

# **Parking Garage/Lot Automation**

Software Engineering Report Part 2

Group 14

Tingcong Jiang, Chenyu Cao, Shijie Xu, Yiran Tan, Zhuohuan Li, Buyuan Lin, Samuel Cho, Christopher Cheng

<https://cc1539.github.io/SE-project/>

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### Contribution Matrix

	Tingcong Jiang	Chenyu Cao	Shijie Xu	Yiran Tan	Zhuohuan Li	Buyan Lin	Samuel Cho	Christopher Cheng
Section 1	7%	8%	6%	6%	7%	8%	7%	51%
Section 2		5%	10%	20%			50%	15%
Section 3	10%	8%	10%	20%	25%	12%	20%	
Section 4	40%		30%	10%	10%			10%
Section 5	15%	15%	15%	15%	15%	15%	8%	2%
Section 6	11%	11%	11%	30%	11%	20%	5%	1%
Section 7	28%	11%	11%	11%	11%	19%	8%	1%
Section Project Management	8%	7%	7%	8%	6%	6%	7%	51%
Section References								100%

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## Section 1: Customer Problem Statement

As consumers, we face a major problem when dealing with parking garages today — one that stems from a lack of modern management strategies regarding parking lots in decently populated areas. Our society's current, deprecated system provides only an inefficient and inelegant solution to the high-density, simultaneous parking of many vehicles in a single parking garage. Thanks to the absence of proper and effective communication between the parking garage owners and us customers, these ineffective methods are not ameliorated or improved upon, but instead continue to proliferate. For commuters like us and those across the globe, who are plagued by the constant concern of successfully and quickly finding a parking space in busy metropolitan areas, the ultimate effect is a significant amount of wasted time and effort.

As the global population skyrockets (Roser and Ortiz-Ospina, 2019) and we move into a fast-paced age of new and improved transportation technology, it is disappointing, to say the least, to see how little progress has been made in the area of parking lot management to accommodate the increasing popularity of owning a private vehicle (Hedges & Company, 2019). The issue is only exacerbated by establishments that believe they can address the problem by simply making the parking lot bigger (Rasmussen, 2016), when a more modern solution would be to employ novel techniques such as giving indication to customers about the availability of space and decreasing wait times by eliminating cumbersome payment options. As commuter students, our team members must find a parking spot on campus every working day of the week, and therefore encounter this problem almost every day.

Although there are couple of huge parking lots located in different campus, we have to spend a lot of time driving through all the rows in the parking lot to find a vacant parking space. Sometimes, to save the time finding a vacant parking space, well park directly at a spot that is far away from the campus. However, we have to walk a lot and we might even miss those spots that's closer to the campus.

What if we already know the location of the vacant parking spot when we enter the parking lot? What if there is a system which can guide you through the parking spot that suit

your need the best? This will save the overall time for all the commuters. The problem described above is the reason we chose this project. The potential treatment is included as well. Besides the parking spot finding function, we are also interested in implementing an automatic payment function for those commercial parking lots.

As customers, we would suggest implementing these four paradigms: quantification, reservation, automation, and virtualization. If properly and intelligently implemented using modern technologies, each of these should be more than able to alleviate one or more of the aforementioned issues.

The first paradigm, “quantification”, encompasses the idea of managing a garage by separating it into different sections and subsections and “quantifying” the information that describes each section in an intuitive, easy-to-visualize way. One can then view this information in real-time in the form of an online parking garage map. Utilizing this, customers and administrators alike can quickly gauge the state of the lot and make informed decisions. Additional features, such as the ability to sort all cars by their information (e.g. entry time, exit time, car make, car model, and car plate) can be implemented to facilitate ergonomics for the management team. On the physical side of things, LED displays can be connected to this system and then placed around the garage to relay relevant information in appropriate locations (e.g. a display at the entrance of each section indicating how many spots are available in that section), which can significantly improve the efficiency of garage management and usage.

The second paradigm, “reservation”, encompasses the idea of time management. Through reservation, customers who have a plan and know ahead of time when and how long they will leave their car in a parking lot, like us commuter students who have a well-defined class schedule, are given the option to take the initiative and apply for reservations. To simplify operation of the lot, the system should be implemented so that what customers can reserve is not a specific spot, but *a* spot. Of course, if this idea applied uniformly to the entire lot, the problem of our parking space being far from your destination would still remain. Therefore, we re-apply the concept of “quantification” and assert these rules within particular sections. On the same

vein, the owner should be given the option to designate a reservable section and a “normal”, un-reservable section to alleviate the effects of overbooking.

The third paradigm, “automation”, encompasses the idea of lessening the burden of the customer. For customers like us, who will consistently visit the same lot, something like an account system would be of great benefit. After the initial account creation and setup, any and all payment should occur automatically, with no further intervention by the customer or owner. This would put an end to the hassle of paying at a machine or booth, which can easily become a source of congestion when there is an influx of customers. To promote the usage of this account system, clients will be prompted to create an account with a QR code as they enter the gate, or perhaps, as they walk into the establishment. This account will be tied to the customer’s license plate and bank account/credit card. Through this account, the customer can be systematically billed for the correct amount according to the length of their accommodation when they exit. As a result, a cashier is no longer required, and this particular cost of labor can be eliminated.

The fourth paradigm, “virtualization”, encompasses the idea of synchronicity between the physical and the conceptual. Using the online interface described earlier, customers can remotely view the data displayed by the physical LEDs in their corresponding locations on a virtual map. They may also perform actions such as select where they parked on the interactive map on the website upon arrival. This way, the user will be able to locate their spot when they return. As a customer, I know that more often than not, I don’t immediately know exactly which row and which spot in that row that I park in. Therefore, only spots that are deemed occupied by sensors should be able to be marked, so as to combat human error and prevent erroneous entries to the system. Optionally, customers may save information about their car make and model to their account for further identification purposes. On the administrative side, backend management software that can help the owner maintain and oversee the garage should be included. Through this interface, various values and properties, such as lot pricing, can be viewed and adjusted on the fly and perhaps according to an algorithm of choice.

## Section 2: System Requirements

### Functional Features

Identifier	Priority	Requirement
REQ-1	10	The system shall allow a user account to make a reservation
REQ-2	8	The system shall send text or email confirmation for either reservation success or failure
REQ-3	10	The system shall read a car's license plate when it approaches the entrance gate
REQ-4	10	The system shall recognize existing accounts from previously scanned license plates
REQ-5	8	The system shall provide payment methods for walk-in customers
REQ-6	9	The system shall mark the time a customer entered the lot
REQ-7	5	The system shall direct the driver to the nearest available spot
REQ-8	6	The system shall display on a map which spaces are occupied or not
REQ-9	4	The system shall show customers the spot they occupied.
REQ-10	5	The system shall guide users to special spots for their special needs (electric car, disabled parking)
REQ-11	7	The system shall update the map when a car leaves or fills a spot
REQ-12	6	The system shall mark the time when a customer leaves the lot
REQ-13	4	The system shall notify a customer who has been parked for too long

REQ-14	10	The system shall automatically deduct the parking fee from the customer's account
REQ-15	9	The system shall allow the lot owner to view the information in the database
REQ-16	2	The system shall allow the lot owner to edit the information in the database
REQ-17	3	The system shall allow the lot owner to set the maximum number of spots that are allowed to be reserved
REQ-18	6	The system shall allow the lot owner to change the price of parking at the lot
REQ-19	5	The system sets higher priority for registered customer than walk-in customer
REQ-20	3	The system should offer special needs when registered users make reservations. Disabled parking, spot with charging pile for electric car owners, etc...
REQ-21	5	The system should let the user to cancel their reservation if they do not want to park here anymore or they want a different type of parking spots.
REQ-22	6	The system shall allow customers to view and edit their own information
REQ-23	7	The system should be able to send a message or email to the desired phone number or email address
REQ-24	7	The system should be able to detect any unexpected situation
REQ-25	7	The system should be able to follow a predetermined solution to solve any unexpected situation
REQ-26	10	The system shall allow a user to create an account on the website.
REQ-27	10	The system shall save the user's information in the database.



### Non-Functional Features

Identifier	Priority	Requirement
REQ-28	10	The system shall have access to the internet
REQ-29	8	The system shall have access to one or more SIM cards to facilitate automatic texts
REQ-30	10	The system shall include two or more cameras capable of clearly capturing the license plate of a car moving at moderate speed
REQ-31	10	The system shall store database information in the form of a filesystem.
REQ-32	8	The system shall be capable of interfacing with an optional, manual payment booth
REQ-33	5	The system shall be able to interface with an LED display
REQ-34	6	The system shall translate information about the state of the lot into a visual form
REQ-35	5	The system shall be able to identify special-needs customers through information on the account
REQ-36	7	The system shall interface with proximity sensors.
REQ-37	4	The system shall allow an administrator to configure its behavior

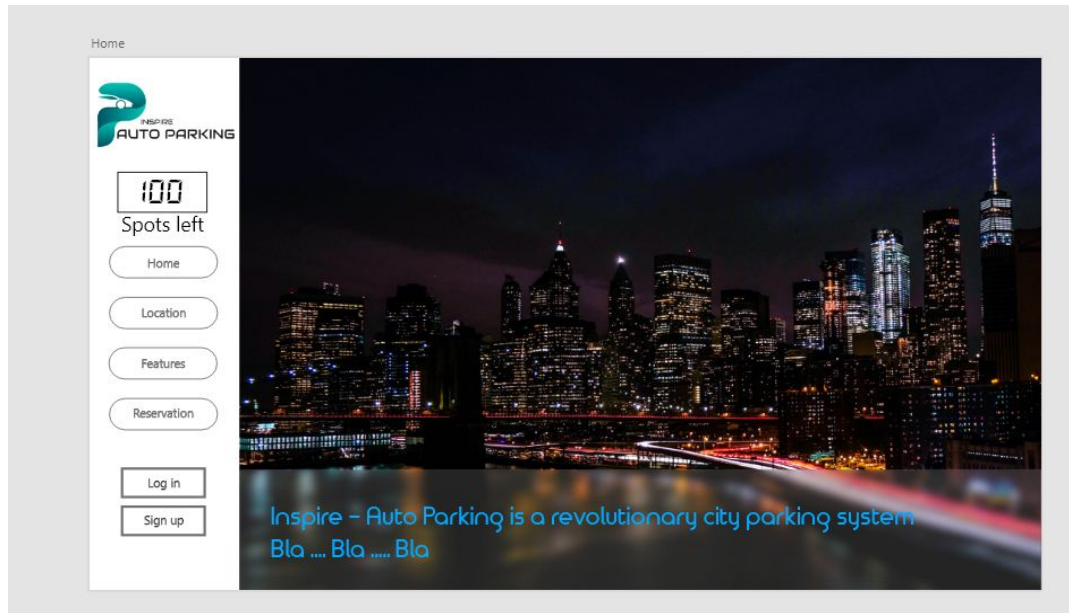
REQ-38	10	The system shall be able to automatically make transactions online.
REQ-39	5	The system shall be able to differentiate between a registered car and an unregistered one.

