CARPOOL EASY

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***Abstract* - CarPoolEasy is an application that may be effectively used to address urban transportation challenges. The implementation of the carpool application is suggested in this report utilizing Java based object-oriented programming paradigms and Scene Builder assisted JavaFX, a framework for quickly developing graphical user interfaces. The primary scope includes Multi-role Platform, ride creation, real-time matching algorithms, and User-friendly experience. Utilizing JavaFX, an event-driven approach is employed for user-friendly interfaces, ensuring responsiveness. The design encompasses robust features such as user authentication, dynamic ride creation, and efficient search and matching algorithms using Google Maps API and Email Integration.**

***Keywords* –** *User Authentication, Dynamic Ride creation, Search and Match Algorithms.*

I. PROBLEM DESCRIPTION

Urbanization has led to increased traffic congestion and environmental challenges, necessitating innovative solutions for efficient transportation. The conventional reliance on individual vehicles contributes to congestion and pollution. Current carpooling options often lack user-friendly interfaces and effective matching algorithms, limiting their widespread adoption. Additionally, concerns related to data security and privacy hinder the seamless implementation of carpooling services.

The need for a comprehensive carpooling application arises from these challenges. A solution is required to provide users with an intuitive platform that encourages carpooling, addresses the intricacies of real-time ride matching, and prioritizes data security and user privacy. The application should be visually appealing, easy to use, and capable of fostering a sense of community among users sharing similar routes. To tackle these issues, our project leverages JavaFX and Scene Builder to create a dynamic and user-centric carpooling application, offering an efficient and sustainable alternative to individual commuting.

II. ANALYSIS (RELATED WORK)

According to a review of existing carpooling platforms [1], it is evident that the primary challenges lie in limited platform availability and a lack of seamless communication among users. CarPoolEasy addresses these challenges by providing a multi-role platform that caters to the diverse needs of Riders, Car Owners, and Drivers.

Research by Smith and Johnson [2] emphasizes the importance of user-friendly interfaces in increasing the adoption of carpooling services. CarPoolEasy acknowledges this by employing JavaFX, a modern and visually appealing framework, to create an intuitive user interface. This aligns with the findings that an engaging user experience positively influences the success of transportation solutions.

Findings from studies on the environmental impact of individual commuting [3] support the need for carpooling solutions to reduce traffic congestion and lower carbon emissions. CarPoolEasy aligns with these environmental goals by encouraging shared rides, thus optimizing vehicle usage and contributing to a greener and more sustainable urban environment.

However, shortcomings in existing solutions include security concerns and fragmented user experiences [4]. CarPoolEasy addresses these by implementing a robust security framework and providing a seamless, unified interface for all user roles.

The integration of Google Maps API is supported by research [5] highlighting the significance of real-time navigation in enhancing the user experience. CarPoolEasy leverages this technology to provide users with detailed trip information, contributing to efficient travel planning and a smoother overall commuting experience.

While existing literature sheds light on the challenges and benefits of carpooling solutions, CarPoolEasy strategically combines various elements such as a multi-role platform, user-friendly interface, environmental considerations, and advanced technologies to create a comprehensive and impactful transportation solution. It not only addresses the identified issues but also aligns with the latest findings and advancements in the field.

III. SYSTEM DESIGN

The CarPoolEasy system is designed with a client-server architecture to effectively address the identified transportation challenges. The system consists of three main components: the client-side application, the server-side application, and the database. The client-side application, developed using JavaFX, serves as the user interface, handling interactions such as signup, login, ride offers, and searches. On the server side, the application manages user accounts, ride information, and facilitates communication between users. It implements core business logic, including ride matching algorithms and email notifications. The database stores user details, ride information, and related data, enabling seamless data management and retrieval for the server-side application.

The original UI design encompasses a homepage providing signup and login options, signup and login pages with forms for user details, and role-specific dashboards tailored to Riders, Car Owners, and Drivers. Additionally, there are dedicated pages for offering rides, finding rides, and displaying detailed trip information, integrating Google Maps API for enhanced mapping and navigation experiences.

