



LICENSE PLATE RECOGNITION SYSTEM

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INTRODUCTION

Automatic Number Plate Recognition (ANPR) system is an important technique used in intelligent transport System (ITS), which provides services to different modes of Transport and traffic management. ANPR system is an advanced machine vision technology used to identify vehicles by their number plates without direct human intervention. It is a challenging problem in the field of machine vision and automation with various applications such as parking lot ticketing system, automated hands free toll collection, automated vehicle access in secure establishments, law enforcement, border security and custom security etc. The whole ANPR system is generally framed into 3 steps:

1. Number Plate Detection,
2. Character Segmentation and
3. Character Recognition.

In the Number plate detection work, many techniques have been proposed such as: statistical analysis of Discrete Fourier Transform (DFT) of the plate signal, global edge features and Haar like features, wavelet transform and EMD (Empirical Mode Decomposition) analysis, region and edge based methods and sliding window technique for efficient number plate localization based on discrete wavelet transform Morphological In the characters segmentation module, there are also some techniques to address this work such as: edge detection, color model transform, connected components analysis an intelligent framework that outlines character of car number plate by various illuminations

Horizontal projection multi-clustering algorithm threshold and connected components horizontal and vertical projections Color reverse, vertical edge detection, horizontal projection histogram, vertical projection morphology operation and connected components In the characters recognition module, there are also many techniques to address this work such as: color image processing hidden Markov model support vector machine [9], multi-cluster and multilayer neural networks Least squares support vector machines multi-layer perceptron network template matching fuzzy multilayer neural Bayesian framework radial basis function neural networks. Although, there are many method proposed for ANPR system.

But, there is not a single method can provide satisfactory performance in all the applications in various complicated background such as: uncertainty of edges, various types of plate, the plate is small, dim lighting low or high illuminated images, types of plate, colors, character fonts, syntax, size, angle of the number plate, weather and environment, multi-rows, Kannada number plates.

To cope with these limitations, we have considered the Indian NP to propose a new method for the Indian ANPR system, which satisfied for all types of Indian NP. This paper is organized as follows: section I introduces Number plate Detection, section III shows the characters segmentation and recognition, section IV shows experimental results and section V is conclusions and the last is references.

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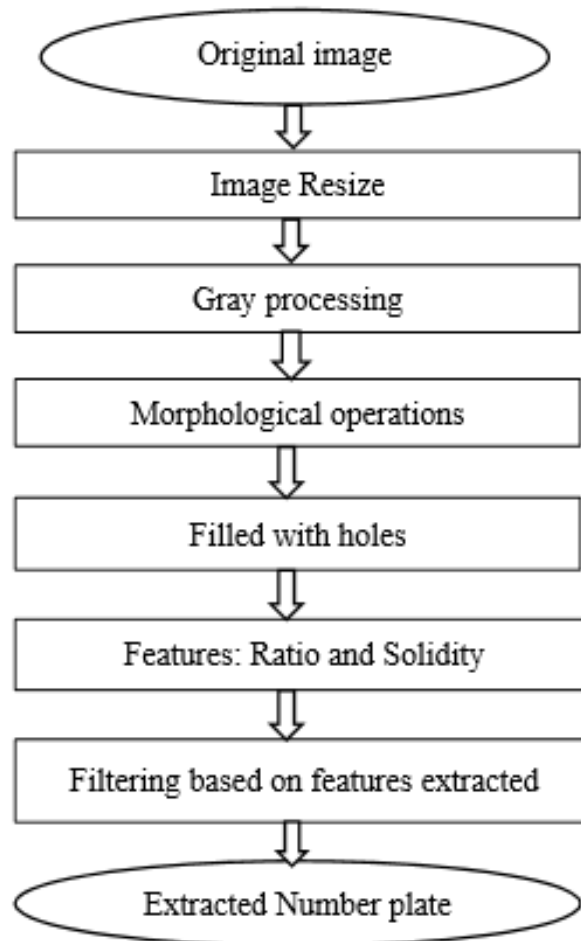
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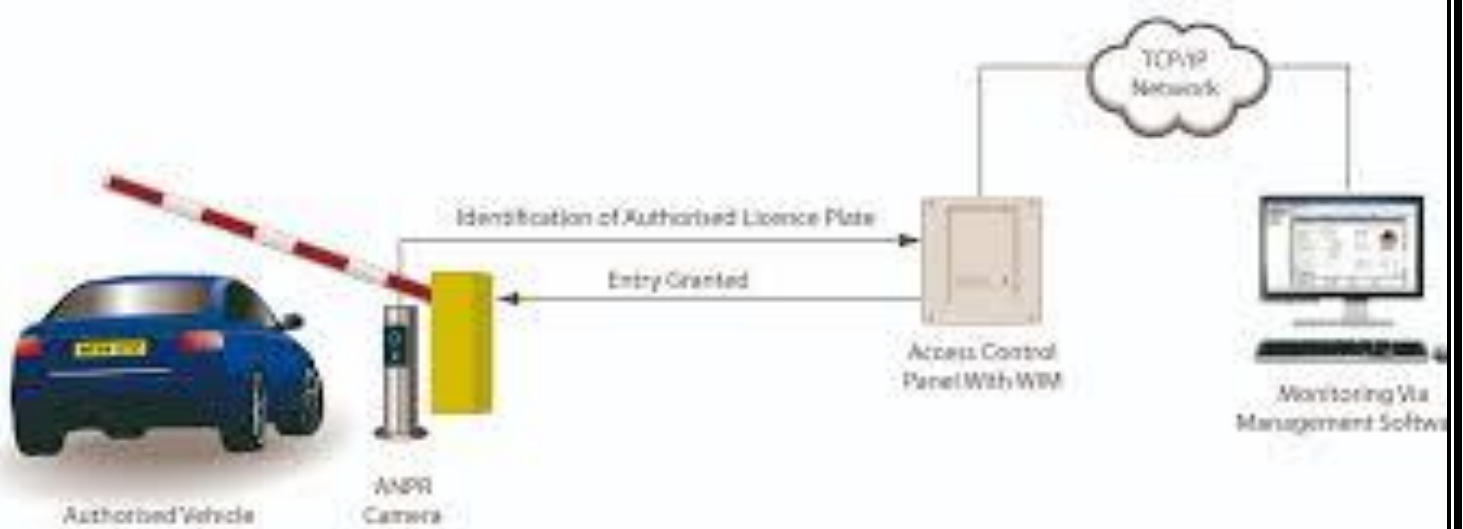
NUMBER PLATE DETECTION

