Parkour: A Parking Sharing System

Final Report

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Executive Summary

Development Standards & Practices Used

- Agile project development
- IEEE 802.11 Wireless Internet Standard
- IEEE 802.21 Cellular Data Standard
- Open Source License(s)
  - The software that we use must be allowed for commercial use, as we are making a closed source project that will be released to the public.
- Mozilla Development Network Javascript Standards

Summary of Requirements

- Our application will require a dedicated frontend and backend that supports both iOS and Android applications.
- A platform will be needed that can host our server 24/7 once the application is up and running.
- The application will need to be published on the Google Play and Apple App Store so that anyone can use our app.

Applicable Courses from Iowa State University Curriculum

- COMS 227 + 228 (Object-Oriented Programming and Data Structures)
  - Knowledge of object-oriented programming and data structures are essential and will be utilized.
- COMS 252 (Linux Operating Systems)
  - Useful for setting up the VMs and hypervisor on our server.
- COMS 309 (Software Development)
  - Knowing how to research unfamiliar technologies would be very applicable to this project.
  - Utilizing Agile development practices.
- COMS 311 (Algorithms)
  - Knowledge of algorithms would be beneficial for our application's performance.
- SE 319 (Construction of User Interfaces)
  - Teaches the basics of how to design an attractive and usable user interface through a variety of languages and tools.
- COMS 362 (Object-Oriented Analysis and Design)
  - Some project management techniques would be useful such as CRC cards and knowledge of UML. This would be helpful for planning.
- COMS 363 (Introduction to Database Management Systems)
  - Gained experience with SQL and other databases. It will be useful as we develop our database and backend system.

New Skills/Knowledge acquired that was not taught in courses

- How to build an application using MERN stack (MongoDB, Express, React Native, and NodeJS)
- Exposure to web development for mobile applications
- How to create a backend server with API endpoints using NodeJS
- Connect and use MongoDB as a database
- How to research and utilize different packages and APIs that will be used throughout the application

1 Introduction

1.1 Acknowledgment

Outside of our own team members, Dr. Ahmed Kamal, the client who proposed this project, has been and will continue to be, a significant contributor to the overall lifecycle of the project.

1.2 Problem and Project Statement

The problem that our project hopes to solve is finding parking. In large events, such as football games or the Iowa State Fair, designated parking can be limited, expensive, and overall a hassle.

The Parking Sharing System aims to provide an alternative for finding parking at busy events or locations. This application will enable two kinds of users: to either find parking spaces, or host parking spaces. The host will be able to post a parking spot to the application. They will provide an address, number of spaces available, time slots, and a price for that time. The guest will be able to search through the existing posts to find a spot close to the event they want to go through. All transactions will be processed through Stripe. Similar to ridesharing apps such as Uber and Lyft, this application is crowdsourced and will heavily rely on individuals willing to use the application to host parking spots, as well as individuals willing to use the application to find and reserve the listed parking spots. We plan to create an application that makes event parking easier, cheaper, and an overall better client experience. Because of the parking sharing idea, this application will be environmentally friendly, saving on fuel consumption.

1.3 Operational Environment

The backend server application will live on a publicly hosted server, so the frontend application can connect. The frontend application will be available through the Apple App Store, and the GooglePlay Store, so it will reside on both Android and iOS devices.

Physically, the application will function at its best in large cities or local events such as concerts, football games, etc. It is not limited to specific events and large cities, but it is available wherever users can host and need to find additional parking. The application will need a large user base to make it viable. Urban and suburban areas are suitable areas because there are ample people to use the application, list their properties, and to reserve the listed spots.

1.4 Requirements

The application will depend on two types of users:

- Individuals or groups who are willing to host parking spaces
- Individuals looking for parking spaces

1.4.1 Functional Requirements

- Host User:
  - Have access to a list of reservations that contains the following information:
    - Guest Information
    - Reservation Time slot(s)
    - Vehicle license plate numbers and models
  - Handle payment between guests through Stripe APIs and endpoints
  - Provide a listing of their property with location and descriptions
  - Manage reservations
- Guest User:
  - Create an account that allows them to reserve parking spots
  - Securely send a payment to the host through Stripe API
  - Be able to receive information about the host's location, price, time-slots, and number of available spots
    - Based on selected location within a 10-mile radius
- Both Users:
  - Log into their account on the application
  - Access a list of available parking spots
  - View the available listings with their respective locations

1.4.2 Nonfunctional Requirements

- Intuitive and simple user interface
- Application feels responsive
- Allow users to update their public profile page easily
- Users should be able to add information about the location they are hosting
- Web browser application port
- Each payment should be documented with a corresponding log and receipt through Stripe
- The application makes API requests quickly

1.4.3 Engineering Constraints

- COVID-19 will have an impact on many aspects of our project. The following lists each area and why COVID affects it:
  - Face-to-face meetings
    - Meetings with our client/advisor cannot happen, as most of our group members are not on campus or in the area. For health and safety reasons, we cannot meet physically in person to talk about design and development decisions. We will have to meet through some online platform, such as Zoom or Webex.
    - Group meetings will need to be done remotely, and we will need to each locally work on our tasks using Gitlab for version control. Everyone will

have to set up their environment and ensure that it works as intended on their local machines.

    - User Testing
        - Our plan was to test our application with users attending events at Iowa State. We were hoping to test the scalability of our application to test our frontend and backend, but some events were canceled at the start of the school year. To combat this, we have decided to resort to extensive testing by using Jest, an automated test framework. Manual testing will be performed as well.
    - App Publication + Costs
        - Since our application needs to be posted on the Google Play or Apple App Store, we are not sure if COVID-19 will delay any approval processes for our application.
        - Financially, we are unsure if the University will be limiting our finances due to the potential costs we may incur resulting from server needs or publication fees.

1.5 Intended Users and Uses

The intended users include, but are not limited to individuals who are:

- Guests seeking parking spaces
- Hosts willing to rent out parking spaces on their property

The intended use for the application is to provide additional parking spots during events such as visiting a city, going to work, attending a concert, or cheering at a football game. The guest wanting to attend the said event could easily pull up the app and find a nearby host so they could park nearby. The host would be able to make money by hosting their property at the event.

1.6 Assumptions and Limitations

1.6.1 Assumptions

- User (both hosts and guests) has the application downloaded on either an iOS or Android device
- Users might want to access the application on the web
- Strong network/internet connection
    - Users will have a working network and/or internet connection so they may properly use the features of the application.
- Strong user-base of guests and hosts
    - There will be a plethora of guests and hosts in areas of high traffic so that a user may get the most out of the application. This app will be most useful in areas with many people and where parking is an issue, like sporting events, concerts, etc.

    - Individuals in more rural areas with less traffic are assumed to not have as many parking difficulties as those in cities and other highly populated areas.
- Guests have a sustainable payment system set up with the app to pay hosts for parking on their property through a supported payment option in Stripe.
- The host is legally entitled to use, lease, or sublease the parking spot(s)
- Both guests and hosts have read and agreed to the various terms and conditions of the application and all they entail.

1.6.2 Limitations

- Regional support
    - The more popular parking apps tend to serve only a specific state or region of the US whereas a majority of the parking apps akin to what we are trying to build tend to try and support all users from any location. More often than not, a user will download a residential parking app only to find out that it features little to no support in their area because they may not live in a busy and well-populated city like Los Angeles, New York City, or Boston.
- Available users in any given area
    - Some areas may have more hosts than guests and vice versa. This ratio is expected to vary, and there is not much that can be done about it. However, regardless of the ratio, our app will still require hosts and guests. After all, it is assumed that there will be a fair amount of hosts and guests available in most areas.
- User compliance
    - In a perfect world, the individuals who will use our app will do so after reading and agreeing to the terms and conditions. However, most users don’t read a software product’s terms and conditions, they simply accept without fully understanding what is being asked of them from the software. For example, drivers are supposed to arrive and leave at a predetermined time agreed upon by both parties. In the worst-case scenario, they leave their car for several days and the host has to call a towing service to remove the car. On the other side, the host may interact with the driver’s car in an undesired fashion when the driver is away.

1.7 Expected End Product and Deliverables

The expected end product is a mobile application that is available on both Android and iOS, with the possibility of a web application. The application should have the following deliverables:

1.7.1 Frontend Deliverables

- Users will be able to sign up, log in, and interact with the application
- Hosts will be able to create and view their listing, along with information about users that are reserving their spaces and receive payments (through Stripe)

- Guests will be able to view parking spot listings, reserve a parking spot, and send payments to the host

1.7.2 Backend Deliverables

- A database that contains:
    - User credentials
        - SessionID and tokens will need to be provided to the user upon login
        - A list of vehicles the user owns (they may use multiple vehicles)
        - User payment information
    - Locations of available parking spaces with associated fees
    - Stripe API endpoints for payment

2 Specifications and Analysis

2.1 Proposed Approach

As stated in the problem statement, when attending events, it can be very difficult to find parking and at a reasonable rate. Thus, Parkour aims to provide a parking alternative where drivers can pay to park their ride within the residential borders of a host's living space, such as a driveway or front yard. The app will be released as both an iOS and Android application and will feature an intuitive, easy-to-use, simple UI so the users can worry more about a parking spot than a cluttered home page.