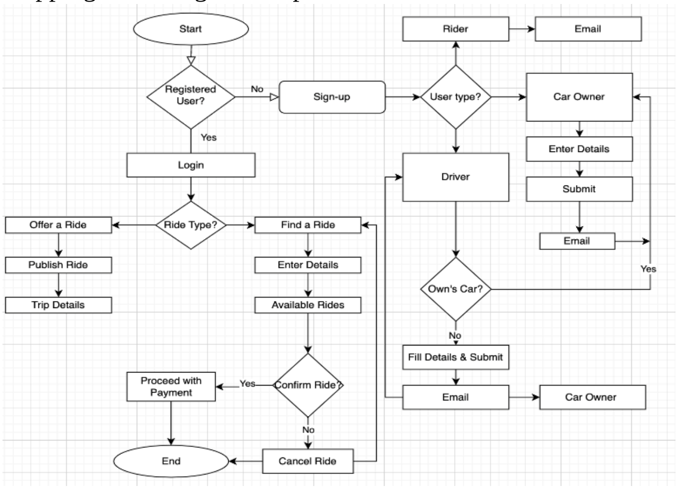


Figure 3. System Design

IV. Implementation

A. *Login/Signup Page*

The first page of the application lets the user to either login or signup to use CarPoolEasy. If the user does not have an account, he/she needs to sign up by clicking on Sign Up button. To use the application, a user is expected to login with his/her credentials. This information serves as the gateway to the carpool application, providing a secure and personalized experience for users. The credentials created during signup will be stored in our database and the user can login using their credentials. Login authentication and user registration is facilitated by linking controller classes with the respective UI components, these controller classes perform the job of appending new pairs of credentials to the database. While signing up the user needs to create a password which is of the length 6 characters and includes a special character and gets an option to select the user role. There are 3 roles, Rider, Driver and Car Owner. ArrayList collections are used to store the user roles.

Rider

If the user chooses to sign up as a Rider, upon entering all the required details and clicking submit, a registration conformation email will be sent to them from the recipient email address 'noreplycarpoolsystem@gmail.com'. The Rider information will be stored in our database for future use. We are using SMTP email integration for this purpose.

Driver

Form is displayed, prompting the user to indicate car ownership. If affirmative, the page redirects to a detailed car owner information form. If negative, users are prompted to provide basic information, including name and contact details. Upon submission, two simultaneous events occur. First, the entered details are stored in the MySQL database. Second, an email is dispatched to the car owner, seeking verification of the driver's legitimacy. Simultaneously, an email is sent to the driver, notifying them to await approval. The email dispatch system integrates with Google's SMTP for efficient communication. The functions responsible for sending emails to both the driver and car owner inherited from a foundational function named BaseEmailSender. These functions operate recursively, attempting to send the email. In the case of failure, the function calls itself with an incremented attempt number. This recursive process continues until either the email is successfully sent or the maximum allowable number of retry attempts is reached. This approach ensures robustness in email delivery, enhancing the reliability of the system.

Car Owner

The user is required to input fundamental information, including their Social Security Number (SSN) and essential car model details. Upon submission, two simultaneous events unfold: the entered details are stored in the MySQL database, and a verification email is dispatched to the car owner.

B. Main Dashboard

Upon logging in, existing users are presented with the main dashboard, offering two choices:

Offer Ride

To offer a ride, a car owner/driver must input the pickup and drop locations, validate them using Google Maps, specify the date and time, indicate the number of available seats, include comments, set a price, and provide any additional information.

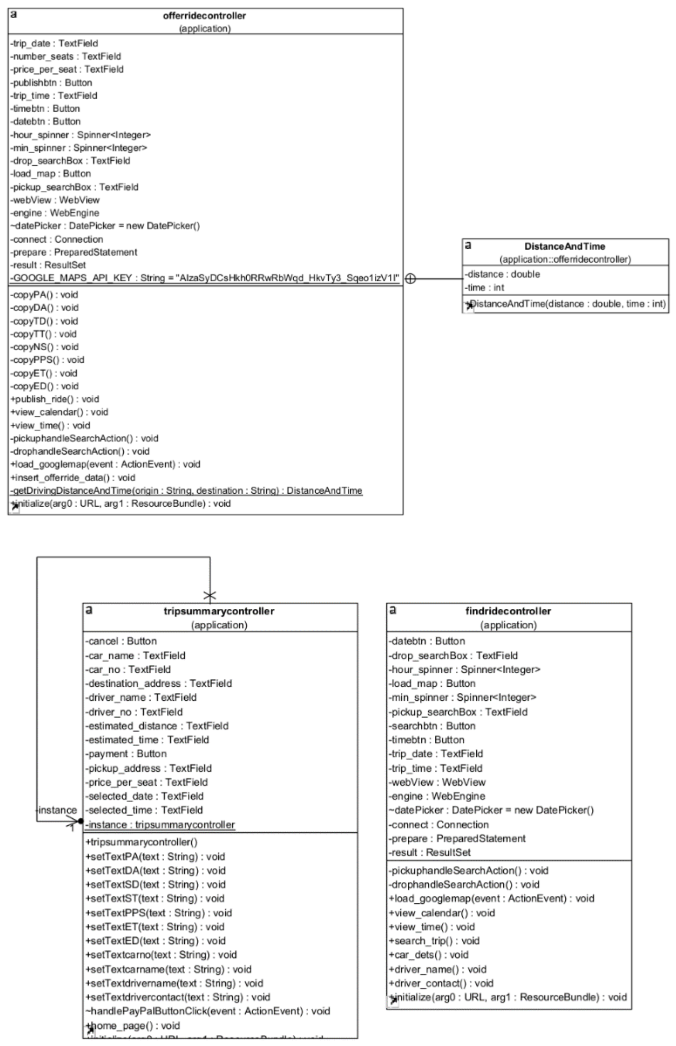
Upon publishing the ride, two actions take place simultaneously.