### On-Screen Requirements

Identifier	Priority	Description
REQ-40	9	On homepage, allow unregistered users to sign up with clicking sign up button and inputting username and password
REQ-41	9	On homepage, allow registered users to login with clicking login button and inputting their username and password
REQ-42	6	Show users the number of available spots
REQ-43	5	Allow users clicking button to see the garage location
REQ-44	2	Allow users clicking button to see the unique features of garage
REQ-45	6	Allow users clicking button to make a reservation
REQ-46	4	Allow users clicking button to access homepage
REQ-47	7	Allow logged in users to access account page
REQ-48	4	On account page, users are able to click a button to edit personal information
REQ-49	4	On account page, users are able to click a button to make and cancel reservation
REQ-50	6	On account page, users are able to click a button to access balance and payment
REQ-51	4	On account page, users are able to click a button to check their parking status
REQ-50	4	On payment page, users are able to make a deposit with credit card or linking paypal account


REQ-51	3	On reservation page, users are able to input calendar date and time for reservations, or cancel the reservation with double check button
REQ-52	6	On parking status page, users are able to see the parking period, current parking fee and spots location


## Home Page UI



## Reservation Page With User Logged In

Reservation With Logged In

 User #1



100  
Spots left

ReservationFeaturesLocationHome

Make Reservation for A New Vehicle:

Location:  
Inspire Auto Parking Lot

Car Brand:  
Lamborghini

Car Model:  
LP - 700

Car Plate:

VIN:

Add This Vehicle

Make Reservation for A Registered Vehicle:

Location:  
Inspire Auto Parking Lot

Registered Vehicle:  
Lamborghini (Dream Car)

Date:  
Tomorrow (02/17/2019)


Arriving Time:  
00:00

Leaving Time:  
23:30

Make Reservation Now

## Background management Toolset UI Preview

Inspire auto parking background management system

 Inspire Auto Parking Monitor

Parking Spot 1

status: ☐

License Plate: Z33 JZR

Make: VW

Color: Red

Fee Rate: 10\$/hr

Parking Period: 0:00:00

Pay Status: ☐

Pay by Cash

Parking Spot 2

status: ☐

License Plate: A45 KSF

Make: NISSAN

Color: Grey

Fee Rate: 10\$/hr

Parking Period: 0:00:00

Pay Status: ☐

Pay by Cash

Disabled Parking Spot 1

status: ☐

License Plate: N21 HTR

Make: Jeep

Color: Black

Fee Rate: 10\$/hr

Parking Period: 0:00:00

Pay Status: ☐

Pay by Cash

Electric Vehicle Parking Spot 1

status: ☐

License Plate: J22 JBP

Make: NISSAN

Color: Black

Fee Rate: 10\$/hr

Parking Period: 0:00:00

Pay Status: ☐

Pay by Cash

### Section 3: Functional Requirements Specification

#### a) Stakeholders

Parking Garage owners

Business owners

Parking Customers

#### b) Actors/Goals

Actors	Type	Goal
Customer	Initiating	Park in the garage
Owner	Initiating	Set reservation limit and pricing
License Plate Camera	Supporting	Read license plates of incoming and exiting vehicles
Proximity sensor	Supporting	Detect when a car has occupied a space
Database	Offstage	Store user information
LED indicator	Supporting	Inform and direct the customer to an open parking spot
Parking User Interface	Supporting	Show the customers how many available parking spots left and allow them to reserve for spots before they arriving
Customer	Initiating	Reserve a parking spot online
Customer	Initiating	Know how many available spots left online
Customer	Initiating	Know the time when they arrive and how much time they have parked

Customer	Initiating	Can cancel the reservation after they have reserved for spots successfully
Customer	Initiating	Pay the parking fee online

c) Use Cases

i) Casual Description

UC#1 : Registration

Utilizing REQ-22, REQ-23, REQ-26, REQ-27 the system allows a customer to register for an account by submitting relevant information to an online form. Users must provide at minimum a license plate number, an e-mail address, and a bank account/credit card number.

UC#2 : Reservation

Utilizing REQ-1, REQ-2, REQ-8, REQ-18, REQ-20, and REQ-21, the system allows a customer to reserve a parking spot by specifying, at minimum, a timeframe to our online reservation page. In general, users may not reserve specific spots, but rather, a spot in a certain section of the parking lot. If at a later point in time the customer wishes to cancel a reservation, he or she may do so on the reservation confirmation page.

UC#3 : Entering the garage

Utilizing REQ-3, REQ-6, REQ-7, and REQ-8, A driver can enter the garage in their car and the camera will automatically scan his/her car's plate and model. The system will show their information and check which spot he/she should go and direct him/her to the spot.

UC#4 : Status Checking

Utilizing REQ-6, REQ-9, REQ-12, REQ-13, REQ-15, and REQ-23, the system shows a customer the state of the parking lot, their car's position, and other relevant information about his or her current stay in the lot on an online visual interface.

UC#5 : Online Payment

Utilizing REQ-14, REQ-15, REQ-16, and REQ-18, the system automatically determines when a car has left the parking lot and charges the account associated with the observed license plate by the appropriate amount to the customer's PayPal(?)

#### UC#6 : Emergency Alerting

Utilizing REQ-4, REQ-25, and REQ-26, the system notifies an owner or administrator by text or email if a critical situation (flooding, significant vandalism, power outage, etc.) has been determined to have arisen at the parking garage.

#### UC#7 : Cancel Reservation

Utilizing REQ-1, REQ-2, and REQ-23, the system allows the customer to cancel a reservation that they made.

#### UC#8 : Price Management

Utilizing REQ-18, the system allows an owner or administrator to adjust lot pricing by using an online form and submitting relevant information.

#### UC#9 : Notification

Utilizing REQ-7, REQ-10, and REQ-20, the system shall use a screen to show customer the necessary information.

#### UC#10 : Reserved Parking

Utilizing REQ-3, REQ-4, REQ-6, REQ-7, REQ-8, and REQ-10, the system automatically determines whether entering customers have a reservation or not, and if so, what type of reservation they have. It then guides them through the parking lot accordingly.

#### UC#11 : Ad-Hoc

Utilizing REQ-3, REQ-5, REQ-6, REQ-7, REQ-10, and REQ-12, the customer who did not reserve for a parking spot can still enter the parking garage. The system still direct the car to the empty parking space and show the parking spot is occupied.

#### UC#12 : Entering parking spot





REQ2	8		✓					✓							
REQ3	10			✓							✓	✓			
REQ4	10						✓				✓				
REQ5	8					✓						✓			✓
REQ6	9			✓	✓						✓	✓			✓
REQ7	5			✓						✓	✓	✓			
REQ8	6		✓	✓					✓		✓		✓		
REQ9	4				✓										
REQ10	5									✓	✓	✓			✓
REQ11	7												✓	✓	
REQ12	6				✓							✓		✓	✓
REQ13	4				✓										✓
REQ14	10					✓									
REQ15	10				✓	✓									
REQ16	9					✓									
REQ17	2														
REQ18	3		✓			✓									
REQ19	6														
REQ20	5		✓							✓					
REQ21	3		✓												
REQ22	5	✓													
REQ23	6	✓			✓			✓							
REQ24	7														
REQ25	7						✓								
REQ26	10	✓					✓								
REQ27	10	✓													
Max PW		10	10	10	10	10	10	10	6	5	10	10	7	7	9
Total PW		31	35	30	39	40	27	24	6	15	45	42	13	13	32

#### iv) Fully-Dressed Description

Use Case UC-1: Registration
Related Requirements: REQ-22, REQ-23, REQ-26, REQ-27
Initiating Actor: Customer
Actor's Goal: Using the website to register for an account. Information stored in the database
Participating Actors: Customer, Database, Garage Manager
Preconditions: *A functional database *Graphical User Interface
Postconditions: The customer's account will be stored in database
Flow of Events for Main Success Scenario: -> 1. The customer goes to the website and choose to sign in. <- 2. The system returns a registration page. -> 3. The customer enter its email address, username and password. <- 4. The system delivers the username and email to check if they are occupied in database a. If any username and email occupied, system returns to step 3 and notify customer to revise. b. If no username and email occupied, system continue to step 5. <- 5. The system show a message to customer that registration succeeded.

