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| The University of Hong Kong  Faculty of Engineering  Department of Computer Science  COMP7704  Dissertation Title  A Smart Phone Application for Valet Parking  Submitted in partial fulfillment of the requirements for the admission to the degree of Master of Science in Computer Science  By  LUO Xianyang  3035237420  Dr. T.W. Chim  Date of submission: 30 / 11 / 2016 |

Abstract



**Declaration of Candidate**

I, the undersigned, hereby declare that the work contained in this thesis is my own original work, and has not previously in its entirely or in part been submitted at any university for a degree.

Only the source cited in the document has been used in this draft. Parts that are direct quotes or paraphrases are identified as such.

I agree that my work is published, in particular that the word is presented to third parties for inspection or copies of the work are made to pass on to third parties.

The University of Hong Kong,

LUO Xianyang

Acknowledgments

I would like to thank~

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1. **INTRODUCTION**
   1. **Background Information**

Nowadays a lot of people will go to clubs for dinners, after-work drinks or having fun with friends. Since Hong Kong is an International and fast-tempo city, it is rather common for citizens to go to places like Lan Kwai Fong after a day’s work or at weekend. It is convenient for customers to drive their own cars to the hotels, clubs or bars. But as a matter of fact that Hong Kong is one of the most crowded cites in the world, it is not easy for drivers to find a parking lot quickly.

Valet parking service can help customers park their cars. It is offered by some restaurants, shopping malls, clubs and so on. A person called valet will drive a customer’s car to parking lot when the customer arrives at the gate of the hotel and return the car when the customer leaves. The main advantage of valet parking is convenience. On one point, customers do not need to find a parking lot by themselves. On the other point, they do not have to walk a long way from the parking lot to the hotel, which saves lots of time. All they need to do is just dropping their cars at drop-off point.

However, in such a fast-tempo city and such a high-tech era, some problems of traditional valet parking for a customer are:

1. must use a valet parking ticket to redeem their cars. If the ticket is lost, customer need to prove that the car belongs to him or her by showing driver license or identity card
2. may do not know where is the drop-off point for a certain hotel, restaurant or clubs and may take time to find it
3. do not know current status of the car

To solve these problems, I would like to develop a mobile application for people in Hong Kong to use valet parking service easier and more efficient.

* 1. Project Description

This project mainly focuses on help drivers enjoy better valet parking service. A customer can register our service via its phone number. After adding a new car by inputting plate, brand and color, he or she can choose a parking lot and generate a QR code. When a valet scans the QR code successfully, the order will be generated and the customer can use the phone as a valet ticket. Whenever the customer wants to get the car back, he or she can just click the “recall” button. Then our valets will return the car back to the customer.

This project has three parts and functions are as follows

1. iOS version application for customer
   1. allows a user to register, login and reset password via phone number
   2. allows a user to add a new car, edit an existing car and delete a car. Information like plate, brand and color are requested
   3. allows a user to generate order by choosing parking lot and car
   4. allows a user to get the car back by just clicking a button
   5. allows a user to view all the historical orders
2. iOS version application for valet
   1. allows a valet to login and reset password via phone number
   2. allows a valet to add an order by scanning the QR code generating by a user
   3. allows a valet to view all the opening orders
   4. allows a valet to end an order by just clicking a button
3. server and database
   1. processes all the http request and sends a proper response back to phone
   2. stores data safely of all users, valets, cars and orders sends notification to a user then an order has been generated and ended successfully
   3. Project Objectives

Since the traditional valet parking service has matured, so the app need to be more attractive to gain users. We have to follow the current trend of design, follow the guideline of user interface design and take some of them into consideration to fulfill the goal, which is Shneiderman’s Golden Rules of Interface Design[1], Jun Gong’s Guideline for Mobile Application[2] and Nurul’s Threes Layers Design Guideline for Mobile Application[3].

Apart from user interface, the app should be rather easy to use. Users do not to do lots of setting or follow a complicate guideline to generate an order. There are some mobile applications in the market with similar purpose like Meibo, Youbo and so on. After analyzing those applications, I found out that they were not that easy to use. Since there are a new technology in iOS called 3D touch which brings a new powerful dimension to Multi-Touch interface, users can enjoy the best convenience while parking their cars. Also, it is rather innovative if there is an Apple Watch application cooperating with application on the iPhone.

The final goal of this project is to change the traditional valet parking service by attractive and innovative features so our objectives can be conducted in three aspects:

1. attractability: to attract users, the application should have friendly and beautiful user interface, reasonable layout and overall clean look.
2. innovation: users are more willing to use the application by using new technology like 3D touch. This project allows user to enter the “parking now” and “current orders” views from the icon which makes it rather convenient and enjoyable.
3. connectivity: a user may enjoy more convenience if he or she has an Apple Watch. The all the parking and recall request can be done through Apple Watch. A user do not even need to take his or her phone out the pocket.
   1. Summary of Chapters

Chapter 1 firstly introduces the background and motivation of this project and then gives brief introduction and objectives of this project

Chapter 2 firstly introduces two similar mobile applications in the market and analyze the advantages and disadvantages.

Chapter 3 design blaalala

Chapter 4 implementation balalallala

Chapter 5 conclusion balalaalal

1. **RELATED WORK**

To develop a successful application, we need to refer to the existing applications and see if how we can do it better.