After meeting with the client, the team received the research paper on which the application is based. The only stipulation was that this project would be 100% software. A full list of requirements is available in section 1.4. Additionally, see section 3.2 for more details on the proposed technologies that will be utilized.

2.2 Design Analysis

The technology stack we will be using is the MERN stack. This stack includes MongoDB, Express, React Native, and NodeJS.

2.2.1 Frontend

- **React Native**: The team has chosen to develop the frontend using React Native, an open-source mobile application framework. It is used to develop mobile applications for Web, Android, iOS, and Microsoft's Windows. It provides developers to access native platform capabilities using React, a JavaScript library created and maintained by Facebook.
- **TypeScript:** Developed and maintained by Microsoft. It is an open-source extension of JavaScript with Types and runs on any OS or browser.

2.2.2 Backend

- **Node w/ Express**: The team has chosen to develop the backend using Node.js because it is a very popular backend language to run on servers. There are plenty of resources for team members who are unfamiliar with Node and the Express library, a widely-used web application framework for Node.
- **Database**: The team has chosen to use MongoDB as the database because it is a popular choice amongst Node.js and Express.js developers, and there exist many resources and community support. Since it is also a cross-platform document-oriented database program, it doesn't rely at all on the manipulation of relational data such as MySQL, which oftentimes presents a steep learning curve for developers.

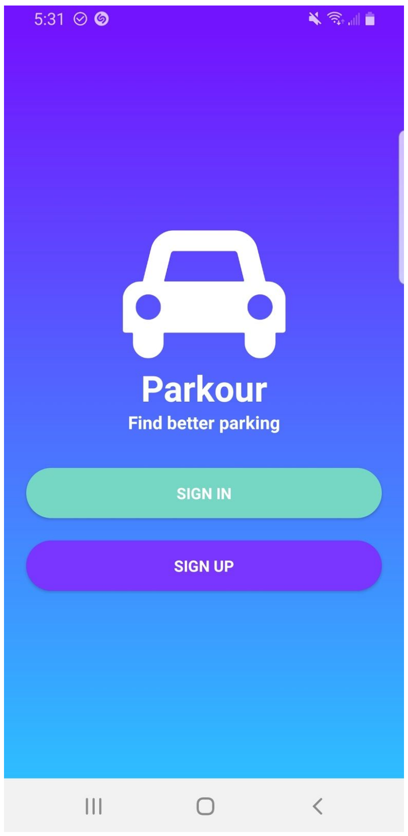
2.3 Development Process

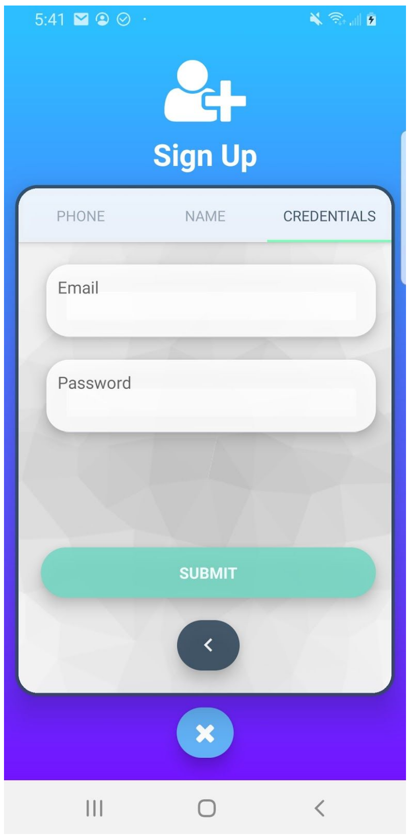
Our group has chosen to follow the agile methodology as per the agile manifesto established in 2001. Routine meetings and frequent testing will be implemented for the application. This also includes frequent collaboration with our client to ensure that his needs as a client are being met and the timeline that he has set forth is being followed.

With the help of the agile methodology, we will cycle through a process of planning, executing, and evaluating that includes continuous team and client collaboration to ensure that the final version of every deliverable is as satisfactory as possible. As a team, we will most likely rely on the agile process framework of Scrum which features frequent daily stand-ups and bi-weekly sprints. Since the development of this application will not be done in the environment of a standard paying 8-hour/day software company, stand-ups will be held a minimum of once per week so everyone can get caught up and on the same page as everyone else. Sprints will be roughly around one week to two weeks depending on the difficulty and size of the task at hand so that there is ample opportunity to discuss our recent advancements with the client for any immediate feedback.

2.4 Conceptual Sketch

Below are conceptual sketches for several different screens inside of the application. Since these are conceptual these screens could change by the end of the project.





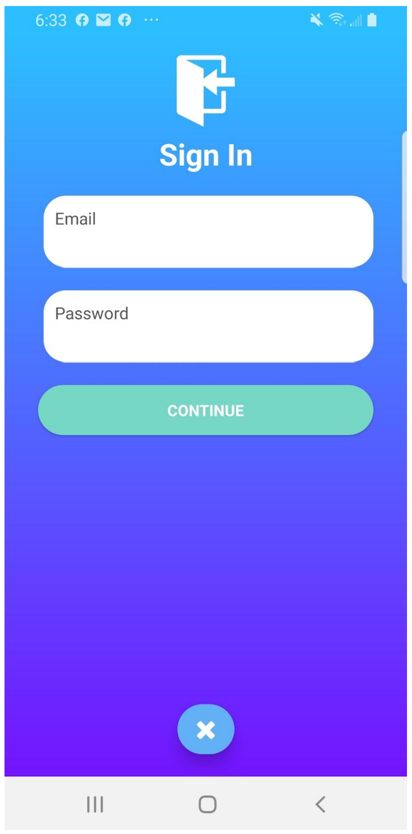


Figure 1. Entry page Figure 2. Sign-up page Figure 3. Sign-in page

The above three figures compromise the proposed login process to Parkour. The user will initially land on figure one and depending on if the user is new or not, will either go to figure two to create an account or visit figure 3 to sign in with their existing account credentials.