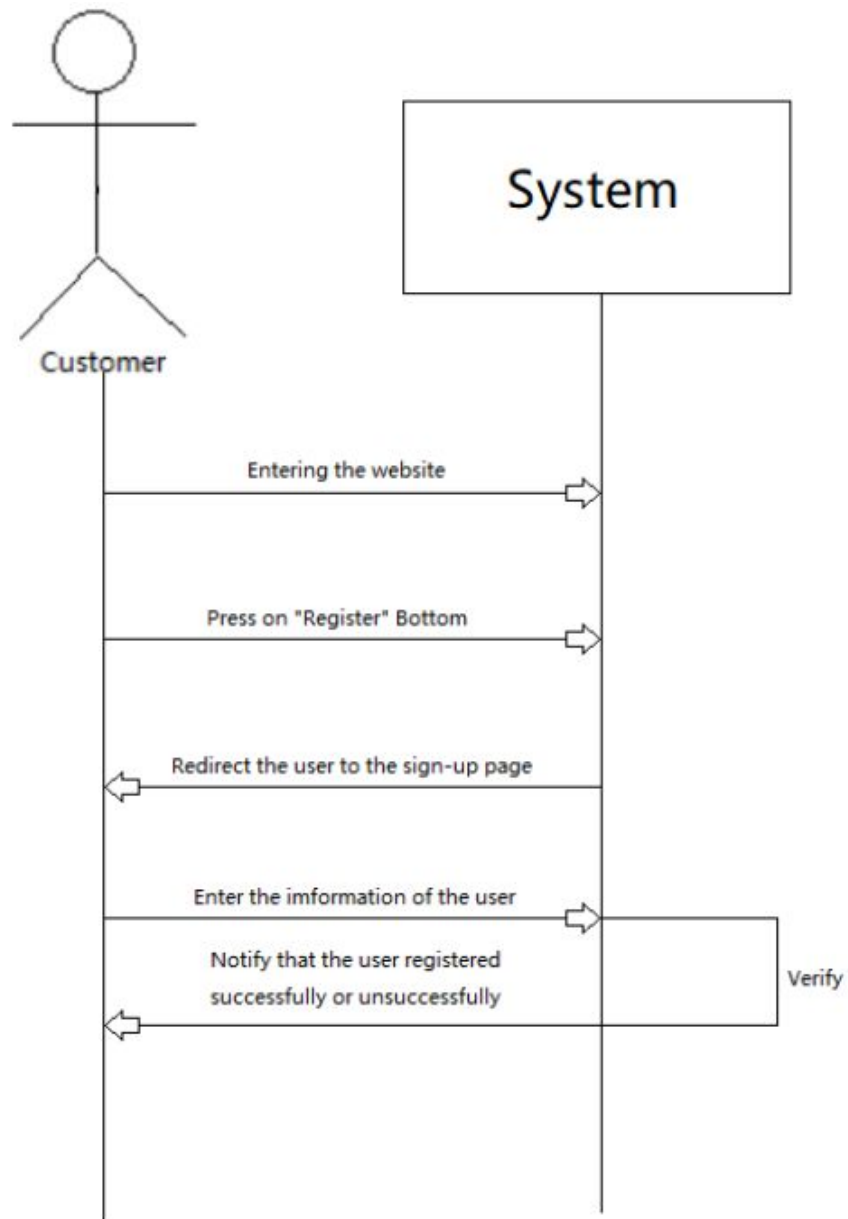


Figure 2: Register Process

## Use Case UC-2: Reservation

Related Requirements: REQ-1, REQ-2, REQ-8, REQ-18, REQ-20, and REQ-21

Initiating Actor: Customer

Actor's Goal: Make a reservation for a parking spot

Participating Actors: Customer, Garage Website, Database

Preconditions: \*An account with sufficient information for reservation  
\*Website with garage status

Postconditions: Database updates and marks specific spot as occupied

Flow of Events for Main Success Scenario:

- > 1. The customer goes to the website and choose to reservation
- <- 2. The system check current cookie
  - a. If customer is logged in, continue to step 4.
  - b. If customer is not logged in, continue to step 3.
- <- 3. The system returns a login page, when customer finishes logged in, continue to step 4.
- <- 4. The system returns a reservation page.
- > 5. The customer enters calendar time period and specific spots to reservation data fields.
- <- 6. The system checks the database of reservation informations.
  - a. If there are available spots in selected time period, system will returns a UI page that indicating available spots for customer to choose, continue to step 7.
  - b. If there are no available spots in selected time period, system will pop a message that no available spots, back to step 5.
- > 7. The customer selects a parking spot.
- <- 8. The system pop a message that reservation succeeded, send text and email confirmation to customer; database updates.

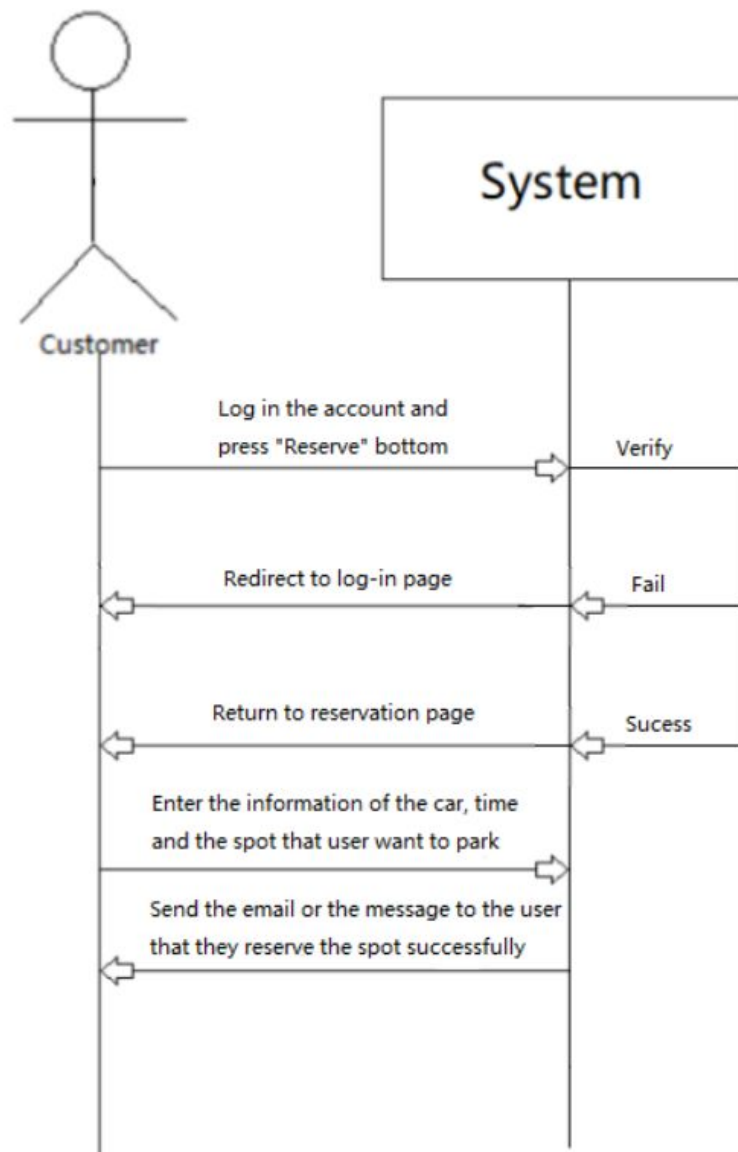


Figure 3 :Reservation Process

Use Case UC-3: Entering the garage

Related Requirement: REQ-3, REQ-6, REQ-7, and REQ-8

Initiating Actor: Customer

Actor's Goal: Park in to the desired spot

Participating Actors: Customer, License Plate Camera, Database, Parking spot sensor

Preconditions: \*A reservation to guarantee a parking spot.  
\*N/A for non ad-hoc customer

Postcondition: \*If a new vehicle has parked, the database will be updated. Marking the spot as occupied.

Flow of Event for Main Success Scenario:

- > 1. The customer drives to the garage gate.
- <- 2. The camera will scan the plate of the vehicle.
  - a. If the customer has a reservation, it will be guided to the reserved parking spot.
  - b. If the customer has no reservation, system continue to step 3.
- <- 3. The system requests information from database to check the availability of parking spots.
  - a. If there is available spots, system continue to step 4.
  - b. If there is no available spots, system continue to step 5.
- <- 4. The system will guide the customer to nearest available spot with LED screen direction.
- <- 5. The system will show no available spots, customer has to leave.
- > 6. The customer drives in or leaving garage.