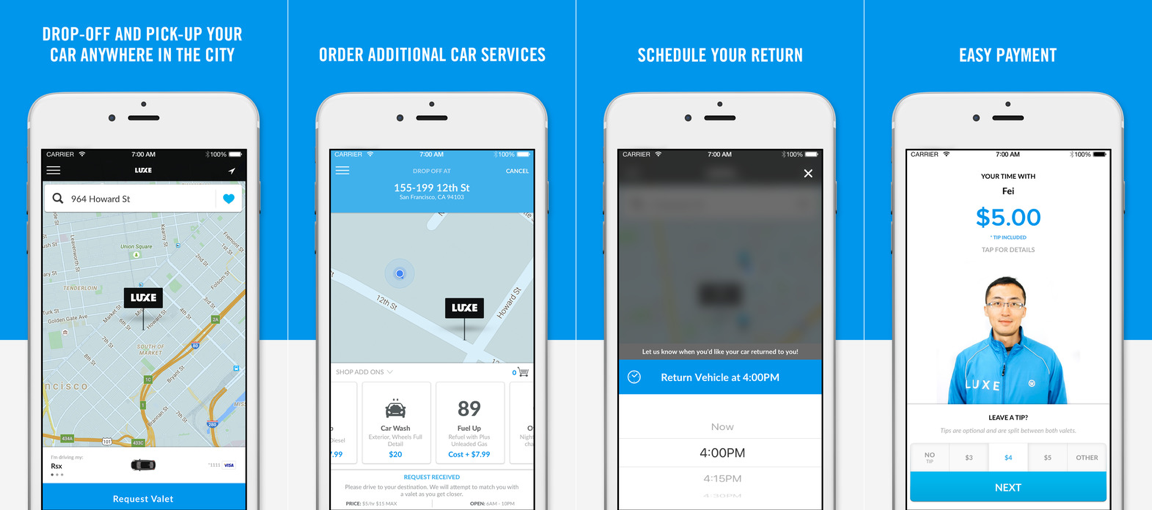
In this part, I will introduce two mobile applications offering valet parking service in the market. The first one is Luxe, which is available in American and then Youbo in China. I will firstly give a brief introduction and analyze the advantages and disadvantages of both applications respectively.

* 1. Luxe

<http://www.luxe.com/>

Luxe is a valet parking app available on both iOS and android. It is currently available in San Francisco, New York, Chicago, Seattle, Austin and Log Angeles. Figure 2-1 shows demo pictures for Luxe.

Figure 2-1 iPhone Screenshots for Luxe



After trying Luxe a few days, I found the advantages and disadvantages as below:

Advanages:

1. the user can drop off and gets returned anywhere and a valet will wait at the drop point. This is the best experience for a valet parking service. The user saves time since he or she does not need to find a certain drop-off point
2. the user can pay for the service using its phone, which makes it a Uber-like application. All the process can be done by the application.
3. the user interface is attractive and modern

Disadvantages:

1. the application does not use new technology like 3D touch and does not offer Apple Watch application
2. the register process is rather complicated, which requires both email account and phone number
3. all those service are only available in the USA
   1. Youbo

<http://www.uboche.com/>

Youbo is a valet parking app available on both iOS and android. It is currently available in Beijing, Shanghai, Chengdu and other big cities in mainland China. Figure 2-2 shows demo pictures for Youbo

Figure 2-2 iPhone Screenshots for Youbo



Youbo offers similar services as for Luxe. After taking a real experience, I found the advantages and disadvantages below:

Advantages:

1. a valet can drive the customer to the destination and then park the car. And the customer can get the car returned at wherever he or she wants. This is rather similar to Luxe
2. a valet could help wash and refuel a customer’s car
3. a user can register and login just using its phone number

Disadvantages

1. the application does not use new technology like 3D touch and does not offer Apple Watch application
2. the user interface does not look good.
3. **BACKGROUND KNOWLEDGE**

There are a lot of third party frameworks to enhance the performance or to optimize the user interface of this project. This chapter mainly introduces some useful frameworks in the development. The first part talks about tools used in front-end which is the mobile application. And the second part talks about tools in back-end which is the server and database.

* 1. Tools used in Front-End
     1. AFNetworking

AFNetworking is networking library used in iOS and Mac OS X development. It is built on top of the Foundation URL Loading System, extending the powerful high-level networking abstractions built into Cocoa. It is a high efficient networking module along with feature rich API which is rather easy to use. It powers some of most popular applications on iPhone and iPad.

The usage of AFNetworking is simple, which differs from the origin method offered in iOS. After initializing a session manager, the user just needs to configure some parameters, sends the request and then waits for the response. A simple post request can be implemented below:

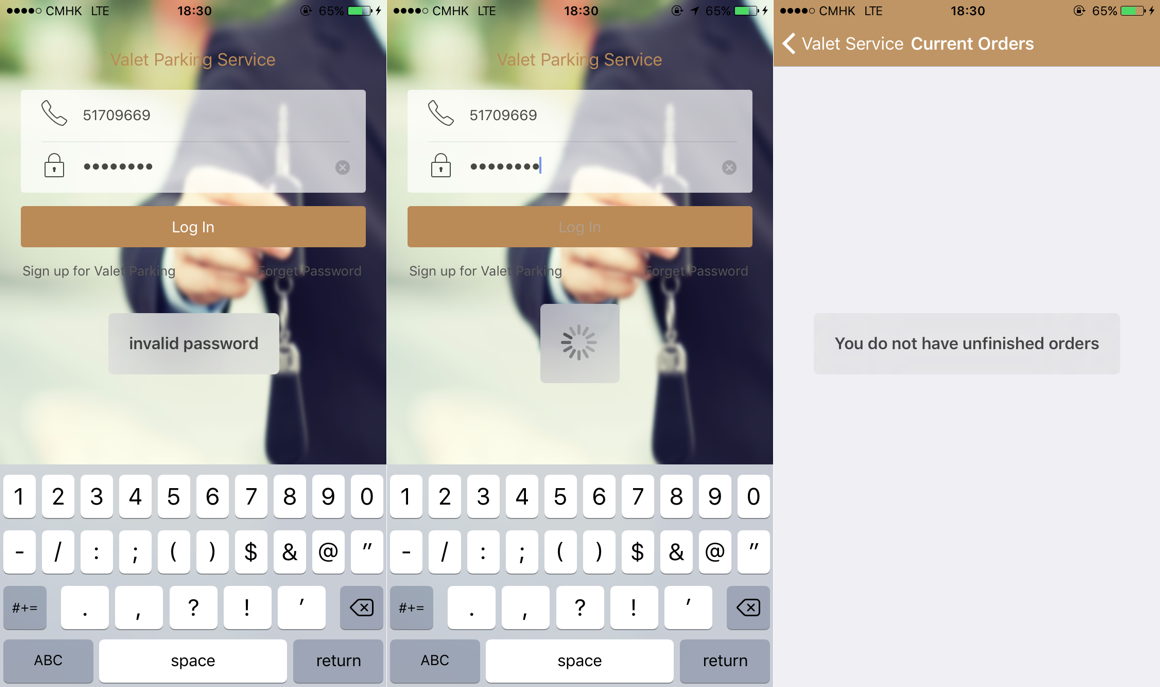
|  |
| --- |
| AFURLSessionManager \*manager = [AFURLSessionManager manager];  NSDictionary \*parameters = @{@"foo": @"bar"};  [manager POST:@"http://example.com/resources.json" success:^(AFHTTPRequestOperation \*operation, id responseObject) {  parameters:parameters  NSLog(@"JSON: %@", responseObject);  } failure:^(AFHTTPRequestOperation \*operation, NSError \*error) {  NSLog(@"Error: %@", error);  }]; |