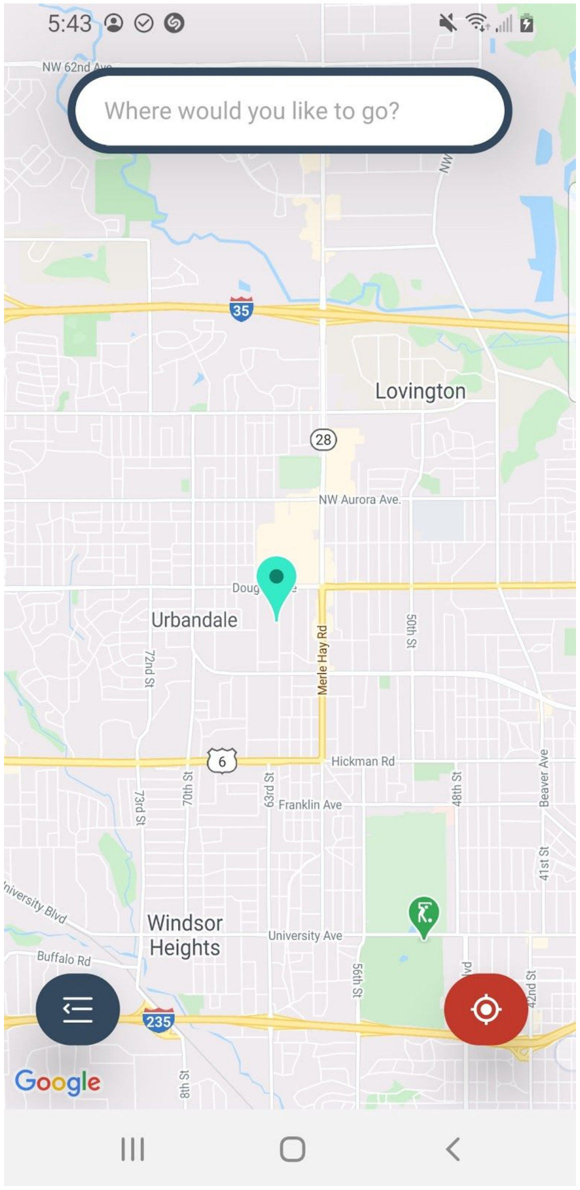


Figure 4: Home page of the app

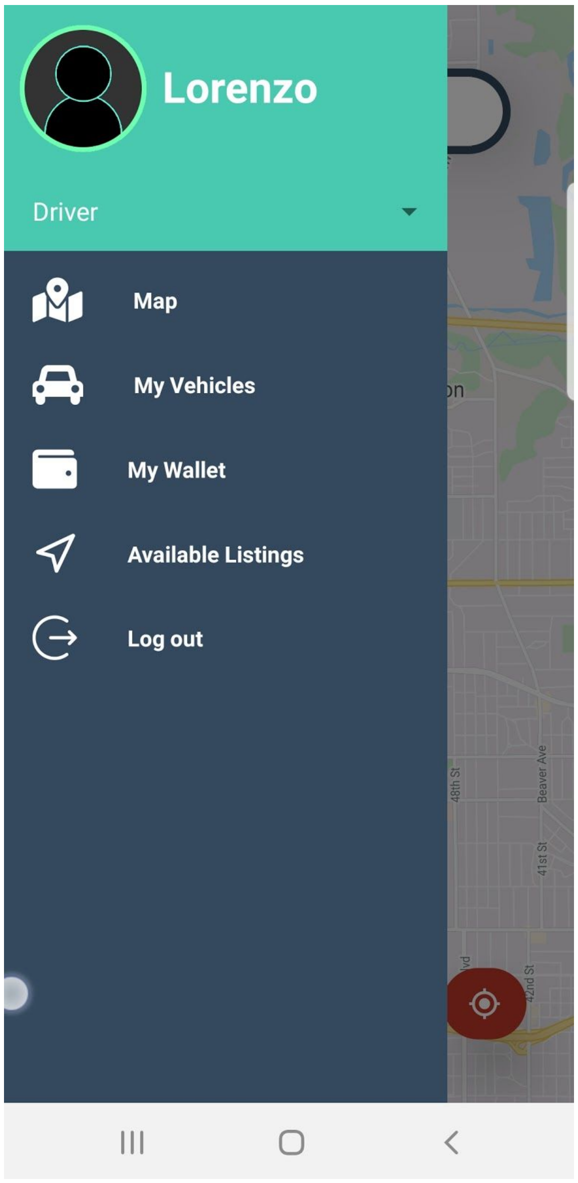
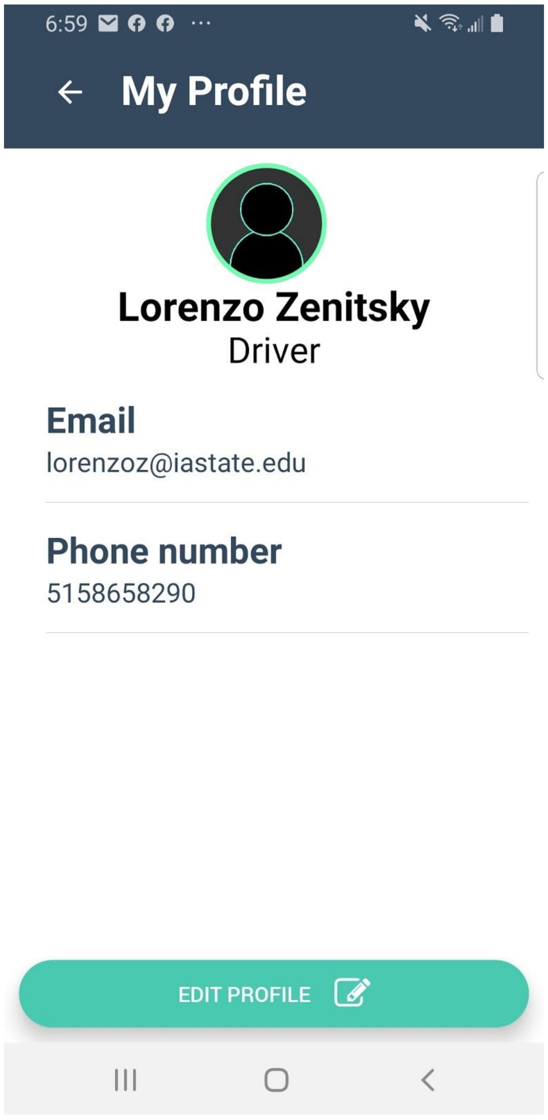


Figure 5: The drawer content for the app

Once the user logs in, they will initially land on a Google Map's view with a pin dropped at their exact location (after asking for permission, of course.) They can either tap the button to the left opening up the drawer, tap the button to the right to return to their initial location, or use the search bar at the top to find available listings within a 10-mile radius of the user's destination. Figure 5 contains the drawer content for a driver user. If a user is a host, there is a slightly different set-up.


6:59

My Profile

Lorenzo Zenitsky

Driver

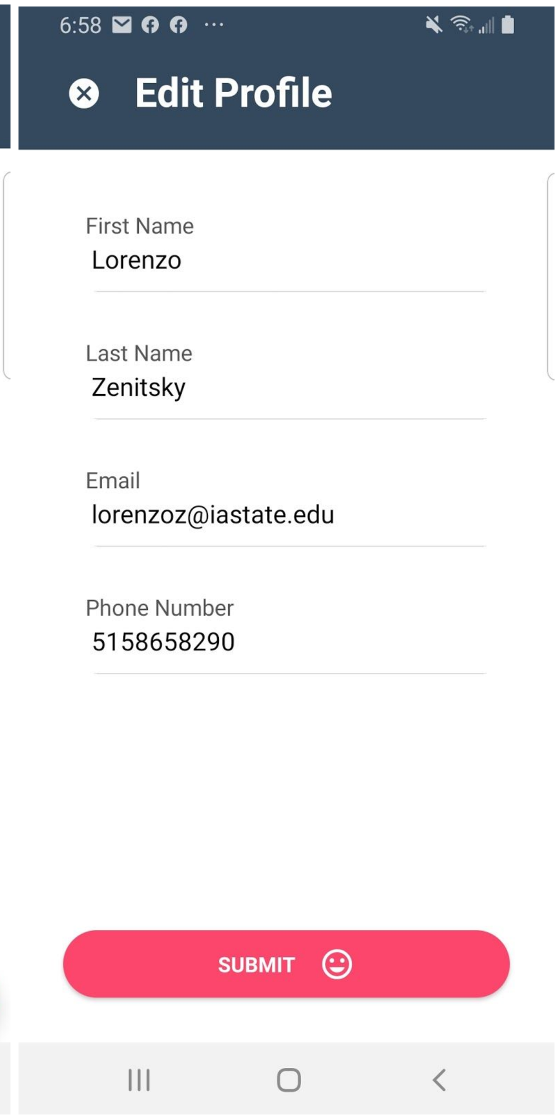
Email

lorenzoz@iastate.edu

Phone number

5158658290

Figure 6: Profile view for the current user


6:58

Edit Profile

First Name

Lorenzo

Last Name

Zenitsky

Email

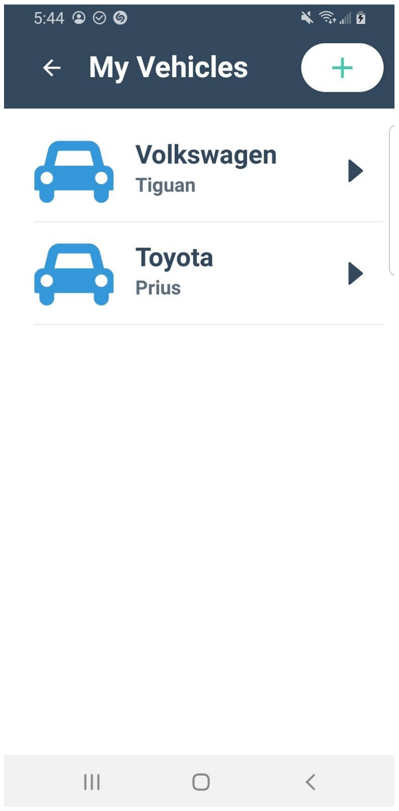
lorenzoz@iastate.edu

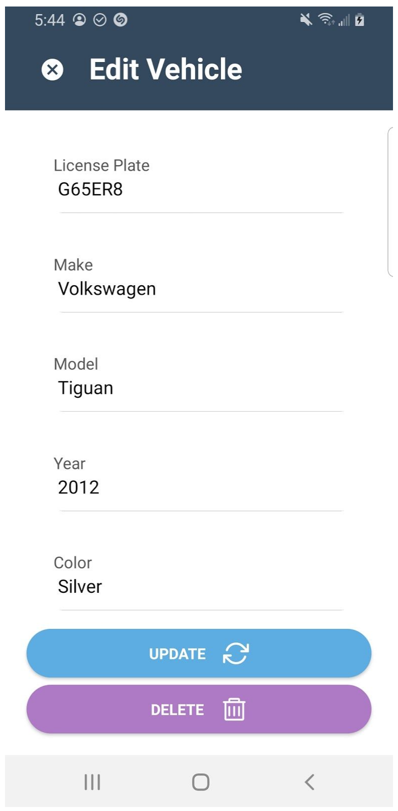
Phone Number

5158658290

Figure 7. Edit profile view for the current user

The above two figures are of the current user's profile page. The left is the main view and the right is the page they will travel to in order to make any necessary edits to their personal information.





License Plate
G65ER8
Make
Volkswagen
Model
Tiguan
Year
2012
Color
Silver

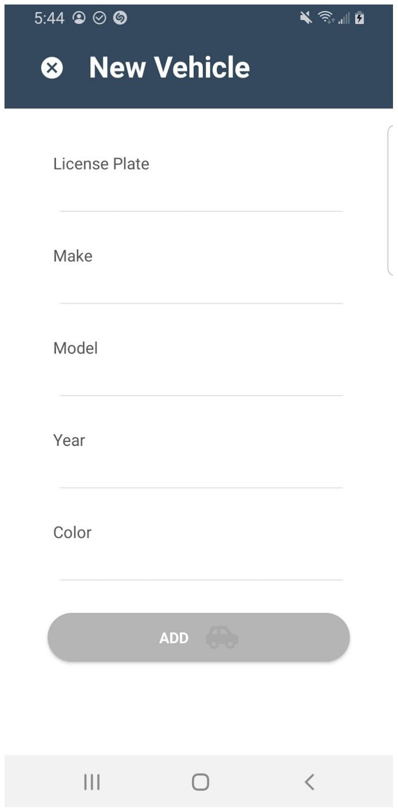


Figure 8: Main vehicle page Figure 9: Edit vehicle page Figure 10: New vehicle page

The above three figures are for the current user's vehicle page. The leftmost is a list of all the vehicles the user has added, the middle is the page is for editing/removing any vehicle they have added to their Parkour account, and the right most are the page they will land on when they decide to add a new vehicle.