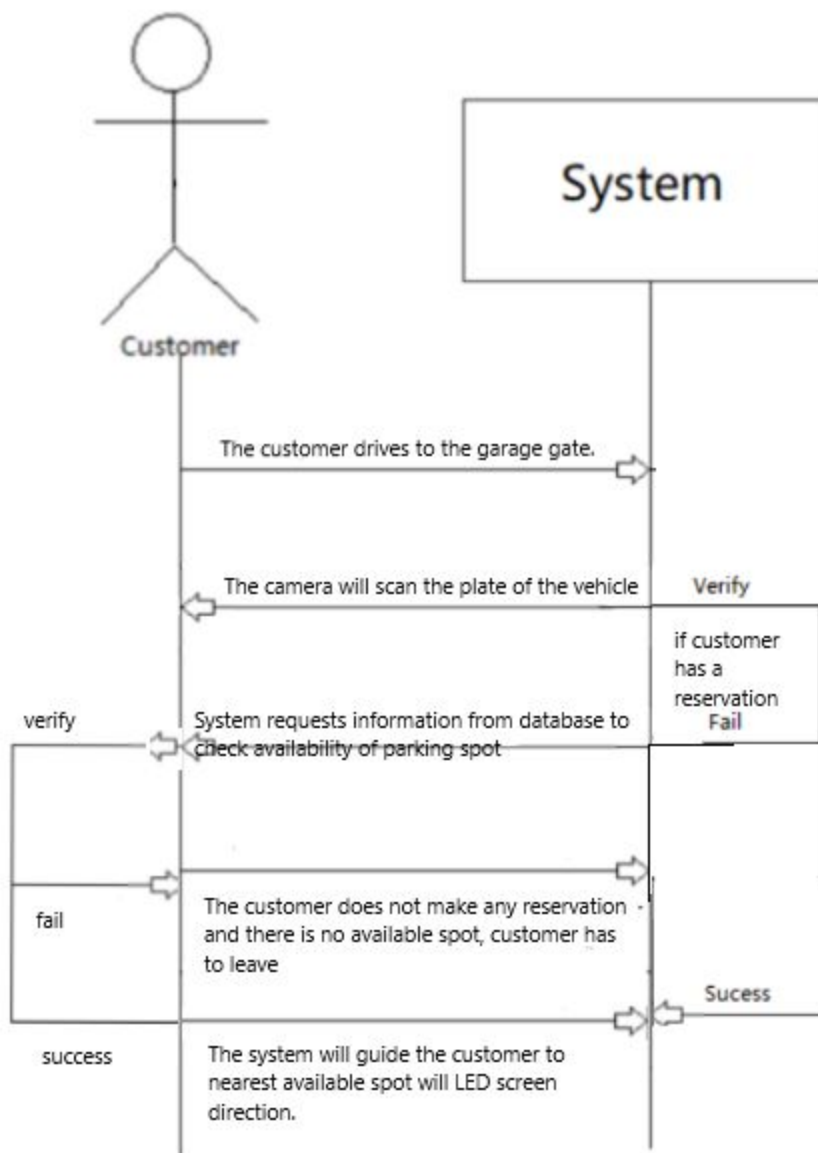


Figure 4 :Entering garage process

#### Use Case UC-4: Online Payment

Related Requirement: REQ-14, REQ-15, REQ-16, and REQ-18

Initiating Actor: Customer

Actor's Goal: Pay for their parking fee

Participating Actors: Customer, Database, License Plate Camera, Owner

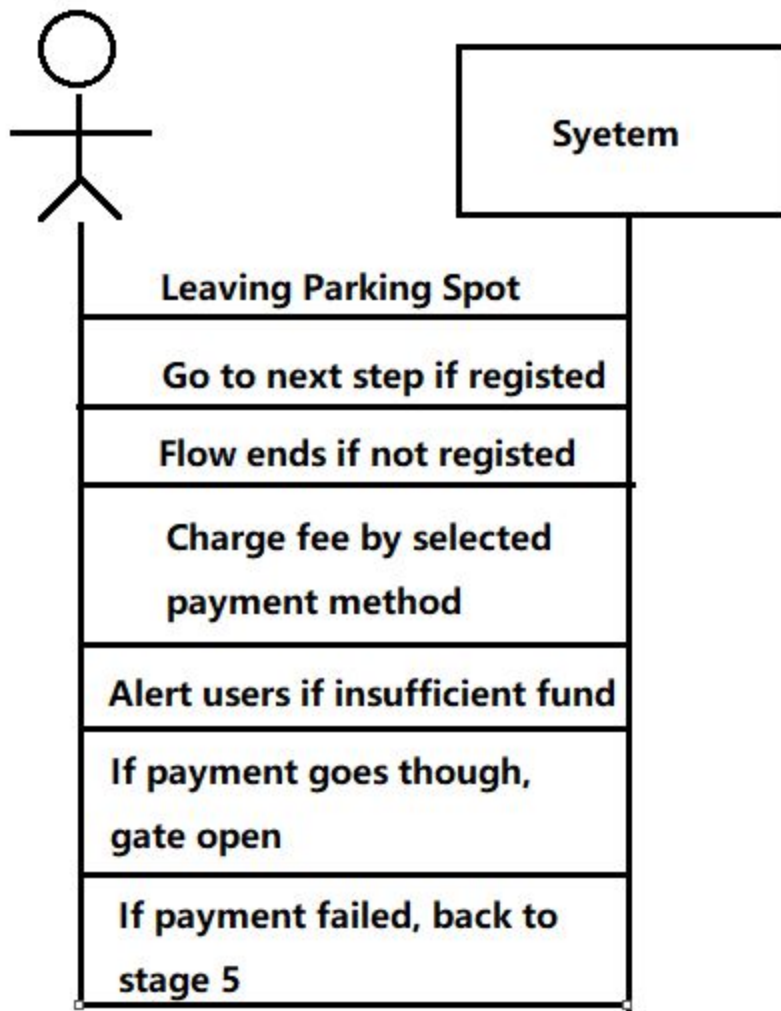
Preconditions: \*The registered customer about to leave garage.

Postconditions: Gate will open to let customer leave.

Flow of Event for Main Success Scenario:

- > 1. The customer drives its car leaving parking spot.
- <- 2. Sensor indicate system that customer is leaving, system check
  - a. If the customer is a registered customer, continue to step 3.
  - b. If the customer is not a registered customer, flow ends.
- <- 3. The system check the account balance and payment linking for valid payment
  - a. If the customer has valid payment method, continue to step 4.
  - b. If the customer doesn't have valid payment method, continue to step 5.
- <- 4. The system will charge the parking fee from customer's valid payment method.
- <- 5. The system will use LED screen, text and email to notify customer that insufficient funds.
- > 6. Customer drives to main gate.
  - a. If the customer has paid, continue to step 7.
  - b. If the customer hasn't paid, returns to step 5.
- <- 7. Security system will open the gate.





Full Description Case 4

## Section 4: User Interface Specification

outline:

\*user enters the website - can login or sign-up:

sign-up : requires a license plate number & valid e-mail address

newcomers are prompted to create an account via a dynamically generated QR code which will not only link the user to the sign-up page but pre-fill the license plate number.

account is in use, but once the new user parks, they are prompted to enter a valid Email address and create a password.

after verification, user legit owns the account

a card reader is at the exit; if at this point the user hadn't yet specified a credit card #, they must swipe, after which the data will automatically be saved to their account for them

those who have already registered don't have to do anything but drive in and then drive out

one click to confirm license plate number

\*user parks\*

one click to select parking spot

form entry : e-mail

form entry : password

form entry : password again

one click to press ok

if not (form entry : credit/whatever card number) then

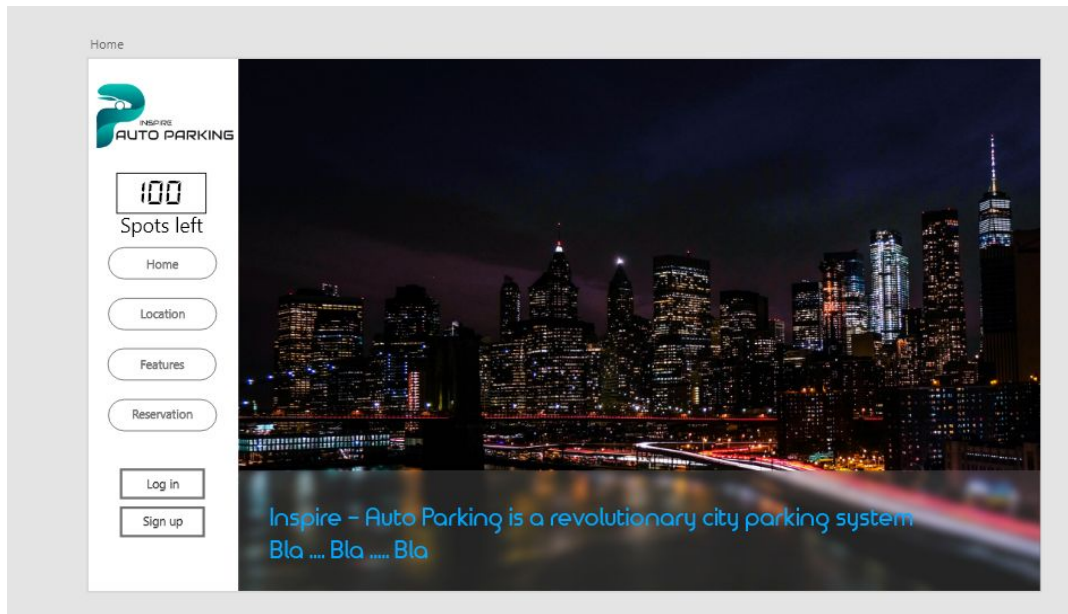
swipe card reader on exit

a logged in user may modify information in their account from a single form

then a save button at the bottom applies the changes

## User Website Preview

### Home Page UI




In the home page, depending on the user's choice of action, there will be 1 mouse click for navigation and 0 keystroke.


1 mouse click, 1/1 navigation, 0/1 clerical data entry.

0 keystroke,

## Reservation Page With User Logged In

Reservation With Logged In

 User #1



100  
Spots left

ReservationFeaturesLocationHome

Make Reservation for A New Vehicle:

Location:

Car Brand:

Car Model:

Car Plate:

VIN:

Add This Vehicle

Make Reservation for A Registered Vehicle:

Location:

Registered Vehicle:

Date:

Arriving Time:

Leaving Time:

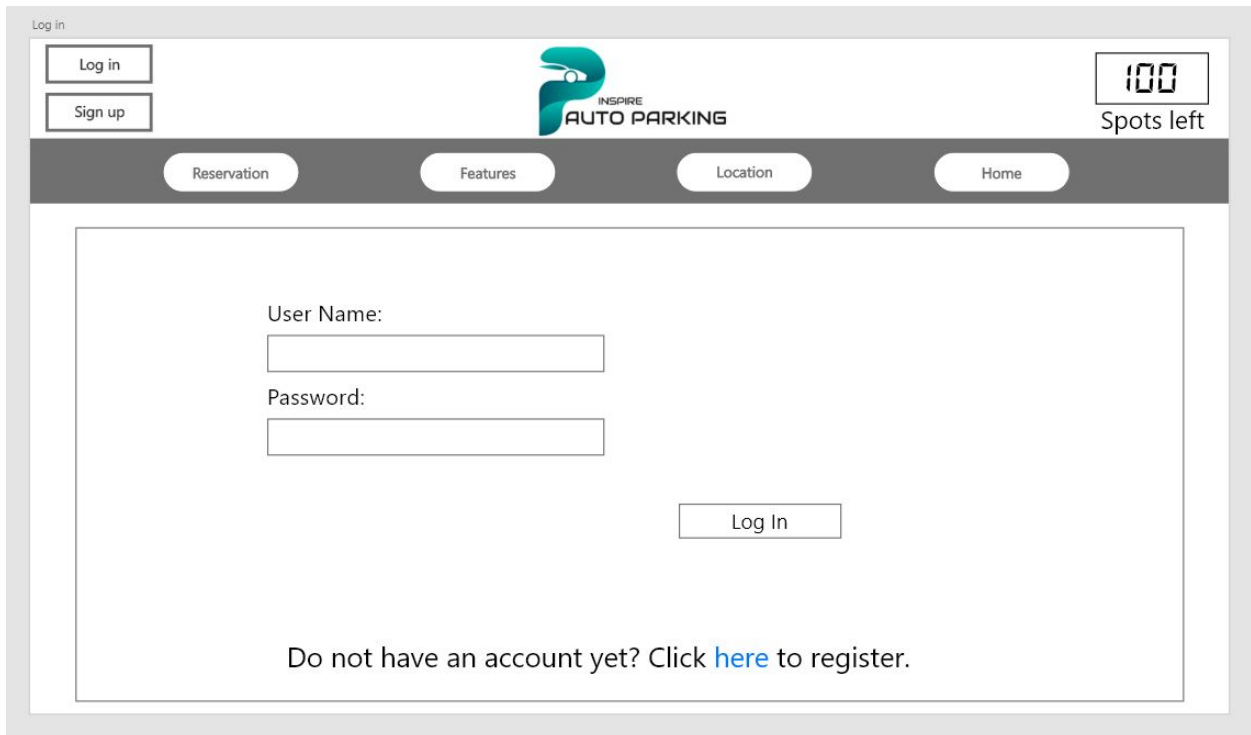
Make Reservation Now

In this page, the user will perform 16 mouse clicks since they have to click on the arrow to show all the detailed information of each block and another click to choose one option. 8/16 of the mouse clicks will be clerical data entry and the rest will be for navigation. And 17 keystrokes will be needed for the VIN number, at least 6 keystrokes will be needed for the Car plate (based on car plate in NJ). 23/23 of the keystrokes are clerical data entry.