All the entered information is stored in the database. Trip details are generated, displaying the distance and estimated travel time between the two locations by car, utilizing the Google Maps geolocation API.

Find a Ride

The rider seeking a trip is prompted to input the pickup and drop locations, along with the desired date and time, to initiate a search for available trips. If a matching trip is found in our database, the system displays a summary of trip details. The user is then presented with the option to either cancel the trip or proceed to the payment stage. If the requested trip is not currently available, an alert box will appear, notifying the rider that the sought-after trip is presently unavailable. SQL search queries and insert queries are used to store and retrieve data from our database.

Implementation of our various classes and inheritance and helped achieve our requirements in the scope of our project. In this project classes that implements the Initializable interface, providing its own implementation of the initialize method. The use of interfaces, like Initializable, helped define a contract that classes must adhere to, promoting a consistent structure in JavaFX applications.


offerridecontroller
(application)
-trip_date : TextField
-number_seats : TextField
-price_per_seat : TextField
-publishbtn : Button
-trip_time : TextField
-timebtn : Button
-datebtn : Button
-hour_spinner : Spinner<Integer>
-min_spinner : Spinner<Integer>
-drop_searchBox : TextField
-load_map : Button
-pickup_searchBox : TextField
-webView : WebView
-engine : WebEngine
~datePicker : DatePicker = new DatePicker()
-connect : Connection
-prepare : PreparedStatement
-result : ResultSet
-GOOGLE_MAPS_API_KEY : String = "AIzaSyDCsHkh0RRwRbWqd_HkvTy3_Sqeo1izV1I"
-copyPA() : void
-copyDA() : void
-copyTD() : void
-copyTT() : void
-copyNS() : void
-copyPPS() : void
-copyET() : void
-copyED() : void
+publish_ride() : void
+view_calendar() : void
+view_time() : void
-pickuphandleSearchAction() : void
-drophandleSearchAction() : void
+load_googlemap(event : ActionEvent) : void
+insert_offerride_data() : void
-getDrivingDistanceAndTime(origin : String, destination : String) : DistanceAndTime
+initialize(arg0 : URL, arg1 : ResourceBundle) : void
DistanceAndTime
(application::offerridecontroller)
-distance : double
-time : int
+DistanceAndTime(distance : double, time : int)
tripsummarycontroller
(application)
-cancel : Button
-car_name : TextField
-car_no : TextField
-destination_address : TextField
-driver_name : TextField
-driver_no : TextField
-estimated_distance : TextField
-estimated_time : TextField
-payment : Button
-pickup_address : TextField
-price_per_seat : TextField
-selected_date : TextField
-selected_time : TextField
-instance : tripsummarycontroller
-instance
+tripsummarycontroller()
+setTextPA(text : String) : void
+setTextDA(text : String) : void
+setTextSD(text : String) : void
+setTextST(text : String) : void
+setTextPPS(text : String) : void
+setTextET(text : String) : void
+setTextED(text : String) : void
+setTextcarno(text : String) : void
+setTextcarname(text : String) : void
+setTextdrivername(text : String) : void
+setTextdrivercontact(text : String) : void
~handlePayPalButtonClick(event : ActionEvent) : void
+home_page() : void
findridecontroller
(application)
-datebtn : Button
-drop_searchBox : TextField
-hour_spinner : Spinner<Integer>
-load_map : Button
-min_spinner : Spinner<Integer>
-pickup_searchBox : TextField
-searchbtn : Button
-timebtn : Button
-trip_date : TextField
-trip_time : TextField
-webView : WebView
-engine : WebEngine
~datePicker : DatePicker = new DatePicker()
-connect : Connection
-prepare : PreparedStatement
-result : ResultSet
-pickuphandleSearchAction() : void
-drophandleSearchAction() : void
+load_googlemap(event : ActionEvent) : void
+view_calendar() : void
+view_time() : void
+search_trip() : void
+car_dets() : void
+driver_name() : void
+driver_contact() : void
+initialize(arg0 : URL, arg1 : ResourceBundle) : void