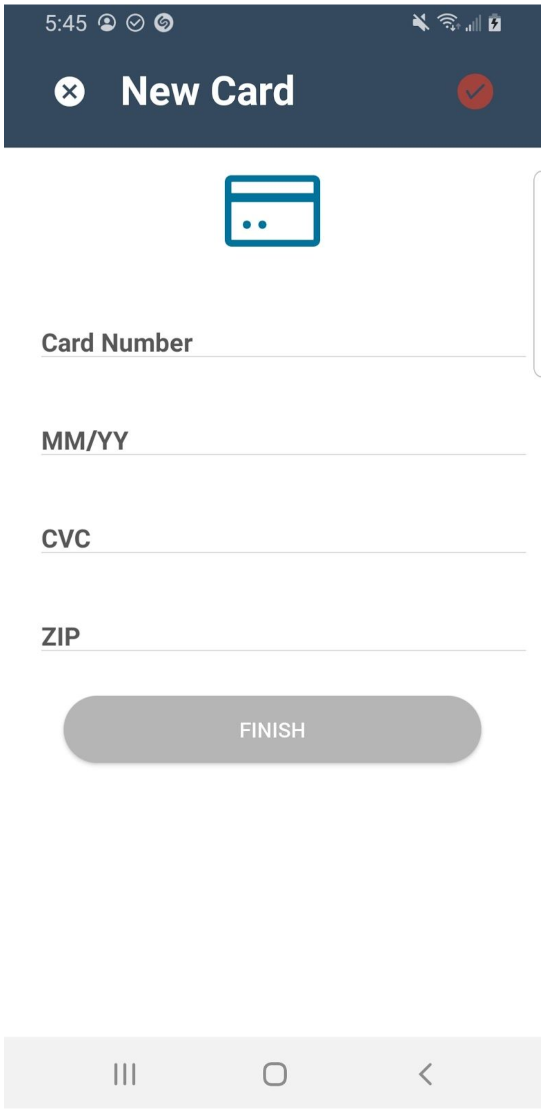


Figure 11: New card entry page

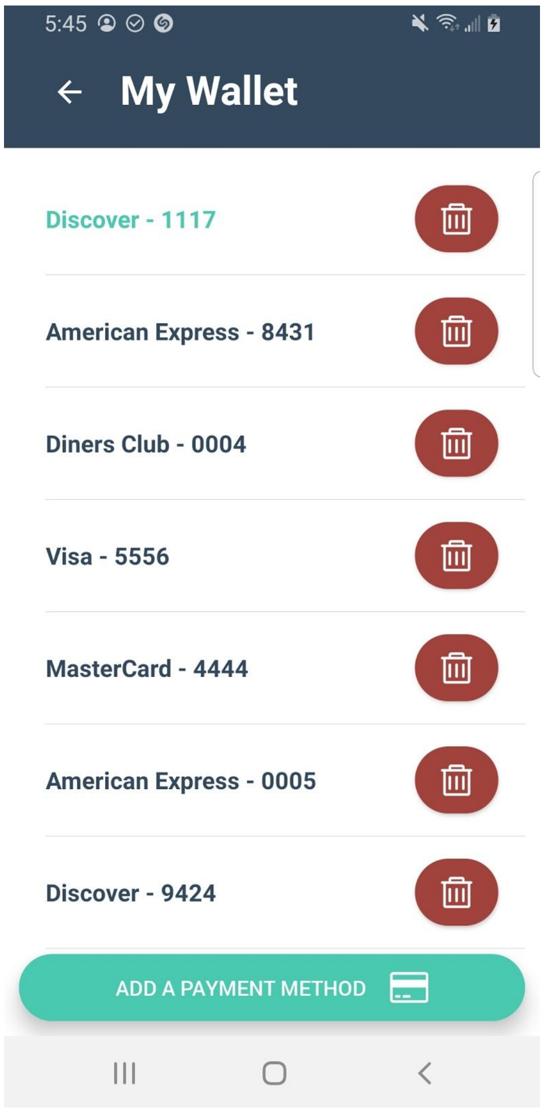
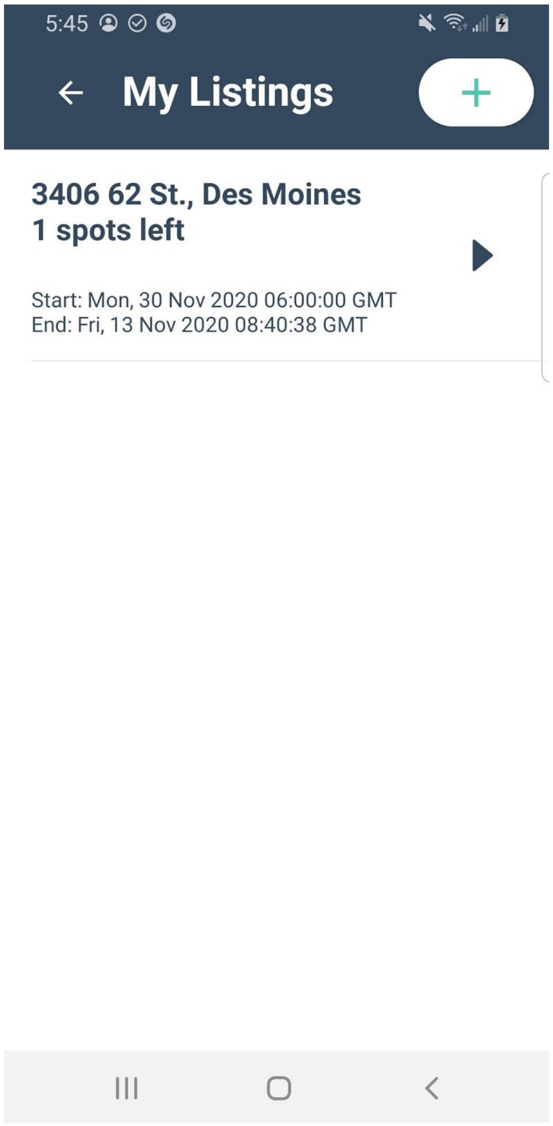


Figure 12: Parkour digital wallet page

The above two figures are for the user's Parkour digital wallet. When a user is registered, they will be giving a Stripe Customer ID so that they can maintain a digital wallet just for Parkour. A regular user will use the default card (colored in figure two as green) they have saved to pay hosts for parking, and hosts will use the wallets to collect payouts from drivers in addition to paying other hosts for parking if they so choose.



3406 62 St., Des Moines
1 spots left

Start: Mon, 30 Nov 2020 06:00:00 GMT
End: Fri, 13 Nov 2020 08:40:38 GMT

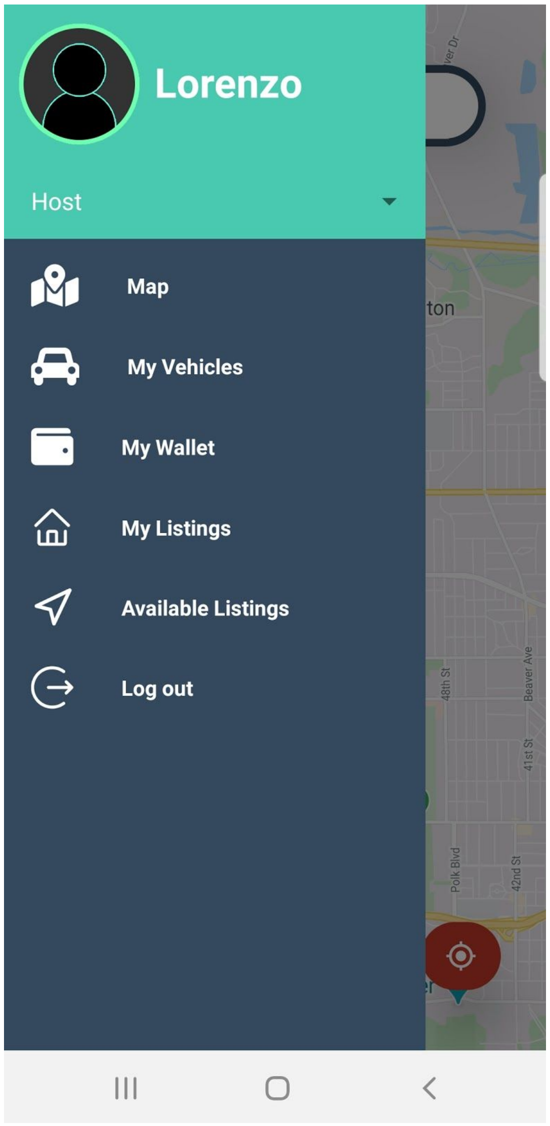


Figure 13: Host's listings page

Figure 14: Drawer content for Host

Figure 14 is the drawer content a registered host will see when they sign in to Parkour. The only thing different compared to a regular user's drawer content is the My Listings page. Hosts can go to the page shown in figure 13 to see all the listings they have registered with Parkour that are available for parking. They can then tap on said listings to edit any necessary information.