This code block sends an asynchronous request containing a parameter dictionary to the server. If the request is successful, the manager will get a *responseObject* containing request information or an *error* if the request is failed.

* + 1. MBProgressHUD

MBProgressHUD is an iOS drop-in class that displays a translucent HUD with an indicator and/or labels while work is being done in a background thread. I use this framework in almost every view in this project. It’s easy to add a text indicator or progress indicator as shown in Figure 3-1

Figure 3-1 Screenshots for usage of MBProgressHUD



The usage MBProgressHUD is very simple by initializing an MBProgressHUD instance and show it in current view. By choosing the mode of a hud, it can display to show text or process indicator or both. The code block below shows how to add a hud to current view and hide until a certain process is finished.

|  |
| --- |
| [MBProgressHUD showHUDAddedTo:self.view animated:YES];  dispatch\_time\_t popTime = dispatch\_time(DISPATCH\_TIME\_NOW, 0.01 \* NSEC\_PER\_SEC);  dispatch\_after(popTime, dispatch\_get\_main\_queue(), ^(void){  // Do something...  [MBProgressHUD hideHUDForView:self.view animated:YES];  }); |

* + 1. JSONModel

MVC (Model, View, Controller) is widely used in object-oriented developing. A model is used to store and manage data. And the format of most data downloaded from server is JSON. In order to use this data, front-end needs to transfer it to model. JSONModel allows rapid creation of smart data models. By creating an model and inheriting it from JSONModel, the front-end can use the *initWithDictionary* method to generate instance of a model rapidly without reading each key-value from response data. The code block below shows an statement of class named *CountryModel* which is inherited from JSONModel. It has three attributes. As long as the JSON data has the same key, the application can generate a model using one line of code.

|  |
| --- |
| #import "JSONModel.h"  @interface CountryModel : JSONModel  @property (assign, nonatomic) int id;  @property (strong, nonatomic) NSString\* country;  @property (assign, nonatomic) BOOL isInEurope;  @end |

* + 1. SMS\_SDK

SMS\_SDK is a framework used to send verification code to users’ mobile phones. It’s totally free and easy to be integrated in the application. Since our valets host customers’ cars, it is important for valets to verify the identity of the user. The code block below shows how to use SMS\_SDK to verify a user’s phone number.

|  |
| --- |
| [SMSSDK getVerificationCodeByMethod:SMSGetCodeMethodSMS  phoneNumber:@"51709669"  zone:@"852"  customIdentifier:nil  result:nil]; |

* 1. Tools used in Back-End
     1. MongoDB

MongoDB is a free and open-source cross-platform document-oriented database program. Being different from database like MySQL, MongoDB is classified as NoSQL database program and uses JSON-like documents with schemas. It works well with Node.js and can implement common database method like create, read, update and delete rather easily and efficiently.

Compared to MySQL, MongoDB has some main advantages as follows:

1. rich data model, dynamic schema, typed data and data locality
2. rich query language which is easier to code and read
3. development is simplified as MongoDB documents map naturally to modern, object-oriented programming languages
   * 1. Express

Express is a fast, unopinionated and minimalist web framework that provides a robust set of features for web and mobile applications. It is the most popular framework in Node.js as for now. Because it provides lots of powerful and useful features including organizing application’s routing and providing template solutions, the user can focus on developing the functions of applications. The main advantages of express are as follows:

1. event driven: this feature enables registering various profound functionalities by connecting them to other events that are being executed once the event is triggered.
2. javascript closures: this feature allow the user to use variables that are defined in the outer calling function inside the callback body, which is extremely useful to solve the conflict while working with various applications.
3. REQUIREMENTS AND DESIGN

In this part ~~~~~~

* 1. Requirements Analysis
     1. Product Perspective

This project has front-end and back-end. The front-end is built on Xcode 8 using Objecive-C and the back-end is built with Node.js and MongoDB. And there are two applications in the front-end. One is for customers and the other one is for valets. Both customers and valets use their phone number as login account.

* + 1. User perspective

There are two types of user – customer and valet. After a customer logging in, he or she can add a car, choose a place to park, check orders and request his or her car. After a valet logging in, he or she can access to all the opening orders, generate an order by scan the QR code on a customer’s phone and end an order after returning a customer’s car.

* + 1. Functional Requirements

Using this product, a customer will be able to choose a place and choose a car to park. Here is the list of high-level functional requirements that this project is focus on. The two apps and the back-end must:

1. Authenticate and authorize a customer or a valet
2. Store a number of data records describing cars. Each record will have attributes as below:
   * Car plate
   * Car brand
   * Car color
3. Store a number of data records describing orders. Each record will have attributes below:
   * Order date and time (create, update, end)
   * Order place
   * Customer name
   * Customer phone
   * Car plate
4. Allow customers to add, edit a car by typing in plate, brand and color. Also allow customers to delete a car.
5. Allow customers to choose a place and a car to park
6. Allow customers to check all current orders and historical orders
7. Allow customers to request his or her car back
8. Allow valets to generate an order by scanning QR code
9. Allow valets to access all the opening orders
10. Allow valets to end an order

Next I will introduce the details of design.