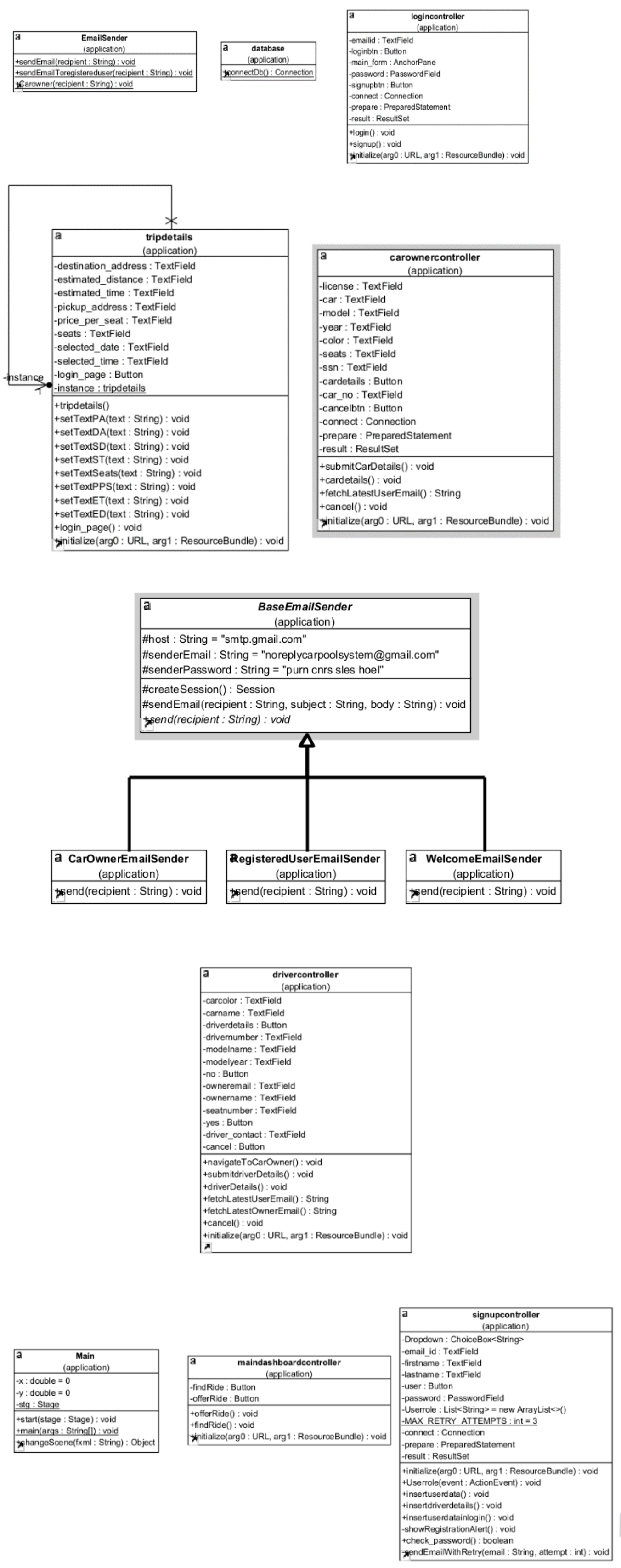
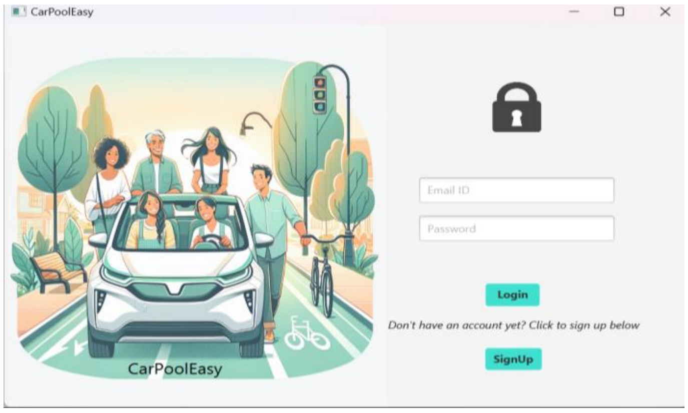