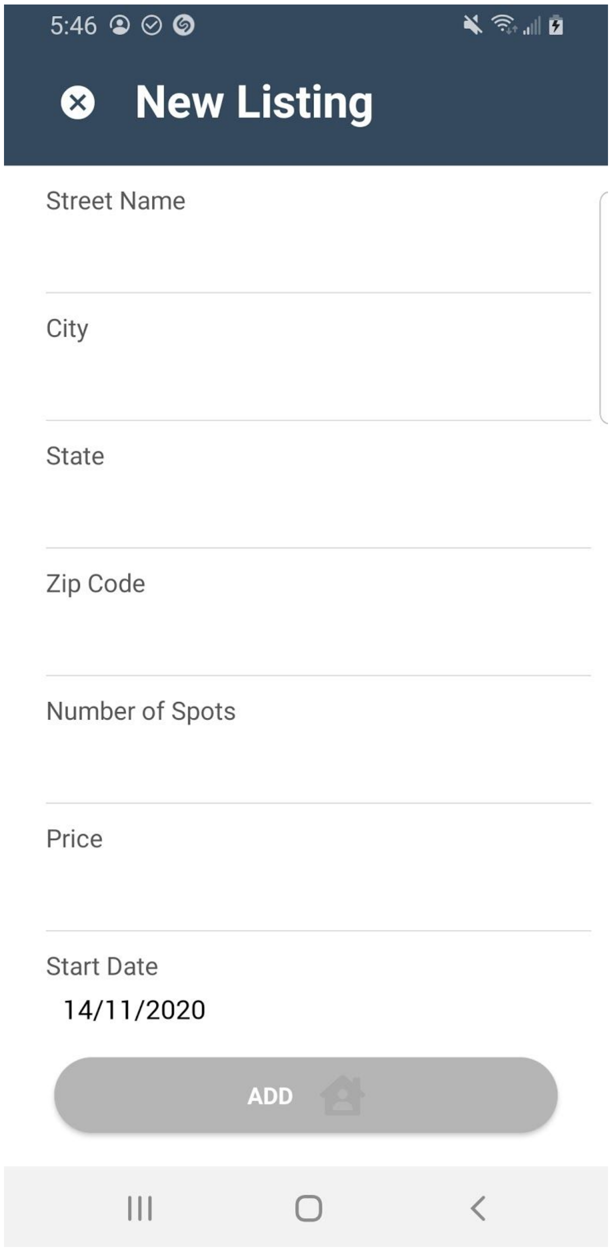
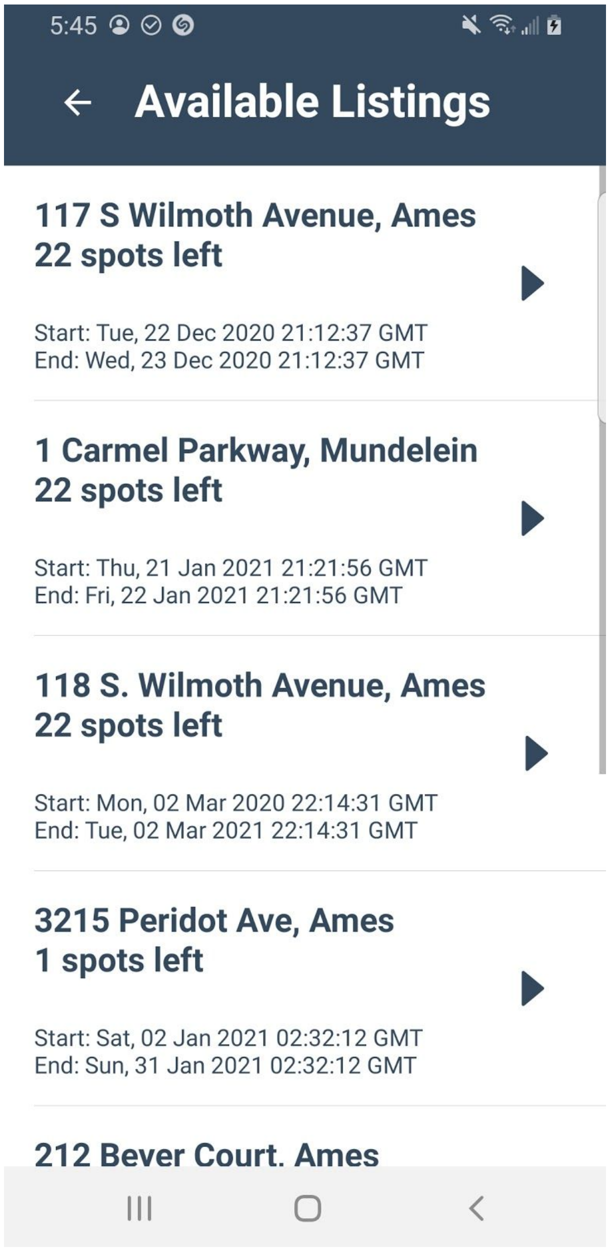


Figure 15: New listing page for Host



117 S Wilmoth Avenue, Ames
22 spots left
Start: Tue, 22 Dec 2020 21:12:37 GMT
End: Wed, 23 Dec 2020 21:12:37 GMT

1 Carmel Parkway, Mundelein
22 spots left
Start: Thu, 21 Jan 2021 21:21:56 GMT
End: Fri, 22 Jan 2021 21:21:56 GMT

118 S. Wilmoth Avenue, Ames
22 spots left
Start: Mon, 02 Mar 2020 22:14:31 GMT
End: Tue, 02 Mar 2021 22:14:31 GMT

3215 Peridot Ave, Ames
1 spots left
Start: Sat, 02 Jan 2021 02:32:12 GMT
End: Sun, 31 Jan 2021 02:32:12 GMT

212 Bever Court, Ames

Figure 16: List of available listings

Figure 15 is the page hosts will see when they wish to add a new listing to their Parkour account. The Rightmost figure is what all users can see as it is simply a list of all available parking spots registered in the app as a whole. Users may visit this page to browse the available parking spots or use the search bar on the home map page to search for a destination and then be sent to the page in figure 16 to see available listings within a 10-mile radius of their searched destination.

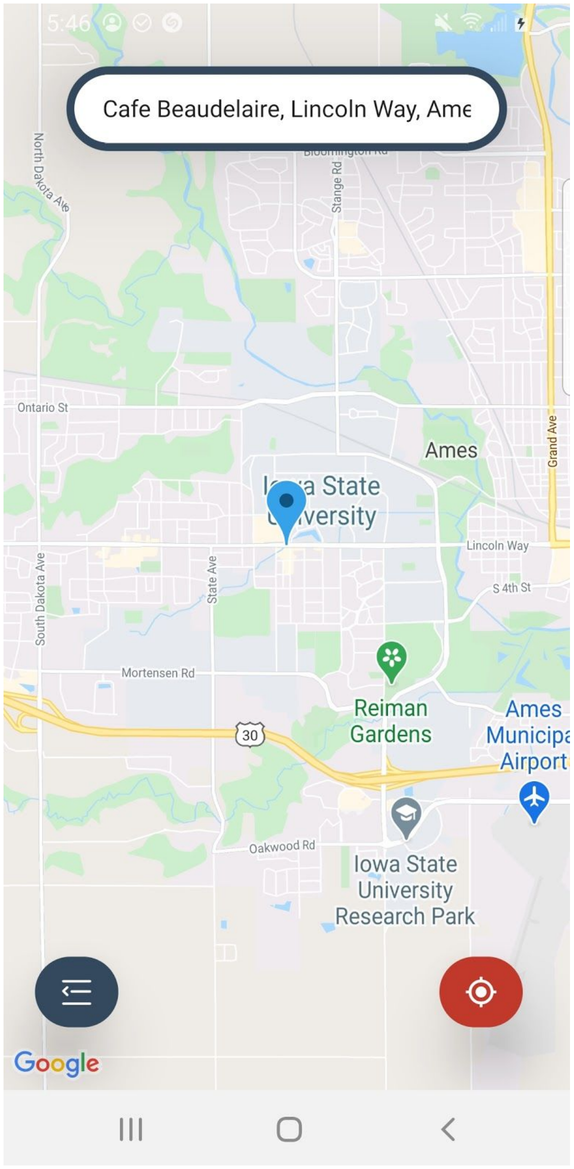


Figure 17: Home page with a dropped pin showing the user's destination

After a user searches for where they wish to drive, a blue pin will be dropped at their destination for reference and they will be taken to the listings page to see all available listings within a 10-mile radius from their searched destination.

3 Statement of Work

3.1 Previous Work and Literature

One similar iOS application in comparison to this project is Prked. This app was very similar to our idea, but it was very barebones in terms of functionality. It was posted on the Apple App Store at the very beginning of the spring semester. The application, despite frequent updates, continues to be very buggy and is unusable at this point in time.

We are basing our project on the paper “Collaborative-Aware Intelligent Parking System for Green and Smart Cities based IoT” that is written by our advisor. It has not been published yet but describes the parking system as it relates to game theory and optimization.

3.2 Technology Considerations

Since the project will be made up of two separate mobile applications (iOS and Android), our team wanted to find a technology solution that would enable us to create one application that could be exported to be used on Android and iOS. Therefore, we will be using React Native to develop the frontend. Ionic was also considered but React was ultimately chosen because of the better performance, its popularity in corporate environments, and community-supported codebase which features plenty of development resources and third-party libraries/frameworks.