* 1. Design
     1. System Architecture

The entire system can be divided into two parts: front-end and back-end. Back-end is a server based on Node.js with MongoDB as database. All the *get* and *post* requests including registering an account, logging in, adding a car, editing a car, deleting a car, creating an order, updating an order are handled by this server. It will check every request for correctness and validity and send corresponding response back. And front-end are two mobile applications built using Xcode and Objective-C. The database used in front-end is CoreData which is native in iOS and easy to use. Figure 3-1 shows the architecture of the system

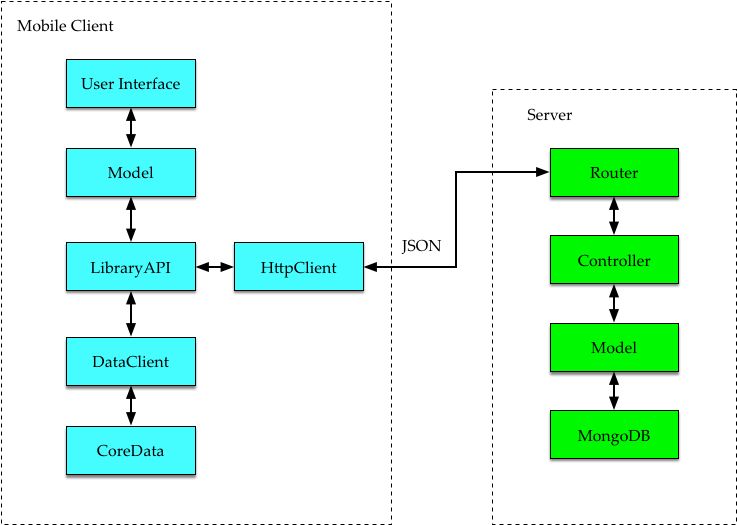


Figure 3-1 Architecture of System

* + 1. System Workflow

The system workflow consists of two parts. The first part is the work flow in the server and the second part is the work flow in the mobile client. These two parts will be introduced separately.

* + - 1. Workflows in Server

Server works as back-end in this project and will handle all the http request sent from front-end. There are three major management in server: account management, car management and order management.

1. Flow chart for account management

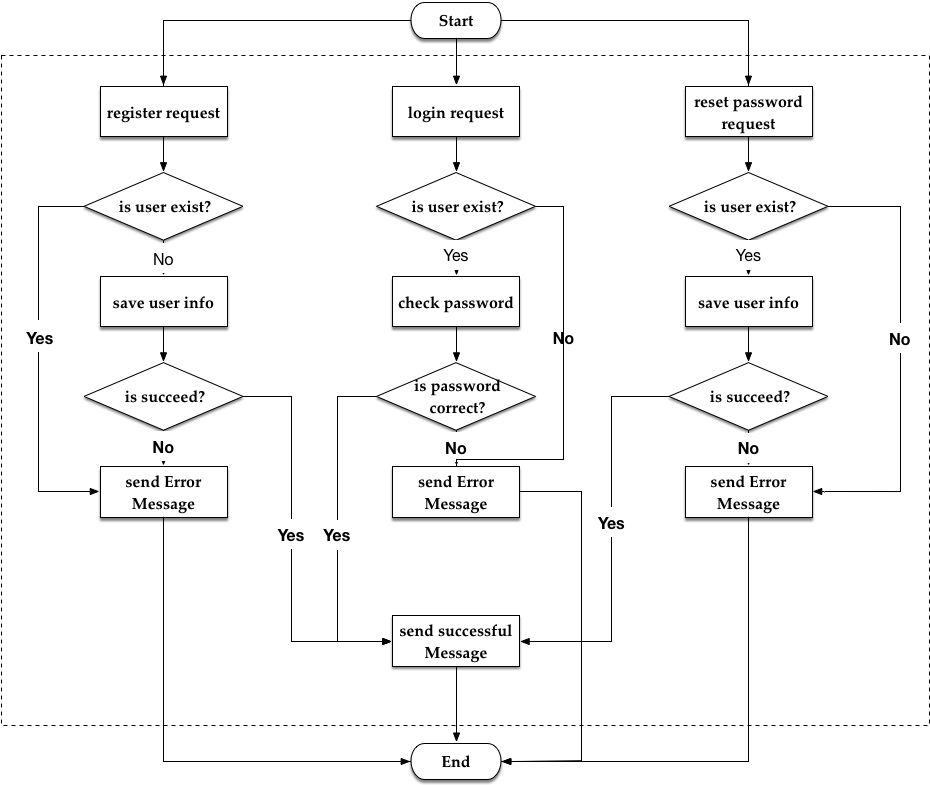


figure 3-2 flow chart for account management

As shown in figure 3-2, server needs to deal with three kinds of account management request: register request, login request and reset password request. For register request, if there exist an account with the same phone number or fail to save user file, the server will send error message. For login request, if it does not find the user with the phone number or the password is incorrect, the server will send error message. For reset password request, if it does not find the user with the phone number or fail to save new password, the server will send error message. For other circumstance, the server will send successful message with the user model.