EmailSender
(application)
+sendEmail(recipient : String) : void
+sendEmailToregistereduser(recipient : String) : void
+Carowner(recipient : String) : void
database
(application)
+connectDb() : Connection
logincontroller
(application)
-emailid : TextField
-loginbtn : Button
-main_form : AnchorPane
-password : PasswordField
-signupbtn : Button
-connect : Connection
-prepare : PreparedStatement
-result : ResultSet
+login() : void
+signup() : void
+initialize(arg0 : URL, arg1 : ResourceBundle) : void
tripdetails
(application)
-destination_address : TextField
-estimated_distance : TextField
-estimated_time : TextField
-pickup_address : TextField
-price_per_seat : TextField
-seats : TextField
-selected_date : TextField
-selected_time : TextField
-login_page : Button
-instance : tripdetails
-instance
+tripdetails()
+setTextPA(text : String) : void
+setTextDA(text : String) : void
+setTextSD(text : String) : void
+setTextST(text : String) : void
+setTextSeats(text : String) : void
+setTextPPS(text : String) : void
+setTextET(text : String) : void
+setTextED(text : String) : void
+login_page() : void
+initialize(arg0 : URL, arg1 : ResourceBundle) : void
carownercontroller
(application)
-license : TextField
-car : TextField
-model : TextField
-year : TextField
-color : TextField
-seats : TextField
-ssn : TextField
-cardetails : Button
-car_no : TextField
-cancelbtn : Button
-connect : Connection
-prepare : PreparedStatement
-result : ResultSet
+submitCarDetails() : void
+cardetails() : void
+fetchLatestUserEmail() : String
+cancel() : void
+initialize(arg0 : URL, arg1 : ResourceBundle) : void
BaseEmailSender
(application)
#host : String = "smtp.gmail.com"
#senderEmail : String = "noreplycarpoolsystem@gmail.com"
#senderPassword : String = "purn cnrs sles hoel"
#createSession() : Session
#sendEmail(recipient : String, subject : String, body : String) : void
+send(recipient : String) : void
CarOwnerEmailSender
(application)
+send(recipient : String) : void
RegisteredUserEmailSender
(application)
+send(recipient : String) : void
WelcomeEmailSender
(application)
+send(recipient : String) : void
drivercontroller
(application)
-carcolor : TextField
-carname : TextField
-driverdetails : Button
-drivernumber : TextField
-modelname : TextField
-modelyear : TextField
-no : Button
-owneremail : TextField
-ownername : TextField
-seatnumber : TextField
-yes : Button
-driver_contact : TextField
-cancel : Button
+navigateToCarOwner() : void
+submitdriverDetails() : void
+driverDetails() : void
+fetchLatestUserEmail() : String
+fetchLatestOwnerEmail() : String
+cancel() : void
+initialize(arg0 : URL, arg1 : ResourceBundle) : void
Main
(application)
-x : double = 0
-y : double = 0
-stg : Stage
+start(stage : Stage) : void
+main(args : String[]) : void
+changeScene(fxml : String) : Object
maindashboardcontroller
(application)
-findRide : Button
-offerRide : Button
+offerRide() : void
+findRide() : void
+initialize(arg0 : URL, arg1 : ResourceBundle) : void
signupcontroller
(application)
-Dropdown : ChoiceBox<String>
-email_id : TextField
-firstname : TextField
-lastname : TextField
-user : Button
-password : PasswordField
-Userrole : List<String> = new ArrayList<>()
-MAX_RETRY_ATTEMPTS : int = 3
-connect : Connection
-prepare : PreparedStatement
-result : ResultSet
+initialize(arg0 : URL, arg1 : ResourceBundle) : void
+Userrole(event : ActionEvent) : void
+insertuserdata() : void
+insertdriverdetails() : void
+insertuserdatainlogin() : void
-showRegistrationAlert() : void
+check_password() : boolean
-sendEmailWithRetry(email : String, attempt : int) : void