The front end application will be connected to a single backend hosted on a web server. The team has committed to the MERN stack as our base set of technologies, but we may use other utilities and tools if necessary. Typescript is good for a large number of concurrent users for our frontend. The backend will also be connected to a database to securely store information needed for our application. The backend will be using NodeJS, MongoDB and Express as our core tools for development.

3.3 Task Decomposition

Our project is divided into a mobile (frontend) application, paired with a backend server that we will make requests to get user information and other stored data that might need to be stored in a database. Since we will have two separate projects going, the team will split up and simultaneously develop the front and backend.

3.3.1 Frontend Tasks

- Initialize the skeleton React-Native Project
- Sign up page
    - Establish a connection to the backend server
    - Make post request to the server to create user

    - Receive a response from the server
        - In the form of User ID and Session ID
    - Create the user interface
- Login page
    - Make a post request to the backend server
    - Receive a response from the server
        - In the form of User ID and Session ID
    - Create the user interface
- Home Page
    - Create the user interface for the map screen the users first see after logging in
- Navigation Bar/Menu
    - Create the component that allows users to navigate the application quickly
    - Create placeholder links for all of the future pages that will be added to the application
- Profile Page
    - Make a get request to the server to retrieve the user's information
    - Receive a response from the server with the user info
    - Create the user interface for the profile page
    - Fill out the user page with the information
    - Add an edit profile link in the profile page
- Payment Page
    - Connect the application to the Stripe payment APIs
    - Create the user interface
    - Send post to the server to log the payment occurred
- Post Parking Space
    - Send post request to the server to store the new parking space
    - Receive a response from the server
    - Create the user interface to post a parking space
- List Available Parking Spaces
    - Send a get request to the server
    - Receive a response from the server
    - Create the user interface for the page
    - Display the spaces retrieved from the database
- Reserve Parking Space
    - Make a post request to the server to modify the number of spaces on the backend
    - Receive a response from the server
    - Add a payment element to pay immediately
    - Create a user interface to reserve a parking space
- Show the Parking Spaces on a Map
    - Make a get request to the server to get available spots in the loaded area
    - Use a map API (Google Maps) to show the map
    - Plot the locations on the map
    - Provide directions to the selected parking location

- Create optional settings

3.3.2 Backend Tasks

- Initialize a skeleton Node.js project
- Setup a database to be used with the project
- Connect the backend server to the database
- Create a user model to be used in the database
    - Include the obvious items such as username, email, password, first name, password, phone number, jwt token, isVerified
    - Also include profile information
- Create a User Signup API endpoint in the backend
    - Create a POST new user API Route that will get triggered when a user signs up on the frontend
    - Create JWT Token and send them to the frontend to store
    - Encrypt user information
- Create a User Sign in API endpoint in the backed
    - Create the needed GET, POST, PUT, DELETE requests
    - Decrypt and verify user login
    - Send back if the user successfully logged in
- Create a Receipt API
    - Create a model to store Receipt objects
    - Create the needed GET, POST, PUT, DELETE requests
    - Store the receipts in the database, link the receipts to users through their ids
- Create a model for the spot locations
    - Include address, and maybe coordinates
- Create a model for a listing
    - Include user that posted the listing
    - Include pricing and stipulation information
    - Include the location object
- Create the Parking API
    - Create the needed GET, POST, PUT, DELETE requests
- Create additional query options

3.3.3 Administrative/Misc Tasks

- 491
    - Biweekly and weekly reports (as requested by the advisor/client)
    - Publish Design Document Version 1
    - Publish Design Document Version 2
    - Publish Design Document Version 3
- 492
    - Biweekly and weekly reports
    - Prepare project poster

  - Present the project
  - Create Final Report

3.4 Possible Risks and Risk Management

There are many risks associated with this application. An early risk was how to securely handle payment information. We mitigated by deciding to use a third party API to set up payment through a well-established company. Users will be given the option of using Stripe, which supports Google Pay, Apple Pay, PayPal, Venmo, or Amazon Pay. This helps our consumers to use a familiar payment method and it helps our team by not having to worry about huge security risks.

The second big risk is the liability that is associated with involving vehicles. There will have to be very strict language in our terms and agreements for users of the application to absolve us from any fault if there is an accident or theft of service. Currently, instructions for owners are being devised if, for whatever reason, a vehicle is left at their parking spot longer than the agreed-upon time.

The next risk that our team has thought through is how to verify users. This would be to keep all users accountable and safe while using our product. The plan is to ask for personal information such as a driver's license number for the owners. We will also ask for the license plate number and other identifying information about the car from the renters, so an owner can verify that the correct vehicle is parked in the agreed-upon spot.

The last and most recent risk associated with this project is COVID-19. There is a lot of uncertainty about how we will be able to communicate with the team as well as work on documentation, development, and testing online. Currently, we all have access to the internet for communication, but we will need to continue to work together to overcome any and all issues that crop up during this project. Our plan was to test our prototype in the fall, but if the situation persists then we may not be able to use our app alongside some events such as football games. Events may be canceled due to COVID-19 health protocols. For the safety and health of users, we will not be attempting to demo the application with a large user base. We were not able to make the milestones past November 30th due to the shortened semester. We were able to work ahead and finish up things that we planned to develop late November to early December. Testing was not as in depth as possible due to running out of time.

3.5 Project Proposed Milestones and Evaluation Criteria

Here is a list of milestones for our project:

Proposed Milestone	Checkpoint Date(s)	Evaluation Criteria
Establish team roles and expectations	January 16th	The team has a set of clear expectations and roles.
Requirements Gathering	February 16th	Full understanding of what our application may need or potentially need is fully understood. Minimize the need to spend extra time researching further technologies.
Present Project Plan via presentation and design document	March 8th	Powerpoint slide that entails all required details of our project. Design document has a start on how everything will be planned out.
Transition from research to learning respective technologies	April 2nd	Everybody has gone through some tutorials regarding the project and did further research if needed. Having a basic familiarity with the technology/language they intend to use for development.
Finish User API development	August-September	The user has a functioning login system and attributes are logged in the database.
Delegate multiple tasks and begin implementing features	September 15th	User API development is fixed, now can begin implementing everything else.
Work on implementing Maps API	October 9th	Maps are integrated into the home screen, and users can see locations on the map. Users can publicly post their locations on a global map.
Property Posting and verification APIs implemented	November 15th	Properties are posted and APIs can verify whether they are legitimate properties or not.
Payment APIs working	November 30th	Hosts and guests should be able to securely transfer payments between each other and accurately keep track of how much is being paid through Stripe.
Project Debugging	December 9th	The application will go through automated and manual testing. The application should not have any bugs or

		issues and be dealt with during this phase.
Prototype	December 10th	The working prototype of the application and all of the existing features work as expected. Hosts should be able to post their properties and guests should be allowed to make a reservation with the host.
Final Presentation	November 19th	The application will be demoed and ready for presentation. Other presentation visuals such as PowerPoint will be available.

Table 1: Proposed milestones

We may change or modify some of the dates or the order on how these tasks will be completed as we see fit within the scope of our project.

3.6 Project Tracking Procedures

Our team will work in an agile environment to track our procedures. We meet weekly to discuss what goals have been met and how the team is keeping up with the timetable that we have built to finish all tasks in time. We divide work up into manageable weekly sprints to ensure high morale and effective communication. Our team will be using GitLab tracking to manage our progress throughout this project. We will be working with GitLab over other project tracking systems because all team members are already familiar with how to use it.

3.7 Expected Results and Validation

Our application must be able to:

- Successfully allow a guest to download the app to their mobile phone.
- Allow said guests to either host or find nearby parking spaces via the app.
- Provide a reservation to the host saying the guest wishes to park at their location
- Allow the host to verify the guest and their identity and set certain guidelines for said guest.
- Securely exchange and validate payment between host and guest through Stripe
- Automated Testing is successful

4 Project Timeline, Estimated Resources, and Challenges

4.1 Project Timeline

First, our team will do research on what technologies and options that are available to us. We had the choice of either doing an API or building a new app from the ground up.