1. Flow chart for car management

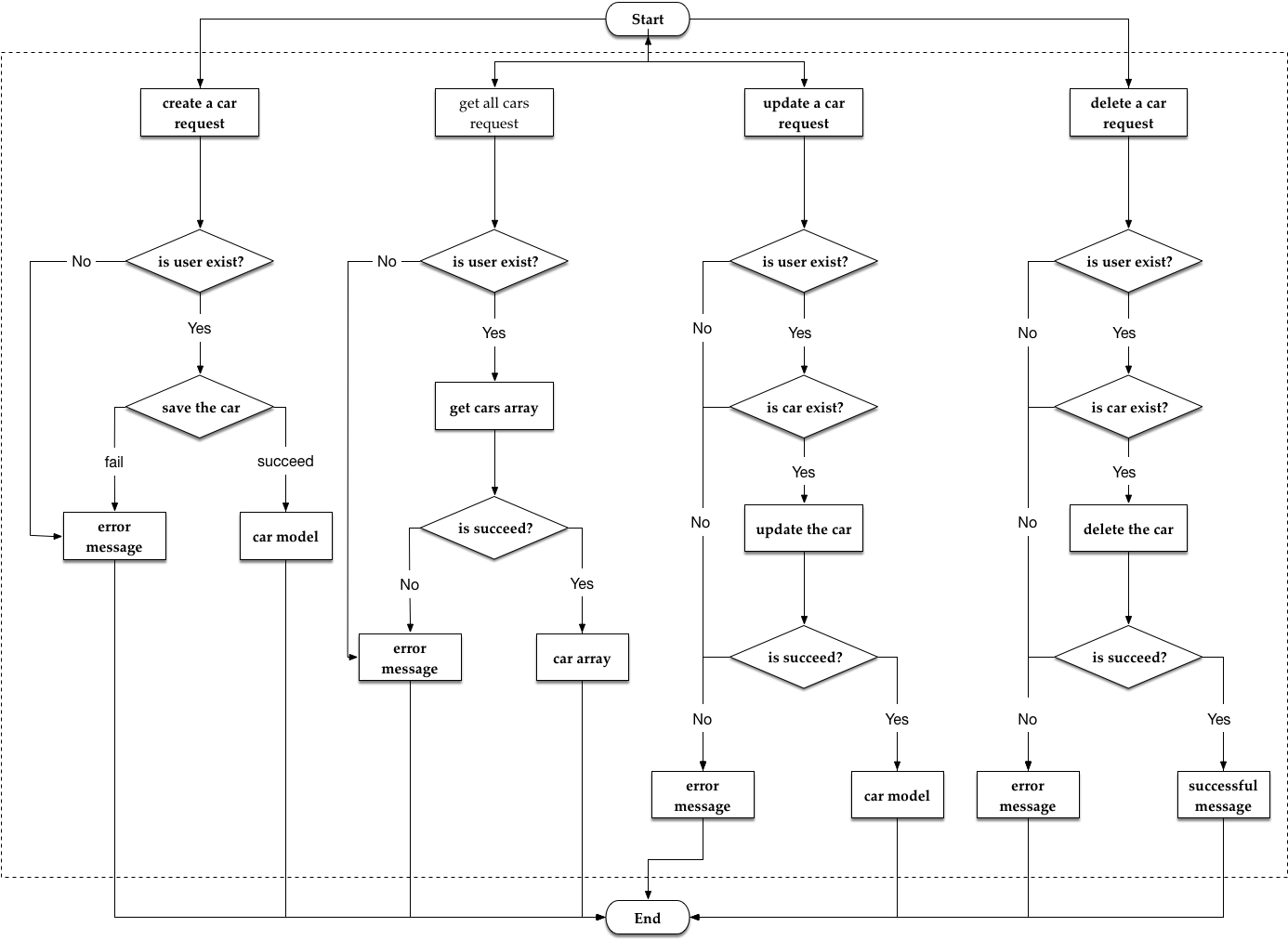


figure 3-3 flow chart for car management

As shown in figure 3-3, the server needs to deal with four kinds of car management request: create, update, delete a car and get all cars for a user. For all these four requests, server will firstly check if the user exists. If user’s account can not be found, an error message will be sent to front-end. If the user’s account is valid, for “create a car request, server will save this car to database. For “get all cars request”, server will get all the car models with corresponding user account from database. For “update a car request” and “delete a car request”, server will check if the car exists. If the car can not be found, an error message will be sent to front-end. If the car is valid, then corresponding database method will be called. If there is any error when processing the data in the database, an error message will be sent to the front-end.