Figure 6. UML Diagram

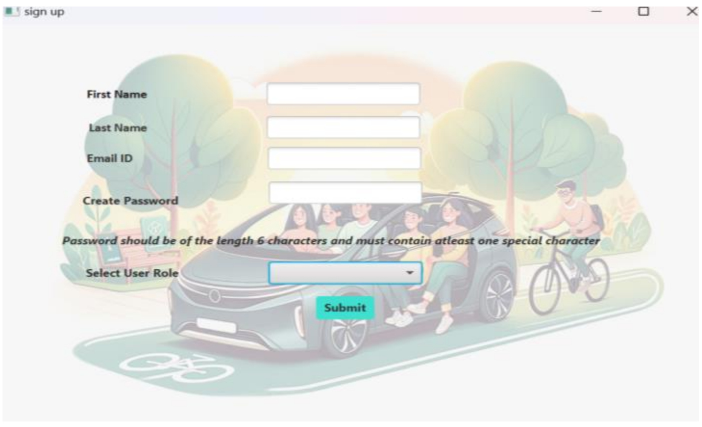
V. Evaluation

User can either Login or Sign Up

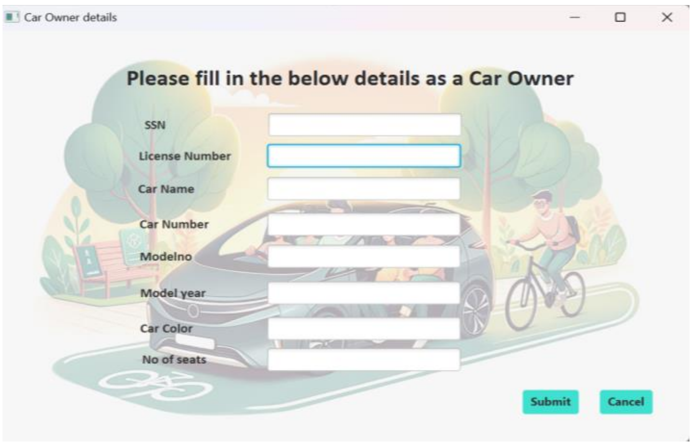


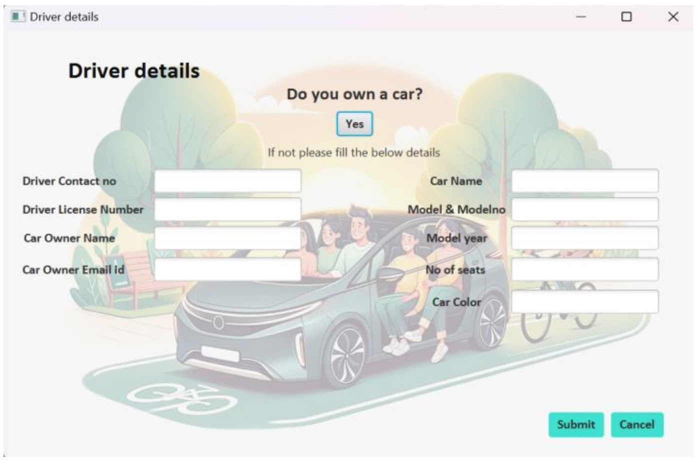
User needs to fill in the required details and select their user Role according to their needs:

- Rider
- Driver
- CarOwner


sign up
First Name
Last Name
Email ID
Create Password
Password should be of the length 6 characters and must contain atleast one special character
Select User Role
Submit

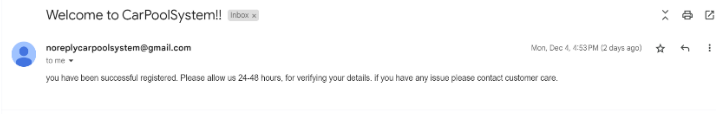
Driver and Car Owner Details Submission Page





Snapshots of the email sent to different user roles.

To Driver and Car Owner:

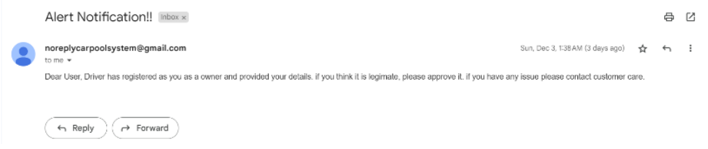


Welcome to CarPoolSystem!! Inbox ×

noreplycarpoolsystem@gmail.com
to me
Mon, Dec 4, 4:53 PM (2 days ago)

you have been successful registered. Please allow us 24-48 hours, for verifying your details. if you have any issue please contact customer care.

Approval request email sent to a car owner when the driver registers:



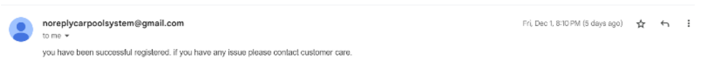
Alert Notification!! Inbox ×

noreplycarpoolsystem@gmail.com
to me
Sun, Dec 3, 1:38 AM (3 days ago)

Dear User, Driver has registered as you as a owner and provided your details. if you think it is legimate, please approve it. if you have any issue please contact customer care.

Reply Forward

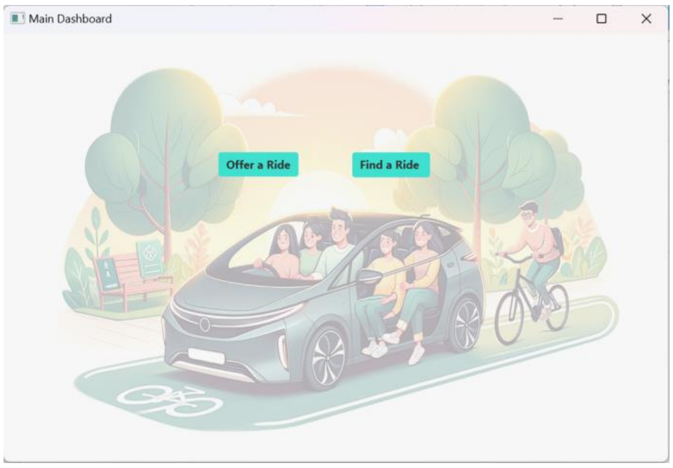
To Rider:



noreplycarpoolsystem@gmail.com
to me
Fri, Dec 1, 8:10 PM (5 days ago)

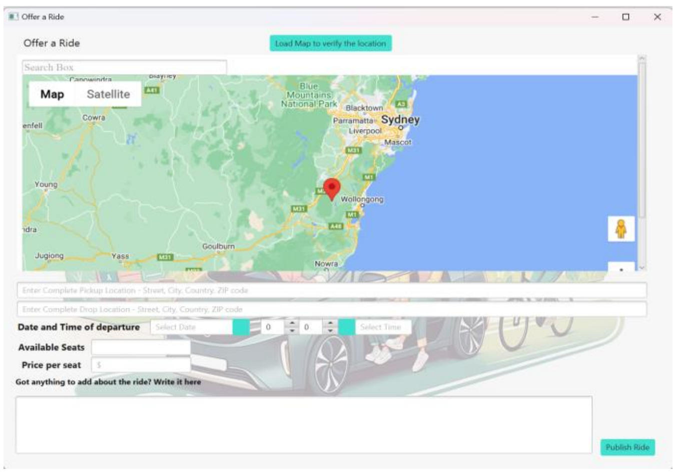
you have been successful registered. if you have any issue please contact customer care.