First Stage (January 2020 - March 2020)

- Familiarize team members with one another
- Work on Design Document
- Gather requirements
- Research technologies for frontend/backend

Second Stage (August 2020 - October 2020)

- Work on implementing application
- Create APIs on the backend for the app to interface with
- Create iOS and Android applications
- Connect MongoDB DBMS with backend server
- Establish a working connection between server and apps
- Implement all important features for applications

Third Stage (October 2020 - End of Project)

- Fix bugs and refactor code design
- Create a working prototype
- Recruit users for testing purposes
- Test application for football games in the fall
- Implement security features for server and applications
- Implement other miscellaneous features in applications
- Continue to improve reliability and efficiency of applications

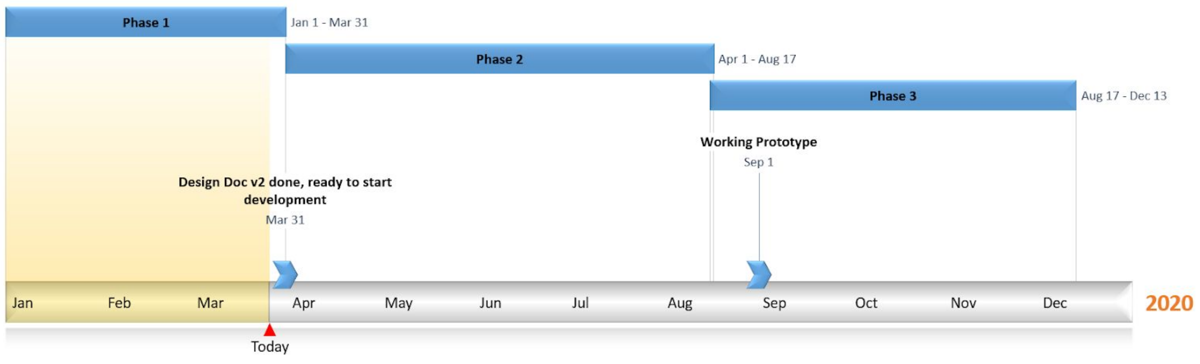


Figure 18: Gantt chart for the schedule. On further review, the third stage was shorter due to a shortened semester

4.2 Feasibility Assessment

By December 2020, this project should be a full stack mobile application anyone can download and use off of the Apple or GooglePlay store. The application's frontend should be refined, easy to use, and professional. The backend should process API calls quickly, and securely.

Realistically the team believes that all of the functional goals are attainable by the above date. The team expects there could be issues with verifying homeowner's identities and proving they own the property they are listing, but large scale applications like Airbnb do not do this type of check so the team will find a solution as more important function requirements are finished.

4.3 Personnel Effort Requirements

Task	**Description**	**Time (hours)**
Research frontend and backend technologies	The frontend technology would need to allow for a fast, high performing UI for a mobile application. Our backend will need to store user and application data.	20+
Research payment options	Payment processing and handling options for users an	10
Come up with solutions for handling user interactions	Handling interactions that might pose as a liability, such as parking for longer durations than allocated.	30
Learn the respective frontend/backend's syntax, framework, or language.	This will depend on individual experience with the chosen languages/frameworks we are working with. Most of us may not be familiar with these languages, so we need to familiarize ourselves with it first.	20
Construct frontend UI	Develop an easy to use UI for the mobile app.	70
Construct backend server	Develop a backend server that would communicate with the frontend and store user/app data.	50
Frontend + Backend testing	Ensure that frontend and	20

	backend are both communicating properly	
Frontend and backend debugging	Check for bugs within the application.	40
Creating Virtual Machines and configuring them with our backend.	Setting up a virtual machine to host our server. Configuring and ensuring the backend server works within the VM with our frontend.	30
Deploying the VMs to a hypervisor or managing VMs	The virtual machines will need to be deployed to a hypervisor.	5
Configuring the server(s) to work with the virtual machines	Once we finish finding the servers and setting up the virtual machines.	10+
Beta testing	Testing of the application in our local environment, ensuring the behavior works.	30
Deploying the application to the Google Play/App Store	Publishing the app could take time, depending on how each store processes their apps.	7-14 days
Live testing	Once all the servers and applications are deployed, we can test it with a live group of users if possible.	20

Table 2: Personnel Effort Requirements

4.4 Other Resource Requirements

No additional resources.

4.5 Financial Requirements

A few financial requirements include:

- Server costs
- Cost of publishing our app to the Google Play and App Store
- Verification + Google API costs

From an economic standpoint, the project will have to include the functionality to carry out monetary transactions for the users of the two mobile applications. To facilitate these transactions, all of which cost developers a small fee, integrations with popular payment options like PayPal will be needed. Also, the integration of software like Google Maps will eventually cost us a small fee to use because more often than not, companies charge based on the number of calls to their APIs. Second, the cost of publishing our app to the Google Play Store for Android devices includes a one-time fee of $25. On the other hand, Apple charges a yearly fee of $299 for a group of developers to publish their app to their App Store. Lastly, we will be using servers for hosting purposes. For now, we are only concerned with hosting our product in Iowa, so our server costs will be next to nothing. However, if we ever choose to expand our scope to accompany other regions of the country and/or the world, we will be subjected to much higher server costs.

5 Testing and Implementation

5.1 Interface Specifications

Since our project is software alone, we will have an iOS and Android application with a backend server. We will have no hardware aspect of this project. Because of this, we do not have to worry about hardware interfacing.

5.2 Hardware and software

Our project is only software-based, because of this there are no required hardware specifications. The team will be testing the frontend on Xcode and android studio, and the backend will be tested using visual studio code with simple test cases.

5.3 Functional Testing

5.3.1 Frontend

We will be using Jest for functional UI testing because it can help with testing TypeScript. Additional testing to carry out similar tests that we would be doing using Mockito if we were using Java. Because we are not using Java, we will use Jest for React framework testing.

5.3.2 Backend

On the backend, we will also be using Jest for backend API testing.

5.4 Non-Functional Testing

5.4.1 Frontend

On the frontend, we will be using simple, manual user testing to test accessibility, how user-friendly the app is, and its response time.

5.4.2 Backend

The main requirement the backend will be testing is the speed in which the backend communicates with the frontend, and how long the backend takes to communicate with the database. To test the speed of communication between the server and the frontend application, as well as the speed of querying the database, we will set up automated tests similar to the integration tests in section 5.3.2. In each of these tests, we will simply start a timer at the beginning of each test, then mock an API call, or query the database. After the API call, or query is complete the test will output the total time taken for the test, which we can analyze and optimize if needed.

5.5 Process

Below is a simple flowchart that demonstrates our process on our testing plan.

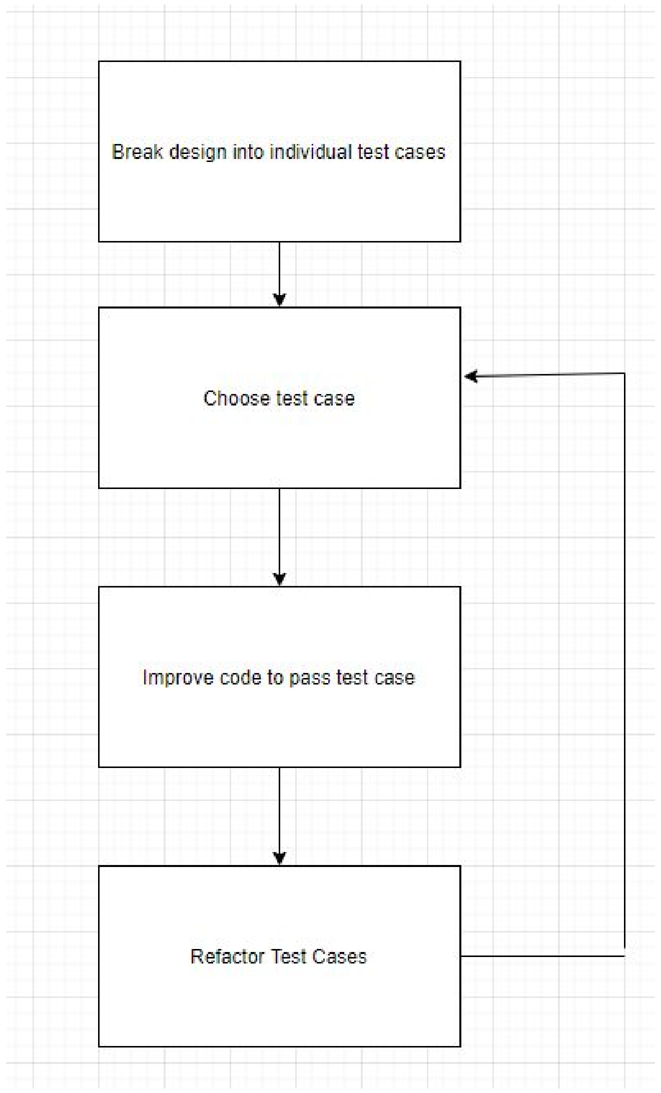

Break design into individual test cases
Choose test case
Improve code to pass test case
Refactor Test Cases

Figure 19: Testing plan

Our testing plan follows the Test Driven Development software development process. In this process, requirements for the project are broken down into different individual test cases. This is so that everything that is created so far can be measurable. After this, code is redesigned for each test case so that the test case passes. Once the developer does this for a number of requirements, the tests are refactored and the process is completed again. This is so the tests get more detailed and the code gets much more secure.

5.6 Results

Since we're using React Native, we expect to have a high performing application that performs on Android and iOS. The UI navigation should map to the proper pages and navigate to the correct locations. The backend needs to properly store user data securely and efficiently within a time period. Since we are using Stripe API to deal with transactions and payments, we don't expect to store sensitive data (i.e. credit card info) on our databases.

