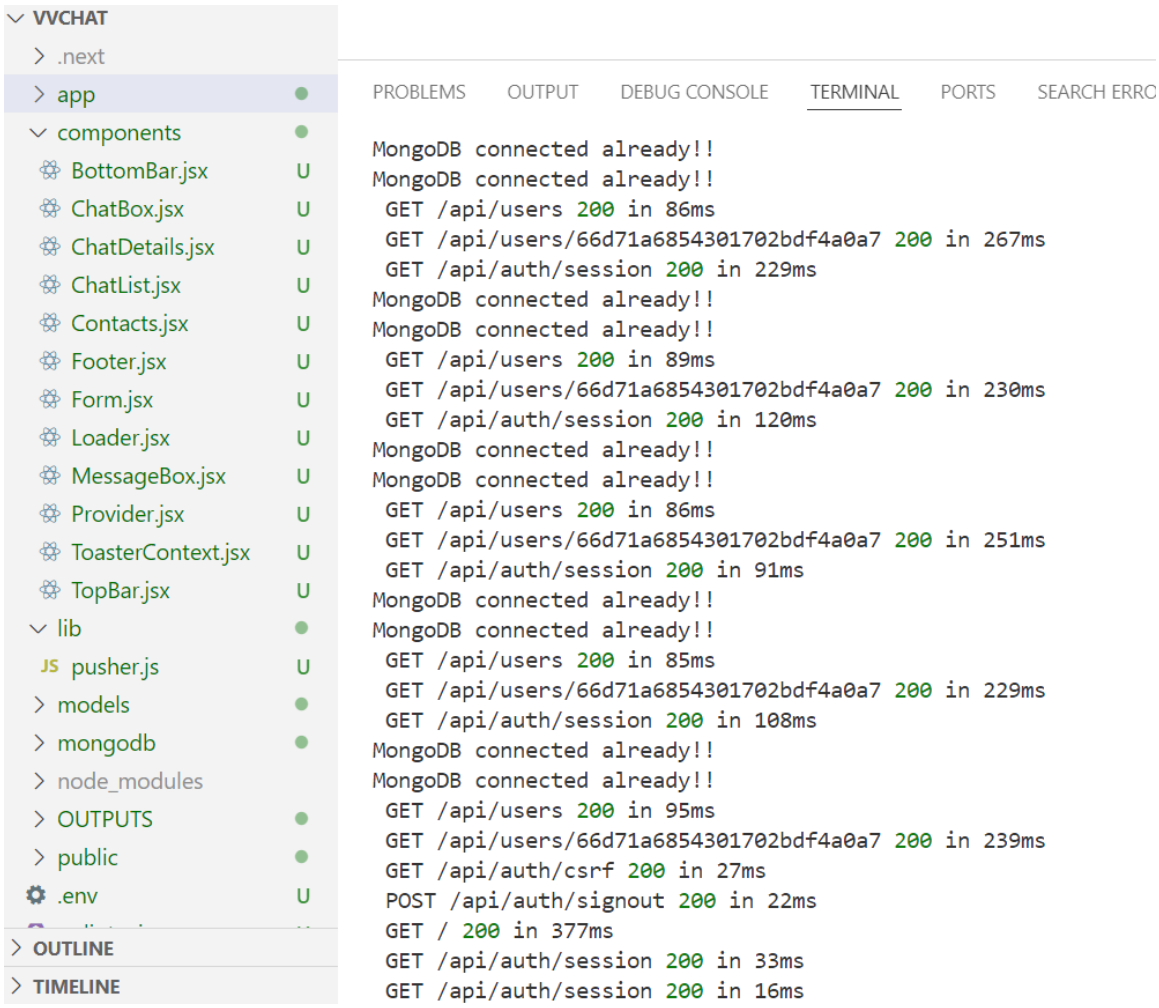


Figure 67

8. Testing

By inculcating popular testing strategies in order to build error-free, optimized web application, I have done testing after each Git commit. During the development stage, frequently ensured the VV CHAT app having proper interactions with each and every component. Appropriate snapshots to depict the PASS of testing scenarios, are engulfed into OUTPUTS directory.

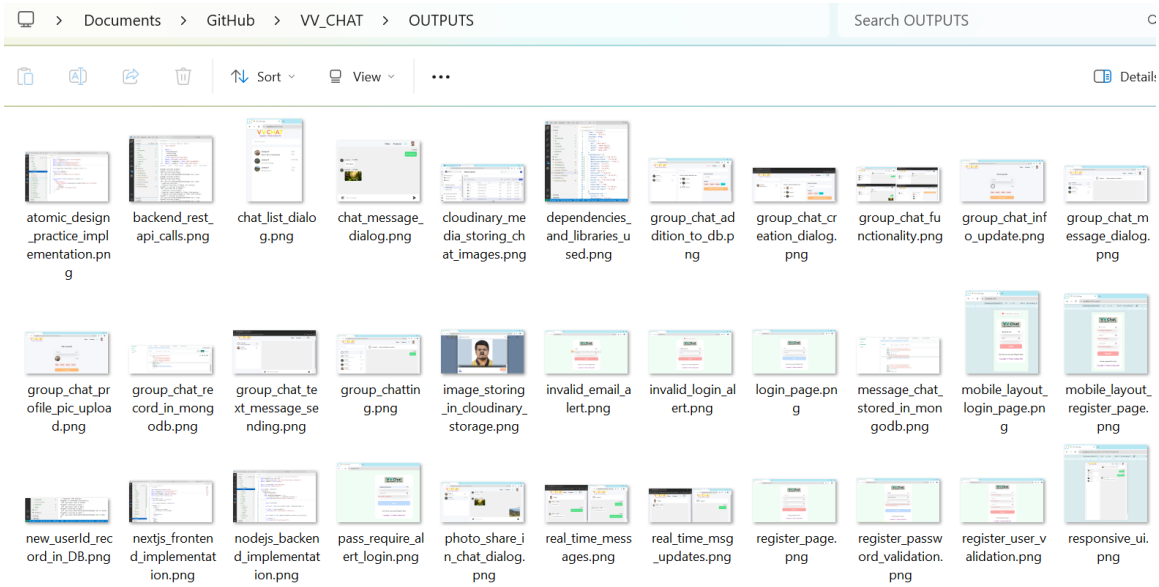


Figure 68

Utilized the npm-package-json-lint to check multiple audits like validity of data types in nodes, whether a strings declared are lowercases, whether a version number is a valid, the presence of a given module, the presence of any bugs and validation of dependencies and licenses.

```
added 237 packages, and audited 510 packages in 22s

158 packages are looking for funding
  run `npm fund` for details

found 0 vulnerabilities
```

Figure 69

9. Abbreviations

VV CHAT => Vishnu Vardhan CHAT

SQL => Structured Query Language

REST => Representational State Transfer

API => Application programming interface

CRUD => Create, Read, Update, and Delete

DBMS => Data Base Management Systems

HTML => Hypertext Markup Language

HTTP => Hypertext Transfer Protocol

UI => User Interface

AI => Artificial Intelligence

NoSQL => Not Only SQL

UX => User Experience

CSS => Cascading Style Sheets

CSRF => Cross-site request forgery

OAuth => Open Authorization

JSON => JavaScript Object Notation

****