1. Flow chart for order management

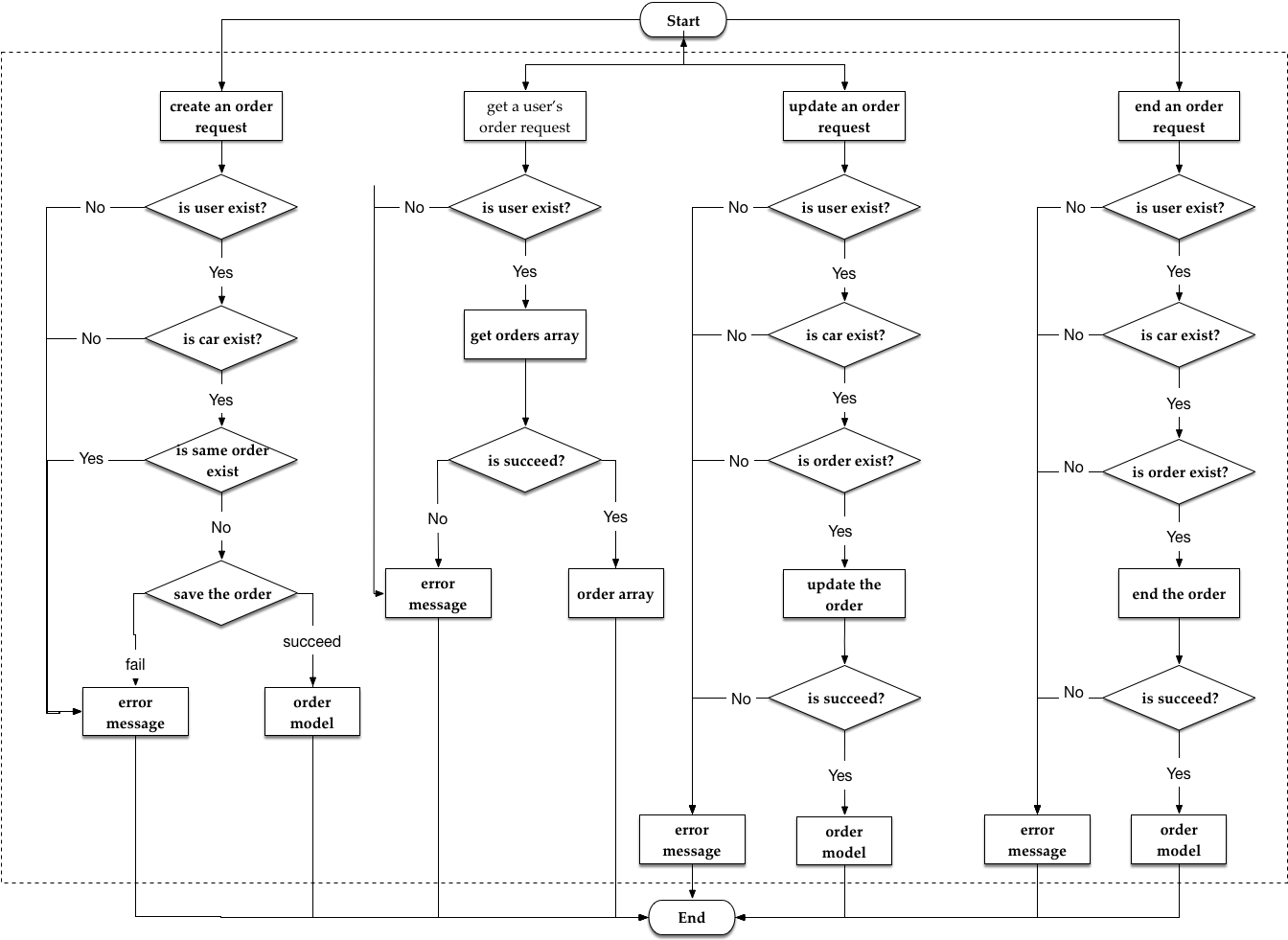


figure 3-4 flow chart for order management

As shown in figure 3-4, the server needs to deal with three kinds of order management request: create, update, read and end. For all these four requests, server will firstly check if the user exists. If user’s account can not be found, an error message will be sent to front-end. If the user’s account is valid, for “create an order request”, server will check if the car exist and if there is an order with the same car unfinished. For “get a user’s order request”, server will get all the orders belong to the user and send them back. For “update an order request” and “end an order request”, server will check if the car and the order exist. If not, an error message will be sent back. If the order is valid, server will update or end that order and send the order model back.

* + - 1. Workflows in Mobile Client

There are two major managements in front-end. One is account management and the other one is car and order management. They are less complex than that in server. Figure 3-5 shows the flow chart for mobile client.

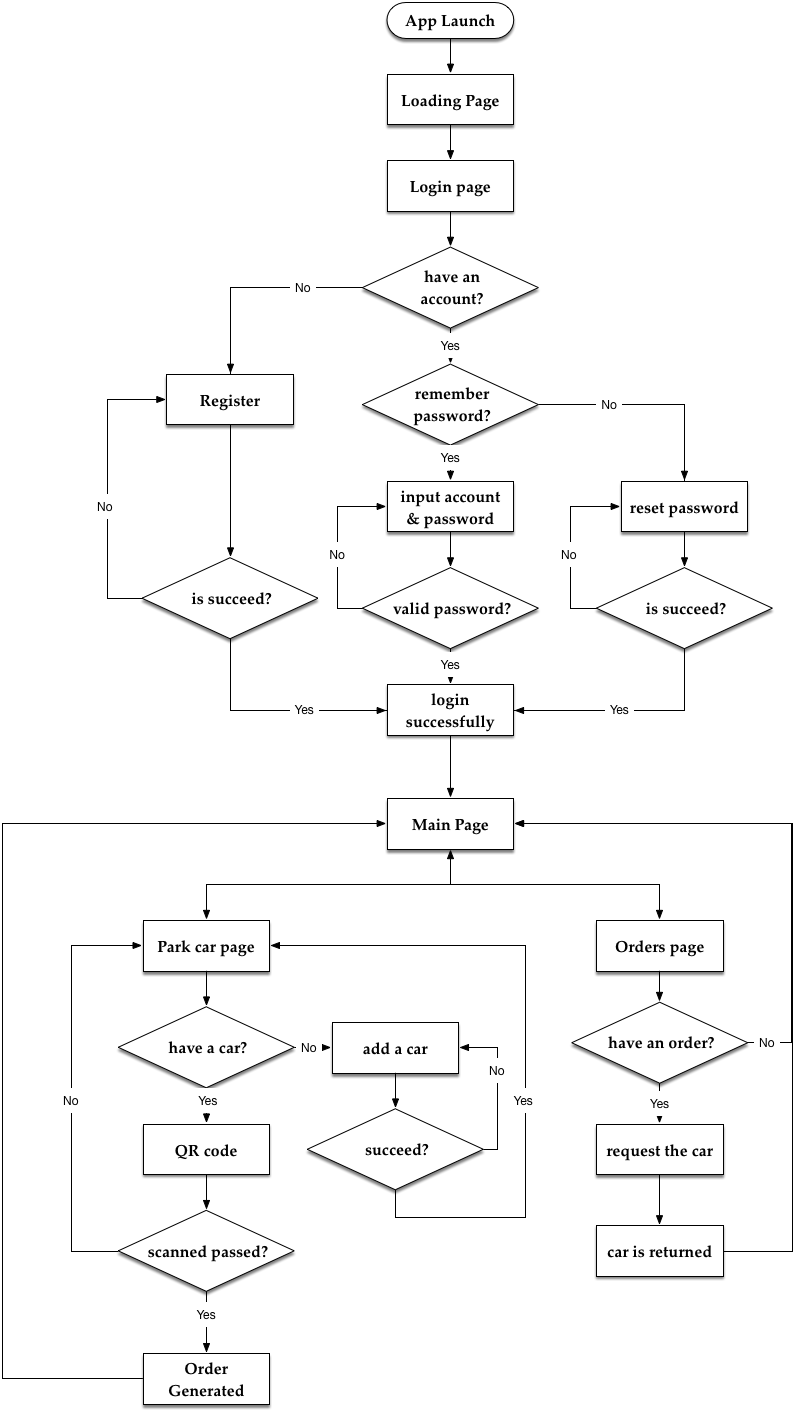


figure 3-5 flow chart for mobile client

1. Account management

When the application is launched at the first time, it will ask the user to input account and password to login. If the user does not have an account, he or she needs to register using its phone to get a verification code. If the user forgets the password, he or she needs to set a new password using its phone to get verification code. The server will do all the verify works including check if the password is valid, if the account exists and so on.