16 mouse clicks. 8/16 clerical data entry, 8/16 navigation.

23 keystrokes. 23/23 clerical data entry, 0/23 navigation.

## Login Page



The screenshot shows a web browser window with the title "Log in". The page features a header with a "Log in" button, a "Sign up" button, the "INSPIRE AUTO PARKING" logo, and a "Spots left" counter displaying "100". Below the header is a navigation bar with buttons for "Reservation", "Features", "Location", and "Home". The main content area contains a login form with labels "User Name:" and "Password:" followed by input fields. A "Log In" button is positioned below the password field. At the bottom of the form, there is a link: "Do not have an account yet? Click [here](#) to register."


In this page, 1 mouse click is needed for navigation, keystroke base on their username and password.

1 mouse click. 0/1 clerical data entry. 1/1 navigation.

n Keystroke. n/n Clerical data entry. 0/n navigation.

## Reservation Page Without User Logged In

Reservation Without Logged In



100

Spots left

Reservation

Features

Location

Home

You do not log in yet, please log in first to make a reservation

User Name:

Password:

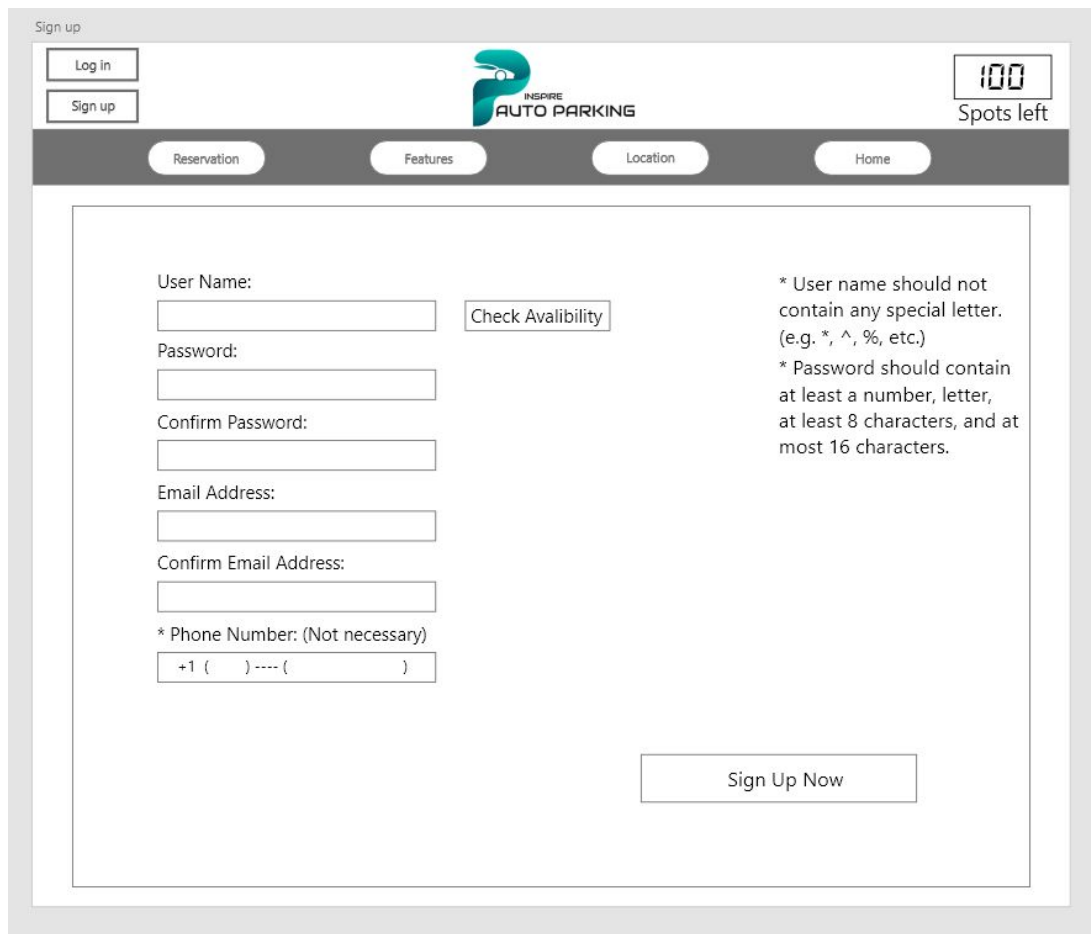
Do not have an account yet? Click [here](#) to register.

In this page, 1 mouse click is needed for navigation, keystroke base on their username and password.

1 mouse click. 0/1 clerical data entry. 1/1 navigation.

n Keystroke. n/n Clerical data entry. 0/n Navigation.

## Sign Up Page



The image shows a web page titled "Sign up" for "INSPIRE AUTO PARKING". The page has a header with a "Log in" button, a "Sign up" button, the company logo, and a "Spots left" counter showing "100". Below the header is a navigation bar with buttons for "Reservation", "Features", "Location", and "Home". The main content area contains a sign-up form with the following fields and instructions:

- User Name:** A text input field. To its right is a "Check Availability" button. A note states: "\* User name should not contain any special letter. (e.g. \*, ^, %, etc.)"
- Password:** A text input field. A note states: "\* Password should contain at least a number, letter, at least 8 characters, and at most 16 characters."
- Confirm Password:** A text input field.
- Email Address:** A text input field.
- Confirm Email Address:** A text input field.
- \* Phone Number: (Not necessary)** A text input field with a placeholder "+1 ( ) ---- ( )".

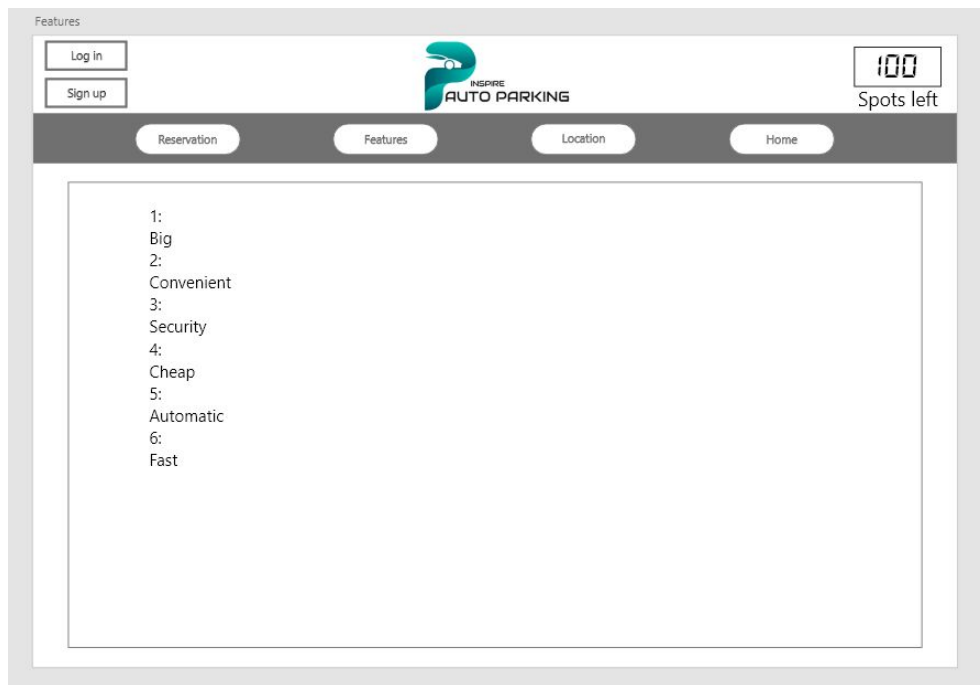
A "Sign Up Now" button is located at the bottom right of the form area.

In this page, there will be 2 mouse clicks. 1 of them is clerical data entry to check availability. The other one is for navigation. Keystroke counts based on user's choice.

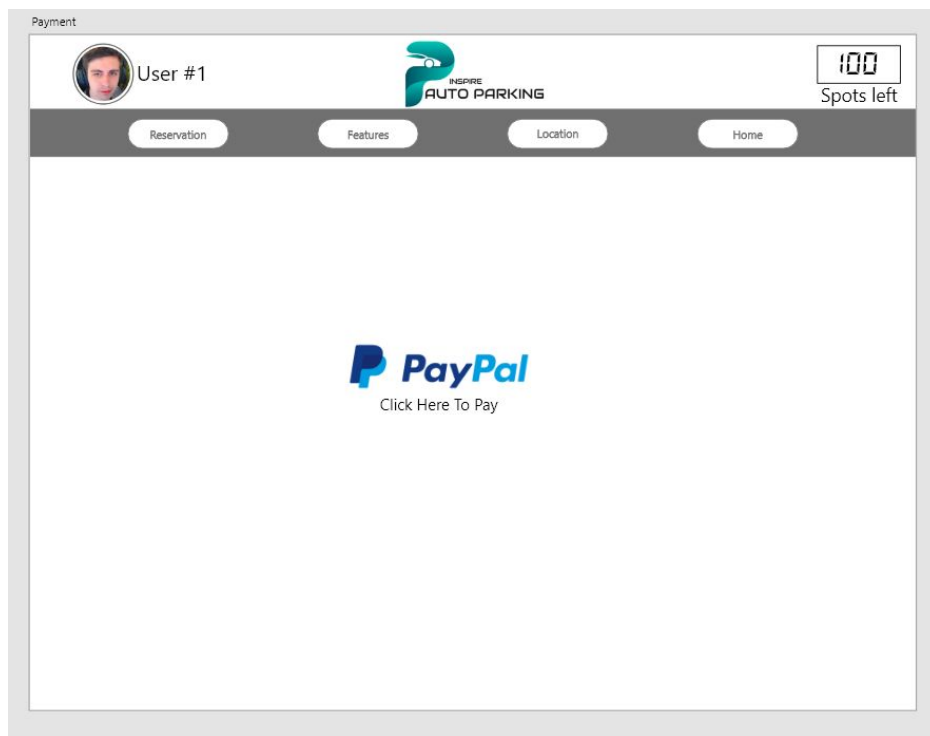
2 mouse clicks, 1/2 clerical data entry. 1/2 navigation.

n key strokes. n/n clerical data entry. 0/n navigation.

## Features Page



## Payment Page






## Location Page

Location

Log in

Sign up



100


Spots left

Reservation

Features

Location

Home




Inspire Parking Deck

Address: XXX XXX St., New Brunswick, NJ 08901

If you have any question or suggestion about Inspire - Auto Parking service, click [here](#) to send us an email.