When an existing user logs in to the application, the main dashboard appears which gives two options: 1. Offer a Ride 2. Find a Ride



Offer a Ride:

Driver or Car owner who wants to offer a ride should fill in the below details as shown and publish it.



Enter Complete Pickup Location - Street, City, Country, ZIP code

Enter Complete Drop Location - Street, City, Country, ZIP code

Date and Time of departure: Select Date 0 0 Select Time

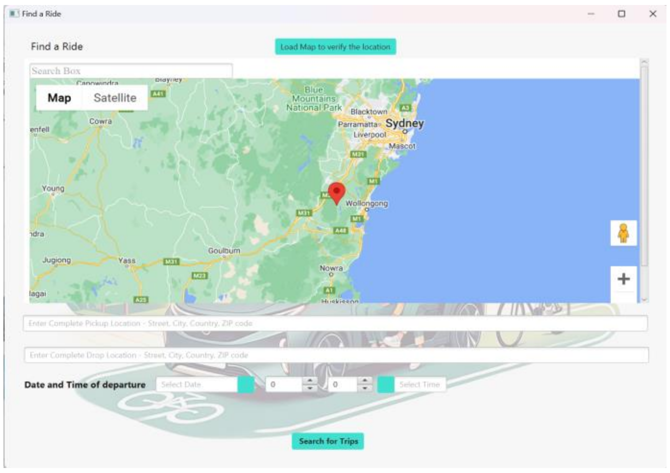
Available Seats:

Price per seat: $

Got anything to add about the ride? Write it here

Find a Ride:

Riders who want to find the ride would need to fill in the required details and check if the trip is available.

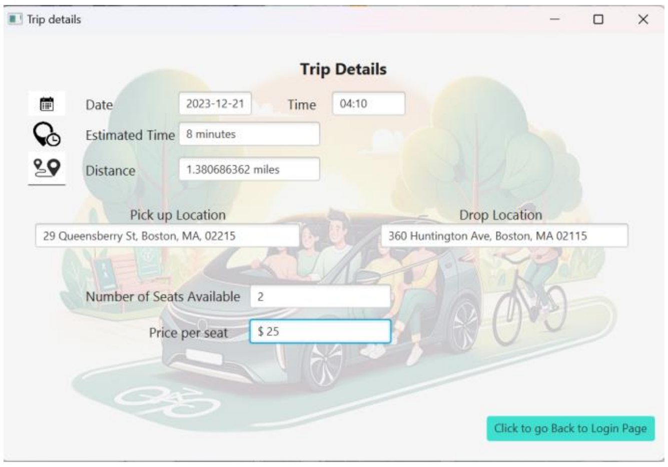


Enter Complete Pickup Location - Street, City, Country, ZIP code

Enter Complete Drop Location - Street, City, Country, ZIP code

Date and Time of departure: Select Date 0 0 Select Time

Offered Ride Trip Details:



Trip Details

Date: 2023-12-21 Time: 04:10

Estimated Time: 8 minutes

Distance: 1.380686362 miles

Pick up Location: 29 Queensberry St, Boston, MA, 02215

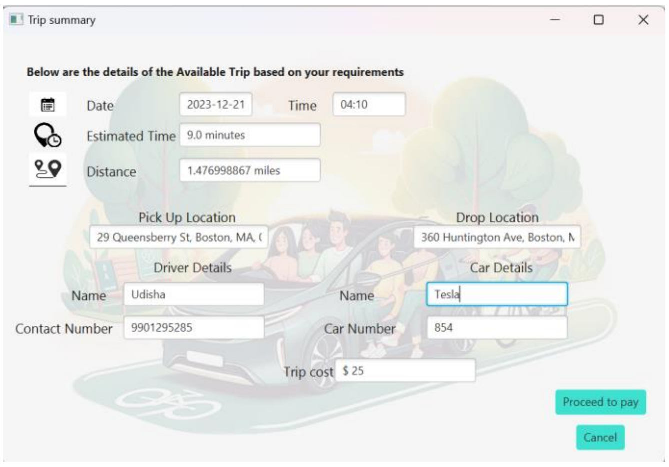
Drop Location: 360 Huntington Ave, Boston, MA 02115

Number of Seats Available: 2

Price per seat: $ 25

Available Trip Details:

Once the available trip details are shown, the user gets an option to cancel the ride or proceed with the payment.