If the account and password are valid, the *login* view will dismiss and the main page will show. If not, it will ask the user to input account and password again.

1. Car and order management

In the main view, a user can park its car. But if the user does not create a car in the application, he or she needs to create a car by inputting information including plate, brand and color. The server will check if a car with the same plate exist. Then the user can choose a place to park its car and a QR code will show on the screen for our valet to scan. After some checking on the server, if all the information is valid, a new order will be generated. The application will go back to the main page.

Whenever the user wants its car back, he or she can enter the order page, choose an order and request that car. Out valet will start to drive its car back.

* + 1. **Object Oriented Design**

Below I will introduce the object oriented design in this project.

* + - 1. Identify actors and use cases

Table 4-1 shows the actors and use cases for this project

Table 4-1 table for actors and use cases

|  |  |  |
| --- | --- | --- |
| Actor | Use Case | Use Case Description |
| Customer | Login | Customer logs in |
| Customer | Register | Customer registers the service |
| Customer | Modify a car | Customer can add, update or delete a car |
| Customer, valet | Park a car | Customer parks its car |

* + - 1. Use case diagrams

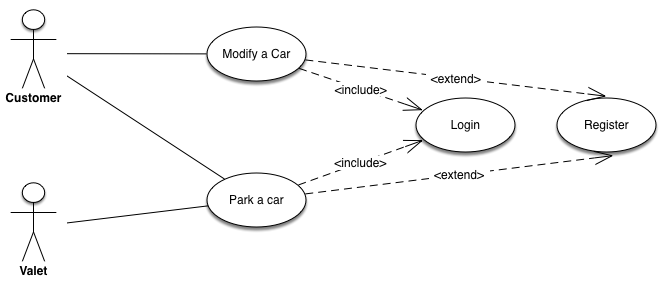


figure 3-6 use case diagram

Figure 3-6 shows the use case diagram. As it shows in the picture, there are three use cases.

1. For the “modify a car” use case, a customer can modify its cars including create, update and delete a car.
2. For the “park a car” use case, a customer can park its car if the order is generated successfully by a valet. And the user can request its car if the car is in a parking lot. Then a valet will return the car.
3. Both the use cases above need to include “login” use case.
4. If the user does not have an account, the “register” use case will be invoked.
   * + 1. Sequence diagrams
5. Figure 3-7 shows the sequence diagram for register and login. As shown in the figure, a customer need to register first to use our service. In this sequence diagram, all the message are asynchronous.

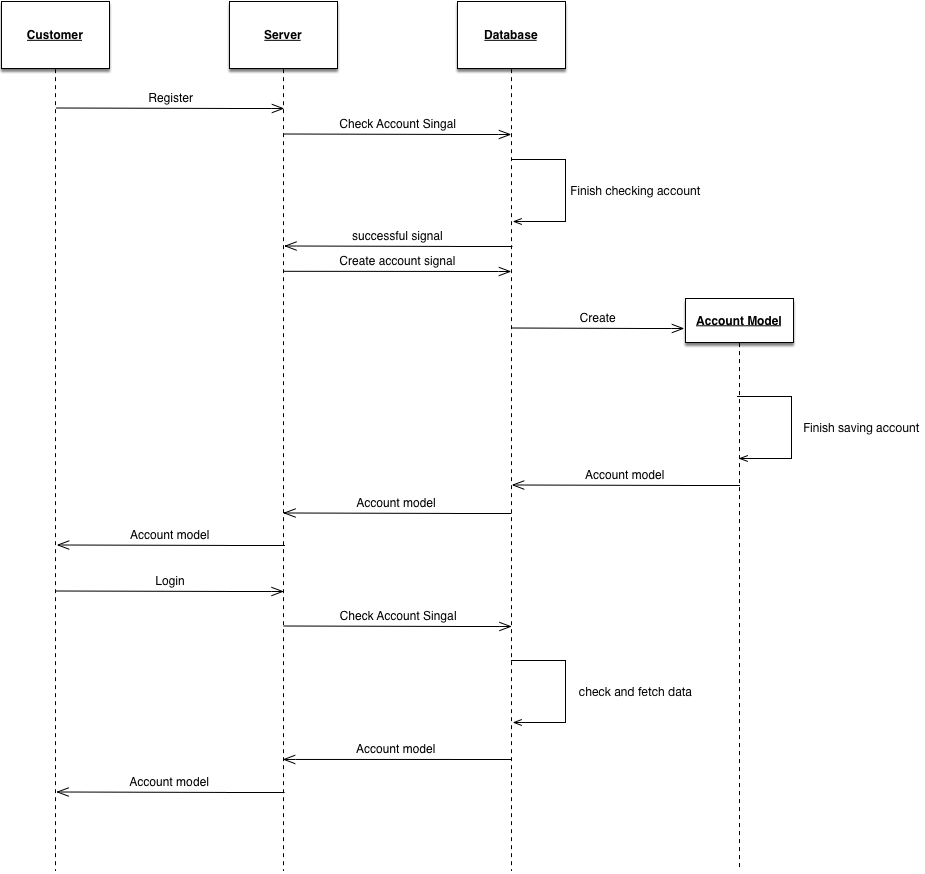


figure 3-7 sequence diagram for registration and logging in.

1. Figure 3-8 shows the sequence diagram for parking a car. As shown in the figure, a customer needs to add a car before using our valet parking service. And it is a valet who sends a an order request to server after scanning the QR code generated by a customer. The server will check each request including “add a car” and “create an order” for correctness and validity. Then the server will communicate with database and send back the corresponding model object.