## Background management Toolset UI Preview

Inspire auto parking background management system



Inspire Auto Parking Monitor

Parking Spot 1

status: ☐

License Plate: Z33 JZR

Make: VW

Color: Red

Fee Rate: 10\$/hr

Parking Period: 0:00:00

Pay Status: ☐

Pay by Cash

Parking Spot 2

status: ☐

License Plate: A45 KSF

Make: NISSAN

Color: Grey

Fee Rate: 10\$/hr

Parking Period: 0:00:00

Pay Status: ☐

Pay by Cash

Disabled Parking Spot 1

status: ☐

License Plate: N21 HTR

Make: Jeep

Color: Black

Fee Rate: 10\$/hr

Parking Period: 0:00:00

Pay Status: ☐

Pay by Cash

Electric Vehicle Parking Spot 1

status: ☐

License Plate: J22 JBP

Make: NISSAN

Color: Black

Fee Rate: 10\$/hr


Parking Period: 0:00:00

Pay Status: ☐

Pay by Cash

Inspire auto parking system background management toolset

## Inspire auto parking system background management toolset Login Preview



Inspire Parking

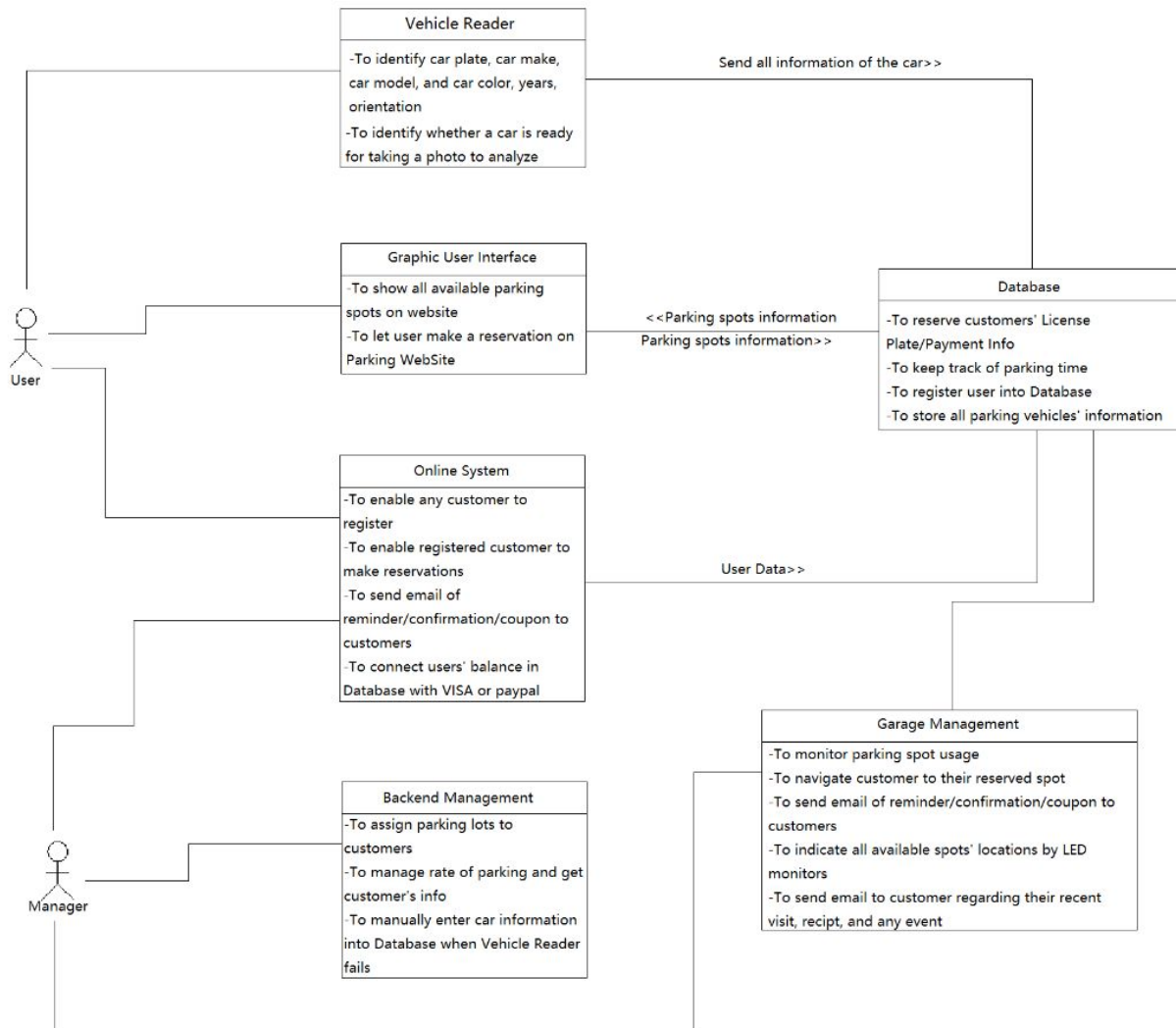
User Name / Email

Passwords

Sign In

## Section 5: Domain Analysis

### Domain Model Diagram



### Domain Model Derivation

The domain model above was derived from the use cases and the requirements. We categorize all the functional requirements into different concepts (database, online system..etc). With only a few concepts, it's easy for us to show how all the participating actors are connected.

As the customer approaches the garage gate, the pressure sensor will be triggered, causing the camera to take a picture of the car plate. After that, the picture will be transmitted to the plate recognizing API we are using. After that, the system will determine whether the customer has reservation or not. Then the customer will be guided to their reserved spot or empty spot for ad-hoc customers. After parked, that specific spot will be marked as occupied and will be updated to the database. That's the end of the parking process. The customer will be able to check their parking time and current rate during their parking. Also, all the information is available to the garage manager all the time.

All the concepts are interacting with the database and the database can only be accessed by the manager to ensure the security.

### **I. Concept definitions**

<b>Responsibility Description</b>	<b>Type</b>	<b>Concept</b>
To reserve customers' License Plate/Payment/Balance/Vehicle Info	N	Database
To identify car plate, car make, car model, and car color	D	Vehicle Reader
To identify whether a car is ready for taking a photo to analyze	K	Vehicle Reader
To monitor parking spot usage	K	Garage Management
To enable any customer to register	D	Online System
To enable registered customer to make reservations	D	Online System
To register user into Database	K	Database
To navigate customer to their reserved spot	D	Garage Management
To show all available parking spots on website	K	Online System
To send email of reminder/confirmation/coupon to customers	D	Garage Management
To assign parking lots to customers	D	Backend Management
To manage rate of parking and get customer's info	D	Backend Management
To manually enter car information into Database when Vehicle Reader fails	D	Backend Management
To register user into Database	D	Database
To manually enter car information into Database when Vehicle Reader fails	D	Online System
To indicate all available spots' locations by LED monitors	K	Garage Management
To connect users' balance in Database with VISA or paypal	N	Online System
To send email to customer regarding their recent visit, receipt, and any event	D	Garage Management

### **II. Association definitions**

Concept Pair	Association Description	Association Name
Vehicle Reader ↔ Database	Vehicle reader identifies car plate, model and color, sending the information to the database. Database stores these information for future use	Store car info
Online System ↔ Database	Online System collects the user data and send them to database. Online System also retrieves parking spots information from database for users to make reservation.	Store and Exchange Informations
Garage Management ↔ Database	Garage management retrieves parking information from database. Garage management system displays spots information on LED display. Garage management also send notification to registered user via email or text to inform any information users are interested in or parking events.	Get Parking Info
Backend Management ↔ Database	Backend Management control and edit Database	Modifying data
Security System ↔ Garage Management	Security System requests information from Garage Management and determine necessary actions	Security Checking

### III. Attribute definitions

Concept	Attributes	Attribute Description
Login request	Customer	Used to determine the identity of customer and determine the rate of parking
	Manager	Used to determine if user have the authority to backend management page
Preprocessor	License Plate Recognition	Get results of LPR system from API; need to specify every information from API and transmit info to backend management
Management	Database	List of customer info for make reservation/payment
	Manage Toolset	UI which hold useful tools for manager to manipulate the rate of parking
Payment Request	Website	Used to initiate a online payment
Notification	E-mail	Contact customers to notify them for confirmation and discounts

### IV. Traceability matrix — show how your use cases map to your domain concepts.

PW	Use Cases	Vehicle Reader	Online System	Database	Garage Management	Backend Management
10	UC-1		✓	✓		
10	UC-2		✓	✓	✓	
9	UC-3	✓		✓	✓	
8	UC-4		✓	✓	✓	
8	UC-5		✓	✓		
5	UC-6			✓	✓	
4	UC-7		✓	✓	✓	
5	UC-8			✓		✓
4	UC-9			✓	✓	
7	UC-10	✓	✓	✓	✓	
6	UC-11	✓	✓	✓	✓	
7	UC-12	✓		✓	✓	
7	UC-13	✓		✓	✓	
6	UC-14				✓	

### System Operation Contracts:

#### UC-1:Registration

##### -Preconditions:

- Manager needs a functional database
- The customer is not in the manager's database
- The customer needs to enter a valid username, email address

##### -Postconditions:

- The customer's account will be stored in database

#### UC-2:Reservation

##### -Preconditions:

- The customer needs to have an account with sufficient information for reservation
- The manager needs to offer the website with garage status

##### -Postconditions:

- Database updates and marks specific spot as occupied
- UC-3: Entering the garage
  - Preconditions:
    - A reservation to guarantee a parking spot.
    - N/A for non ad-hoc customer
  - Postconditions:
    - If a new vehicle has parked, the database will be updated. Marking the spot as occupied.
- UC-4: Online Payment
  - Preconditions:
    - The registered customer about to leave garage.
  - Postconditions:
    - Gate will open to let customer leave.