Below are the details of the Available Trip based on your requirements

Date: 2023-12-21 Time: 04:10

Estimated Time: 9.0 minutes

Distance: 1.476998867 miles

Pick Up Location: 29 Queensberry St, Boston, MA, (

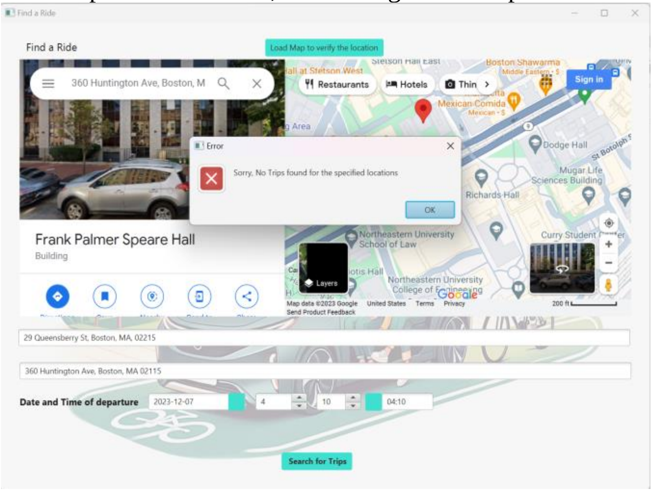
Drop Location: 360 Huntington Ave, Boston, M

Driver Details: Name: Udisha; Contact Number: 9901295285

Car Details: Name: Tesla; Car Number: 854

Trip cost: $ 25

If the trip is not available, the message comes up.



Error: Sorry, No Trips found for the specified locations

29 Queensberry St, Boston, MA, 02215

360 Huntington Ave, Boston, MA 02115

Date and Time of departure: 2023-12-07 4 10 04:10

VII. Discussion (Reflection)

During the development phase, it was crucial to ensure that the project requirements were being fulfilled. This involved maintaining regular communication among the team members and conducting frequent reviews of the project plan. It was imperative to maintain the design structure as per the documented specifications while making necessary revisions to the plan.

The project successfully developed a user-friendly carpool application using JavaFX and Scene Builder, addressing urban transportation challenges. The application allows users to either offer or find rides, integrating features like dynamic ride creation, real-time search and matching algorithms, and secure communication channels. Key functionalities, including user registration, login, and ride management, were implemented with an intuitive interface.

The application's main dashboard offers options to provide or search for rides. For ride providers, a detailed form captures pickup/drop locations, date/time, available seats, and additional details. Upon publishing, trip details are stored in a MySQL database, and real-time distance and estimated time using Google Maps API are displayed.

The login/signup process is secure, and email verification enhances user authentication. The system handles email communication through SMTP Google email integration, utilizing recursive functions for reliability.

The project's success lies in its ability to reduce traffic congestion and promote sustainable transportation. Challenges such as data security and scalability were addressed, ensuring compliance with privacy standards. The application's effectiveness was validated through user testing, emphasizing its potential impact on improving urban mobility and fostering an eco-friendlier transportation system.

VIII. Conclusions and Future Work

The CarPoolEasy project presents a robust solution to address urban transportation challenges, fostering efficiency, sustainability, and user-centric experiences. Summarizing the findings and addressing potential questions, we can highlight the following points:
Advantages or Benefits:

- Efficient Commuting:
- CarPoolEasy optimizes travel by connecting Riders, Car Owners, and Drivers, reducing traffic congestion and environmental impact through shared rides.
- User-Friendly Interface:
- The use of JavaFX ensures an intuitive and visually appealing interface, enhancing accessibility for a diverse user base.
- Data Management and Navigation:
- Database integration streamlines data management, providing seamless access to user and ride details, while Google Maps integration enhances real-time navigation and trip planning.
- Enhanced Communication and Trust:
- SMTP-based email notifications contribute to reliable communication, building trust among users and addressing concerns related to shared rides.

Problems Not Explored:

- Safety Features:
- While the project addresses general security concerns, further exploration and implementation of advanced safety features, such as real-time tracking and emergency services integration, could enhance user safety.
- Scalability Challenges:
- The project assumes a moderate scale; however, exploring potential challenges related to scalability and load handling could be crucial for future enhancements.

Areas for Improvement with More Time:

- Advanced User Verification:
- Strengthening user verification mechanisms to enhance the authenticity and trustworthiness of participants in the carpooling network.
- Dynamic Routing Optimization:
- Implementing dynamic routing algorithms to optimize trips based on real-time traffic data, further improving the efficiency of shared rides.
- Integration with Public Transportation:
- Exploring integration with public transportation systems to create a seamless, multimodal commuting experience for users.

In conclusion, CarPoolEasy presents a foundation for efficient and sustainable urban commuting. As the project evolves, addressing safety features, scalability challenges, and implementing advanced functionalities could contribute to a more comprehensive and impactful carpooling solution.

IX. Job Assignment

- Udisha Dutta Chowdhury:
  Primary Focus- Login page, Main Dashboard– Offer a ride, Find a Ride, Trip Details summary.
  Features: Google Maps Integration along with Database Integration.
- Pooja Kannan:
  Primary Focus- Sign up page – Car Owner, Driver.
  Features: Emails Integration using google Api's along with Database Integration.
- Sejal Santosh Chandak:
  Primary Focus: Sign Up for Rider
  Features: Payment Method, Calendar Integration

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