At a user level, the application should have a simple functioning login system where they can register as a host or guest. Both users need to be able to switch between roles and have different levels of permissions based on their roles. Some of the results we should see include:

The host should be able to:

- List their property and location on the map
- Manage and see the guests parked at their property
- See guest information, such as plate numbers, car models, names, etc
- Securely receive payment from guest users

The guest should be able to:

- View a list of **verified** hosts on a map
- Create a reservation for their parking spot
- Securely provide payment to the host through Stripe API

6 Closing Material

6.1 Conclusion

Our project aims to reduce the stress of parking at big events such as fairs and concerts by providing an alternative to both popular commercial parking apps by giving users the ability to park on a host's residential property instead of the hectic chaos of more populous areas such as cities. To accomplish this goal, we are planning on developing a React Native mobile application and deploy it to both the Google Play Store for Android and Apple's App Store for iOS. For next semester, we plan on developing new functional versions of the project through one-to-two week sprints adhering to the Agile methodology framework of Scrum. Throughout these one-to-two week sprints, we will keep up-to-date with one another through weekly online stand-up meetings to ensure that every team member is on the same page with each other and confident on the tasks that they must accomplish in any given sprint iteration. The project will prove to be a success only through rigorous and ongoing integration between testing and development to ensure a properly working deliverable after each sprint. Our ultimate end goal is to develop an application that will provide to its users a different approach to modern parking apps that will not only help reduce stress and save both money and time but will also help strengthen the community bond between users.

6.2 References

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(PHY) Specifications," *IEEE*. [Online]. Available: https://standards.ieee.org/standard/802_11-2016.html. [Accessed: 24-Apr-2020].

[6] "802.21-2017 - IEEE Standard for Local and metropolitan area networks--Part 21: Media Independent Services Framework," *IEEE*. [Online]. Available: https://standards.ieee.org/standard/802_21-2017.html. [Accessed: 24-Apr-2020].

6.3 Appendices

6.3.1 Operations Manual

6.3.1.1 Prerequisites

To run the application on iOS, you must have a Mac that has the latest version installed along with XCode installed. You will need to ensure that you have an iOS emulator installed within XCode. You can download XCode from the Apple App Store. If you are on Windows, you will need to set up a VM on iOS for Windows. Currently, Windows does not have XCode available for download.

To run the application on Android, you will need to have Android Studio installed. You will need to set system variables and have an emulator downloaded. Every system has different configurations, so you will need to refer to the getting started guide created by the React Native developers. This is the easiest way to set up the development environment in Windows. Mac users can follow the same steps.
Once you have your chosen emulator(s) set up, you will need to install Visual Studio Code. This software is completely free and runs on any operating system.

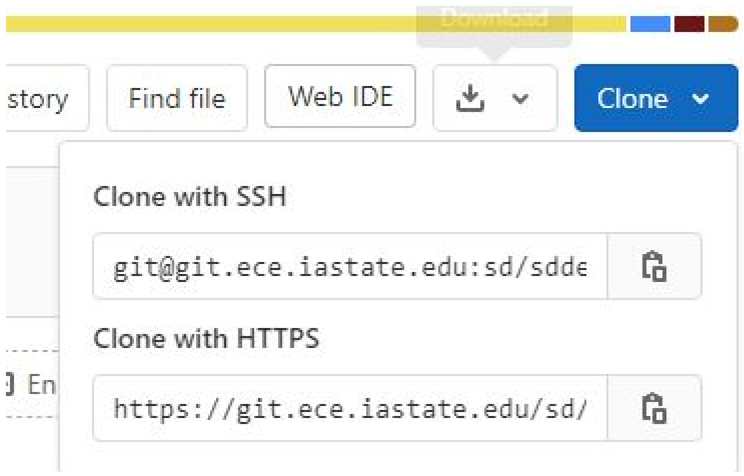
You will need to download the following dependencies, frameworks, and utilities in your project:

- NodeJS: https://nodejs.org/en/
- Express: https://expressjs.com/
- MongoDB: https://www.mongodb.com/
- Jest: https://jestjs.io/

There may be a few additional extensions you can install within VS code that may be helpful to your development. It is not required but provides quality of life features.

To get the code, you will need to have a GitLab account, and you can access our repository here: https://git.ece.iastate.edu/sd/sddec20-20

Copy the clone with HTTPS link



Clone with SSH

git@git.ece.iastate.edu:sd/sdde

Clone with HTTPS

https://git.ece.iastate.edu/sd/

Using git bash, Linux for Windows subsystem, or the terminal (on Linux/Mac), navigate to any directory you wish to store the project in and run:

```
$ git clone https://git.ece.iastate.edu/sd/sddec20-20.git
```

This will provide a copy of our project to you. Within Visual Studio, click on **File < Open < sddec20-20**.

Open a terminal by clicking *Terminal*, then *New Terminal*. Within that terminal, you will need to type in:

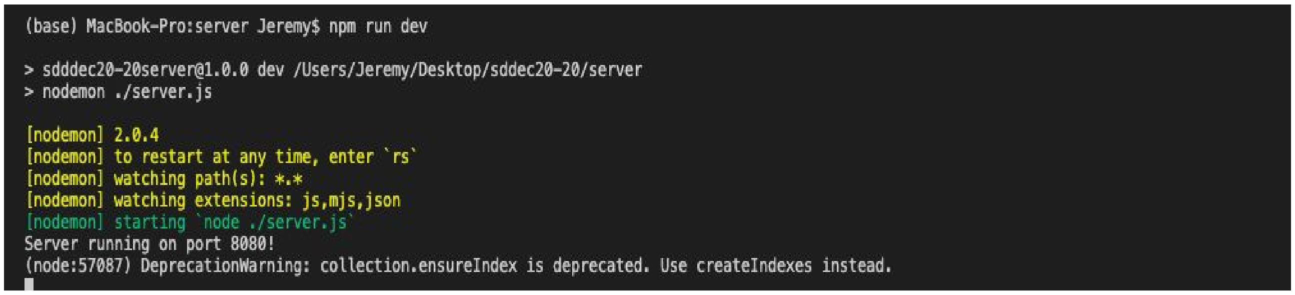
```
$ npm i
```

This will install all the packages and dependencies that are required to run this application. It may take about 5-10 minutes to install. Now run:

```
$ cd server
$ npm run dev
```

This will start the server.

You should see something like this:



```
(base) MacBook-Pro:server Jeremy$ npm run dev

> sdddec20-20server@1.0.0 dev /Users/Jeremy/Desktop/sddec20-20/server
> nodemon ./server.js

[nodemon] 2.0.4
[nodemon] to restart at any time, enter `rs`
[nodemon] watching path(s): *.*
[nodemon] watching extensions: js,mjs,json
[nodemon] starting `node ./server.js`
Server running on port 8080!
(node:57087) DeprecationWarning: collection.ensureIndex is deprecated. Use createIndexes instead.
```

Create a new terminal using the steps mentioned previously. Now, navigate to the frontend folder:

$ cd ..
$ cd frontend

For iOS, you will need to install your pod repository (These contain dependencies specifically for iOS, and you may need to install Ruby if needed):

$ cd ios
$ pod install

You will then begin downloading iOS dependencies.

For iOS run the app using:

$ npx react-native run-ios

For Android, type in:

$ npx react-native run-android

Your emulator will begin running and compiling. You can choose to sign in as an existing user or create a new user if you do not have an account.

In order to connect to the server, you will need to create a .env file in your project. This helps you automatically connect to the server without having to specify or constantly modify your IP address within the code. Create two .env files in the frontend and backend.

A sample .env file for the frontend can be found below:

```
REACT_APP_IP_ADDRESS=<YOUR IP ADDRESS HERE>
API_KEY=<API KEY GOES HERE>
```

Below is the contents of the .env file for the backend: (This IP is our server)

```
DB_IP=10.24.84.169
```

For API documentation, please visit this link. (You may need a Postman account)

6.2 Alternative/other initial versions of the design

Another alternative solution was using Flutter, which is Google's UI toolkit for building applications. This toolkit uses the Dart programming language, while React Native uses JavaScript. Our team, however, was not familiar with Flutter and it still left us to choose what database and other technologies that are needed. Flutter was similar to React Native since it allowed development for one platform.

Developing separately on Android Studio and XCode (iOS) was another consideration our team had. We chose not to develop this way simply because only two of our team members owned a Mac for iOS development. Having to concurrently do development and keep everything consistent between two different platforms would be time-consuming.

While doing research, we felt that the MERN stack fit our needs best. It is a commonly used set of technologies that are used within mobile development, and it includes frontend/backend needs. Some of our members already had a good understanding of JavaScript and React from other courses, side projects, and internships.

An initial plan for Stripe Integration was to use their pre-built UI components that could take care of having a user add a new card to their wallet, assist them through checkout, and onboard a host. However, what we failed to realize upon choosing Stripe as our preferred solution for payment integration was that pre-built React web components do not play nicely with React Native. React web components require a Node.js runtime environment and while we had that in the backend, we did not have an environment for web components on the frontend. This realization and our subsequent solution to build out these components ourselves pushed us back quite a few pegs and slowed down our development speed by having to create a great deal of components and screens that we initially didn't plan on building. In addition to building all new components for our React Native frontend, we moved all Stripe API calls to our backend and made our own endpoints for each Stripe call. This way, the API calls would be coming from a Node environment and be communicating return data with a frontend that won't crash due from having non-native UI views.

6.3 Other considerations

COVID-19 heavily affected our ability to test our application on a large scale. Initially, our plan was to test our application with a large user base during an event at Iowa State University (such as the football game). We wanted how the interaction between posting and reserving parking would work, along with our payment. To combat this, we ended up using Jest for automated testing. We may need to do more extensive manual testing in order to see how our application performs. Features such as user verification, and property verification may need to be cut out. While we do want to have a high level of responsibility and accountability between users, we will need to cut out some features that enforce this. The time we have for developing this application may not suffice for all our needs, so we will focus more on testing and the core functionalities of the application.