## Section 6: Project size estimation based on Use Case Points.

### Use Case Classification

UUCP:  $6(15)+5(10)+3(5) = 155$

Use Case	Description of relevant Characteristics	Complexity	Weight
UC-1 Registration	Simple website GUI. 5 steps for the main success scenario. 2 participating actors	Average	10
UC-2 Reservation	Complex website GUI. 8 steps for the main success scenario. 3 participating actors	Complex	15
UC-3 Entering Garage	No UI. 6 steps for the main success scenario. 3 participating actors	Average	10
UC-4 Status Check	No UI. 4 steps for the main success scenario. 3 participating actors	Average	10
UC-5 Online Payment	Complex website GUI. 6 steps for the main success scenario. 2 participating actors	Complex	15
UC-6 Emergency Alert	No UI. 3 steps for the main success scenario. 2 participating actors	Simple	5
UC-7 Cancel Reserve	Simple website GUI. 5 steps for the main success scenario. 3 participating actors	Average	10
UC-8 Price Manage	Simple backend GUI. 4 steps for the main success scenario. 2 participating actors	Simple	5
UC-9 Notification	Text based interface; 2 participating actors; 2 steps success scenario	Simple	5
UC-10 Reserved Park	Display interface; 4 participating actors; 4 steps success scenario.	Complex	15

UC-11 Ad-Hoc	Display interface; 4 participating actors; 5 steps success scenario.	Complex	15
UC-12 Enter spot	No interface needed; 3 participating actors; 3 steps success scenario.	Complex	15
UC-13 Leaving Garage	No interface needed; 3 participating actors; 3 steps success scenario.	Complex	15
UC-14 Ad-Hoc Pay	Website GUI; 2 Participating actors; 3 steps success scenario.	Average	10

### Technical Complexity Factors (TCFs)

Technical Factor	Description	Weight	Perceived Complexity	Factor (W*PC)
T1	Distributed, Web-based system	2	3	6
T2	User expect good performance but nothing exceptional	1	3	3
T3	End-user expects efficiency	1	3	3
T4	Internal processing is relatively complex	1	3	3
T5	No requirement for reusability	1	0	0
T6	Ease of install is moderately important	0.5	3	1.5
T7	Ease of use is very important	0.5	5	2.5
T8	No portability requirement, system is web-based	2	0	0
T9	Adding payment methods into the system	3	2	6
T10	Concurrent use is required	1	4	4
T11	Security is a significant concern	1	5	5
T12	Third parties included	1	3	3
T13	No unique training needs	1	0	0



Technical Factor Total:	37
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## Section 7: Plan of Work

By submitting the first report, it means we are almost done for the conceptual part. From now on, the major concern is how to accomplish all the requirements. All the work are assigned to subgroups so that we can work on different aspects simultaneously. There are four major parts: Database constructing, GUI design, Website and a fully functional garage model for DEMO.

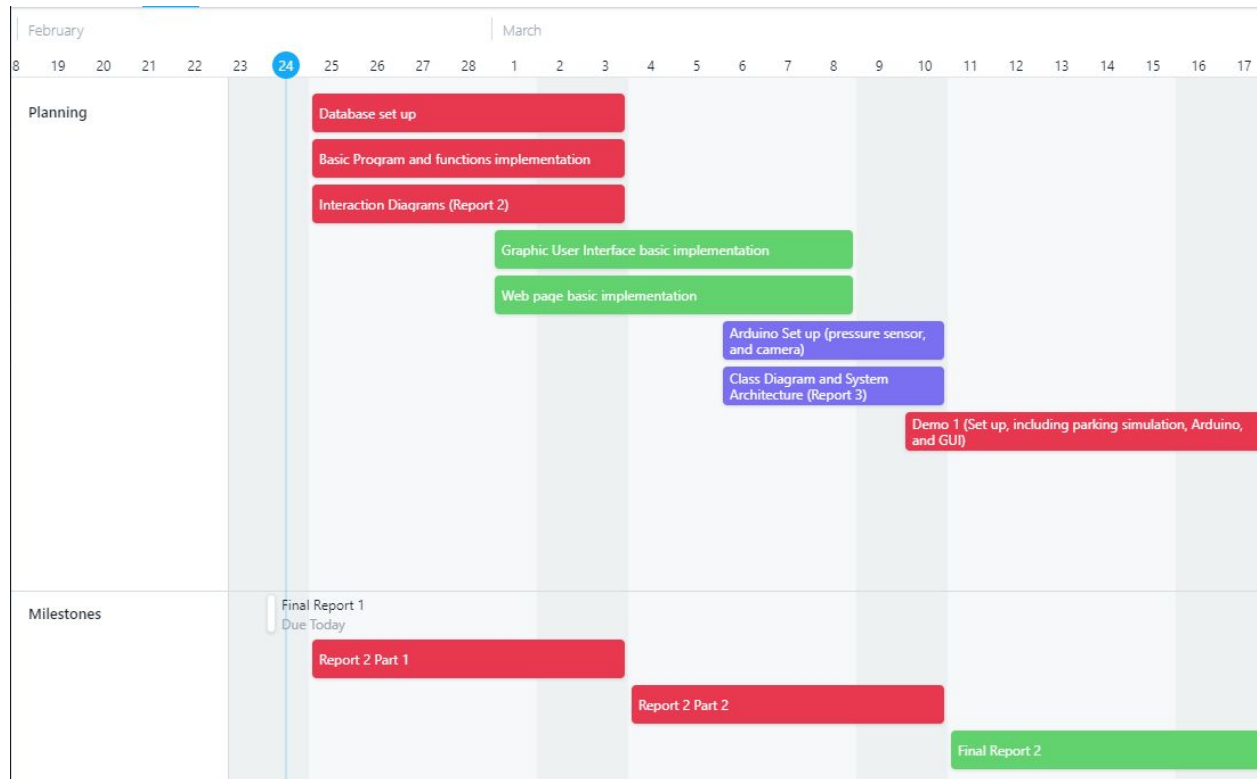
Database: Use MySQL to accomplish database.

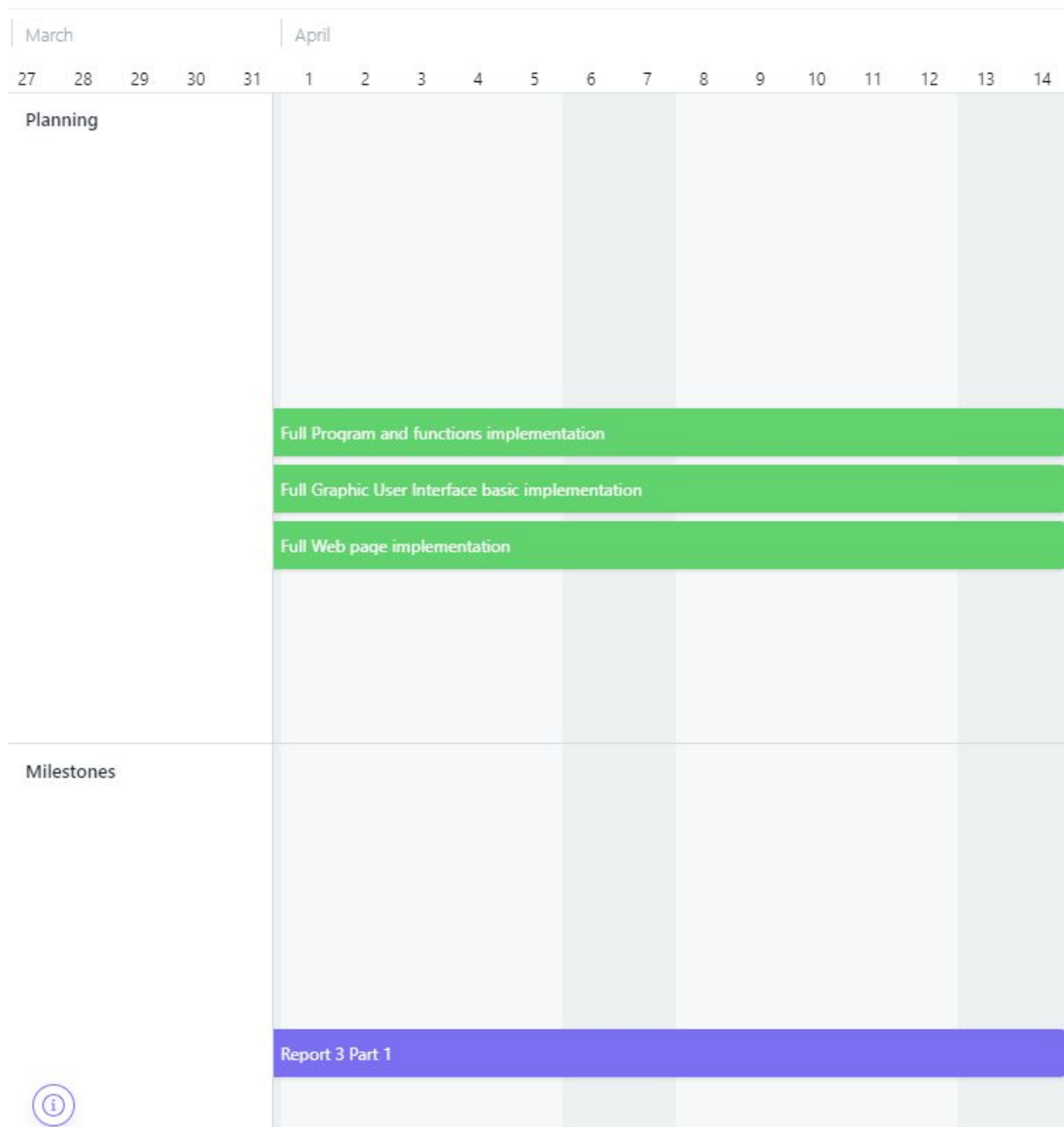
GUI design: Implement the previous design with JAVA FX (via. SceneBuilder).