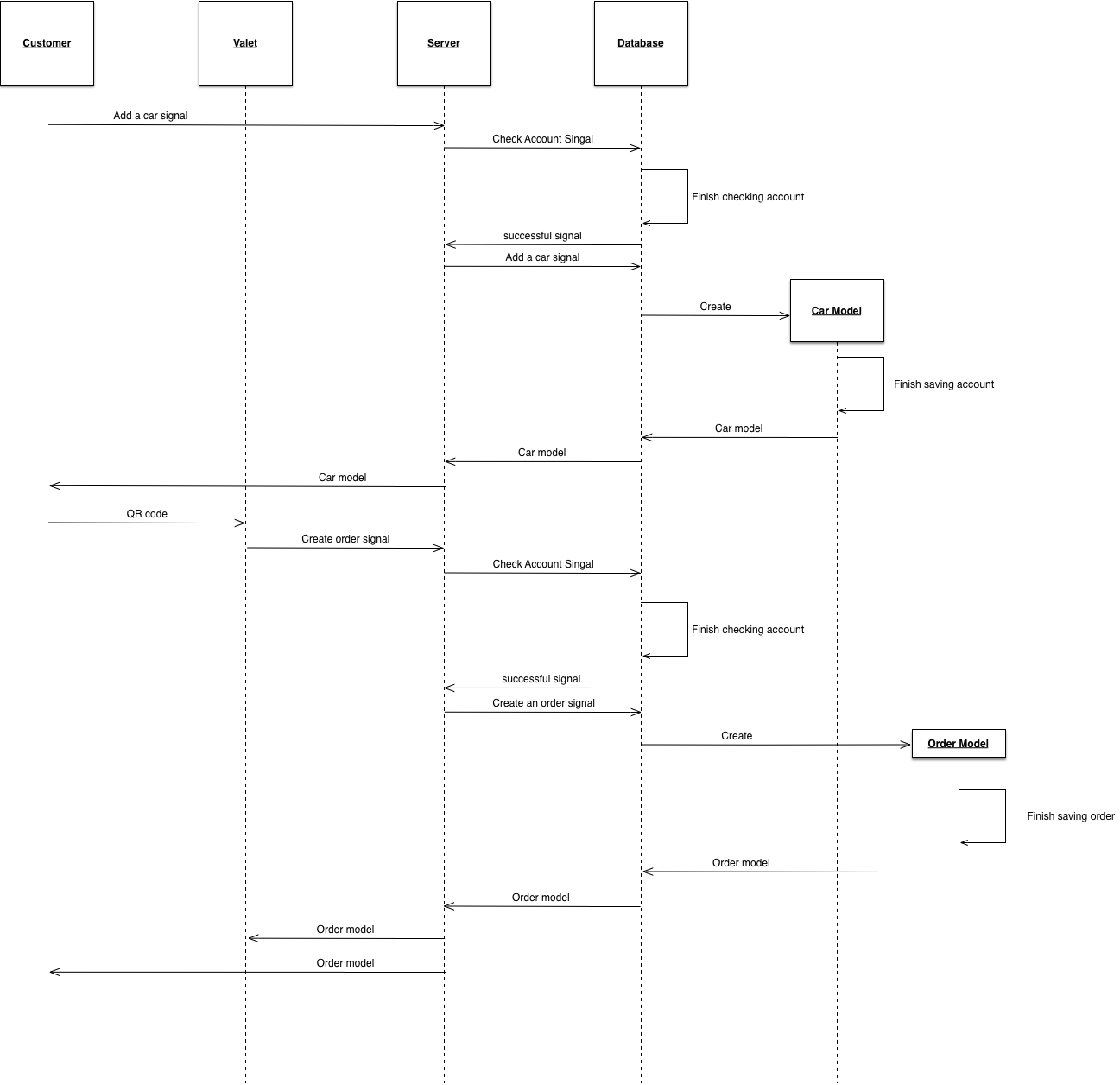


figure 3-8 sequence diagram for parking a car

* + - 1. Documents for design use cases

Below introduces the documents for the four use cases.

1. “Register” use case

|  |  |  |
| --- | --- | --- |
| **Use Case Name:** | Register | |
| **Actor(s):** | Customer | |
| **Description:** | This use case describes the membership registration process. | |
| **Reference:** | FS-1 | |
| **Typical Courses of Events:** | **Actor Action** | **System Response** |
| The welcome window is currently displayed on the screen waiting for the customer to select an option. |  |
| **Step1**: Initiate this use case if the customer clicks the “Sign up for Valet Parking” button. |  |
|  | **Step2**: The system pops up a multi-lined window requesting the following information to be input: First Name, Last Name, Phone Number, Verification Code and Password. The window has one buttons at the bottom: [Sign up] and one button at the left top corner: [Cancel]. And the user can read Terms by clicking the [Terms] button. |
| **Step3**: The customer inputs First Name, Last Name and Phone Number then clicks the [Verification Code] button. |  |
|  | Step4: The system sends the phone number to Mob to get a verification code. If the format of phone number is correct, the customer will get an message with verification code |
| Step 5: The customer inputs the verification code and a password then clicks the [Sign up] button. |  |
|  | Step 6: An progress indicator will display on the screen. The system sends all the information to the server to verify if the phone number is valid, if so, the server will create a user model and save all the information in the server. If the saving process is successful, the server will send the user model back to mobile client. |
|  |  | Step 7: this use case concludes when the mobile client receives a successful message and the user model. The registration view will dismiss and the main page will show. |
| **Alternative(s):** | Step3: if the customer clicks [Cancel] button on the left top corner, the registration view will dismiss and the welcome page will show. This use case concludes.  Step4: if the phone number is not correct, customer needs to correct the number and get verification code again.  Step6: if the account with same phone number already exist, the server will send back an error message and the mobile client will display a MBProgressHUD showing “This account already exists”. Then this use case goes back to step3. If server can not save the information, it will send back an error message | |
| **Precondition:** | None | |
| **Postcondition:** | None | |
| **Assumptions:** | None | |

* + - 1. Class diagrams
    1. User Interface Design
    2. Database Design

1. IMPLEMENTATION AND TEST
2. REVIEW AND FUTURE WORK