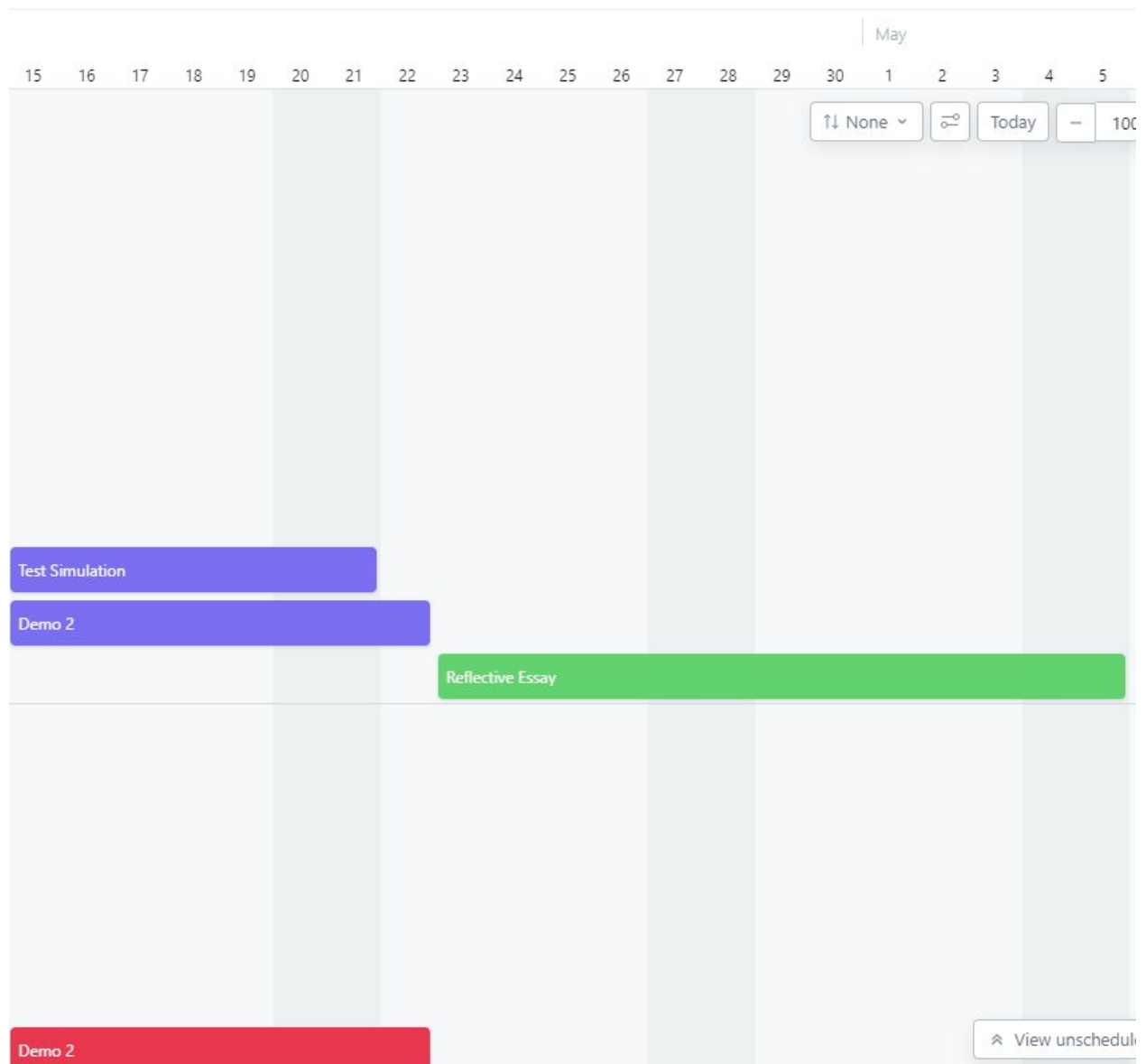
Website: Done with user interface designing and implementing.

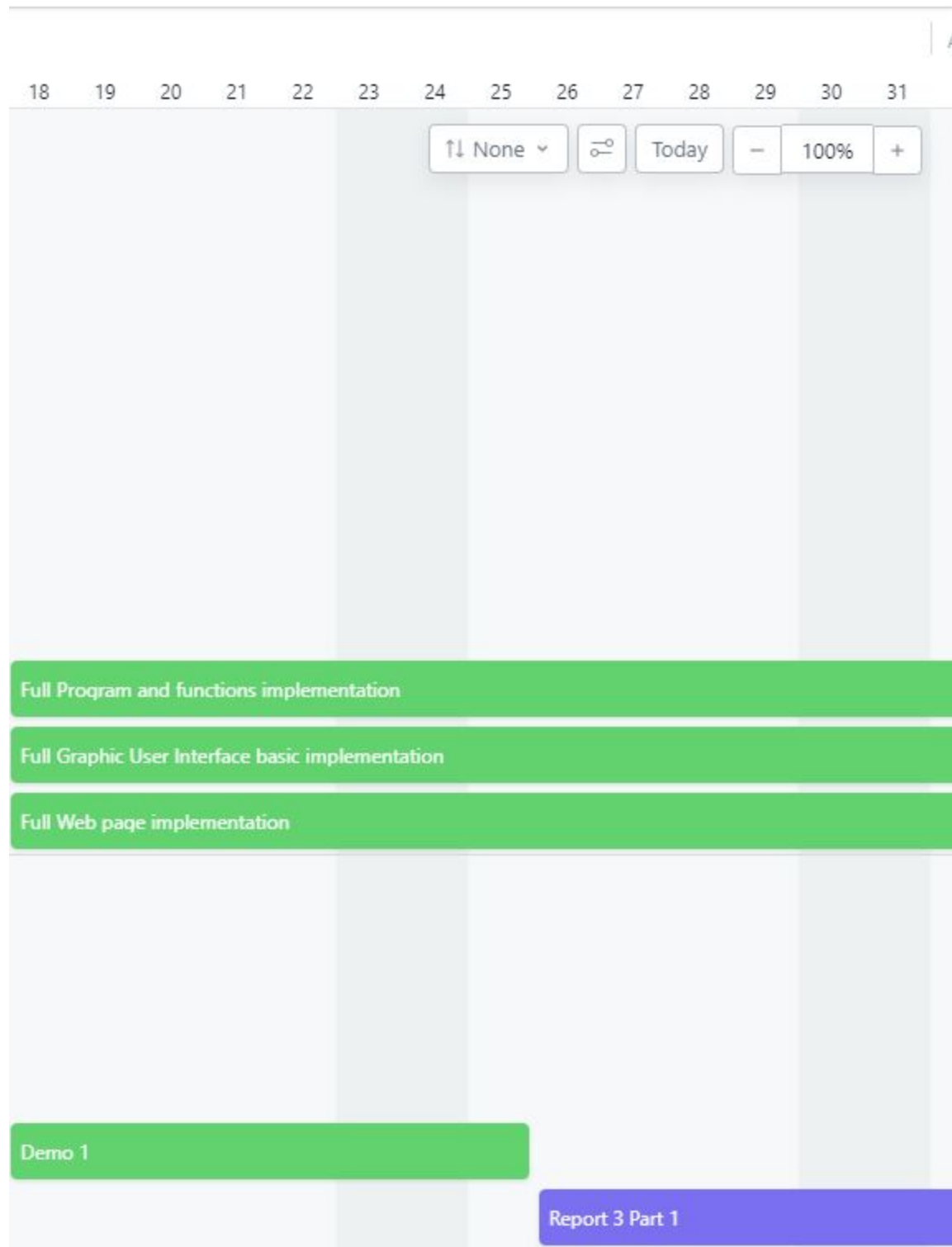
Model for DEMO: Fully functional sensor and camera setup.

After achieving the short term goal, we will start to focusing on the connection and compatibility between each parts. Improve the compatibility as well as the design and functionality of each part. We'll check the progress every week and set the goal for next week.









## **Project Management**

### **Subgroup #1 - (Software & Communication)**

Members:

- Christopher Cheng
- Samuel Cho

Contributed Functionality:

- Parking Spot Reservation
- Parking Lot Visualization

Contributed Qualitative Property

- Develop clean and easy-to-use online UI

### **Subgroup #2 - (Direction and Account System)**

Members:

- Zhuohuan Li
- Tingcong Jiang

Contributed Functionality:

- Account-User Information Binding
- Customer Account Registration

### **Subgroup #3 - (Hardware + Arduino)**

Members:

- Buyuan Lin
- Yiran Tan

Contributed Functionality:

- Parking Lot Status Acquisition
- Parking Lot Management

### **Subgroup #4 - (Test & Development)**

Members:

- Chenyu Cao
- Shijie Xu

Contributed Functionality:

- Online Payment
- Data Submission

Occasionally, a group meeting will be held to enable effective discussion between subgroups and allow team members to showcase their progress. For now, there is no fixed time or location for these meetings; they are simply organized when the majority of the team feels that one is needed, or would be convenient. When this happens, the time and place of the meeting is

discussed on the GroupMe social platform and/or through one or more of Google's services (e.g. Google Docs, GMail).

The general procedure for written reports begins with an initial draft wherein we generally disregard grammar and sentence structure in favor of getting critical details and information into the document as quickly as possible. This way, team members can spend more time brainstorming and improving each other's ideas instead of getting stuck deliberating on what diction to use and how to word a particular sentence. Only after all team members agree that what's written in the document properly expresses the state of our project do we then format everything into proper English.

Each subgroup consists of two team members who are capable of taking over for the other in the case that one, for any reason, is unable to finish his assigned contribution. In the case that both members from any one subgroup are unable to deliver, the subgroup in question should express this to the rest of the team as soon as possible through one or more of the previously established avenues of communication. One or more subgroups can then take over the duties of the defunct subgroup until it recovers.

First we need to procure the materials needed to initialize the project within the next two weeks. On the hardware side, the most practical piece of equipment that comes to mind is an Arduino board, which we can connect to various sensors (for example, distance sensors to determine vacancy), cameras, and displays. Two plate-reading cameras will be configured to log entry and exit times. On the software side, we are planning to implement a plate recognition algorithm and set up a database for the organization of user account information.

To test our system, we are planning to construct a simulation parking lot model. A program will simulate a virtual parking lot, complete with virtual customers and their virtual cars, and interpret information from simulated sensors. The filtered information can be sent to our online services to test the UI and other parts of our system. In order to observe how our system responds to different situations, we can apply various situations to our virtual parking lot. For example, we can induce a huge influx of cars to see how our system handles the sudden

traffic. Once the system appears to work for the most part in our virtual environment, we may then proceed to use actual hardware to confirm that the system actually works. This is an important step in our process, since real-life sensors usually give fuzzy data that can be difficult for software to properly interpret. In other words, the virtual parking lot gives us an indication of how well our system manages information from various sensors, and our hardware experiments tell us how well our system can obtain that information in the first place.



## References

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Hedges & Company. (2019). *US VIO Vehicle Registration Data 2018, Fast Quote on Car Data*. [online] Available at: <https://hedgescompany.com/automotive-market-research-statistics/auto-mailing-lists-and-marketing/> [Accessed 7 Feb. 2019].

Rasmussen, I. (2016). *A Major Parking Garage Problem*. [online] Strong Towns. Available at: <https://www.strongtowns.org/journal/2016/11/21/major-parking-garage-problem> [Accessed 8 Feb. 2019].