The Plate detection phase aims at identifying the number plate area in the image. It is often composed of image pre-processing or plate enhancement phase that helps to enhance the signal in the number plate area and attenuate it elsewhere

Many difficulties occur during the detection and extraction of number plate due to the following reasons:

1. The efficiency of extraction is affected by complex background in an input image.
2. Variations in the position of number plate in different vehicles
3. Different size plates due to camera distance and zoom factor
4. Plates may have various characters and background colors due to different types of plates
5. Unwanted characters, frames and screws introduce confusion
6. Different font size, font style and different languages
7. Occlusion- plates may be obscured by dirt
8. Inclination – plates may be tilted Here we have considered all the above difficulties and worked on all of them. Our algorithm is able to recognize the number plate efficiently in all such difficulties as listed above.





Person Statement of Requirements

Statement of Goals

The main goals of this software development project is to maximize the occupancy and revenue of a parking area and develop a user-friendly mechanism and automatically extract number from vehicle number plate.

Problem Statement

The problems that are faced is as follows:

In this project, the main problem is to design and develop an automatic number plate recognition system for the application in a toll payment and for security purpose. With this project, the vehicles number plate will be automatically captured and the system will do all the images preprocessing method and the output will display using GUI.

Another side problem is to upgrade, improve and rewrite the algorithms to make sure it is convenient with present technology. It is challenge to the system to extract the images because the normal standard license plate number already has its own standard size and pattern.

Proposed Solution

In order to increase profits and reduce personnel costs a computerized system will be put into place to address all three problems suggested above.

The first problem of signaling to persons who may drive by the parking area and not know if any parking is available can be solved by implementing a display at the entrance of the parking area indicating if room is available to house persons driving in off the street. The second problem, congestion inside of the parking area, can be solved by assigning persons parking space numbers of spots in the parking area, so that the person will always know where the next available spot is. Finally, the third problem of not knowing if parking will be available for a given date and time will be solved by implementing a web-based system (a website) that will allow persons to create accounts and create reservations using that account. These reservations will be simple

guarantees that parking will be available for the selected date and time, removing the fear of being stuck in an area with no place to park.

To implement these changes, several new pieces of hardware will need to be adapted for use in the parking area. The system is based upon a multi-level parking area that has a vehicle elevator between levels. Cars may only enter the parking area through the elevator, and can leave through a one-way exit ramp. This elevator can only accommodate passenger vehicles, so large trucks and other high-capacity vehicles will need to be excluded from parking here.

The remaining hardware will handle detecting if a vehicle has entered the parking area, detecting a vehicle leaving the parking area, and determining if a vehicle is occupying a spot in the parking area.

The final piece of our solution is a delineation between person types: registered persons versus walk-ins. Registered persons have created accounts with the parking area's online service, and may make reservations in advance. Walk-ins are not associated with the online service and can only park when they drive in off the street. Since this business will derive a majority of its profits from repeat business of registered persons, we elect to have the ground level of the parking area allow only walk-ins to park, whereas the upper levels will be reserved for registered persons fulfilling reservations. It is possible that at some point in the future these restrictions could be eased, however the initial software solution will be kept simple.

The parking and reservation system will be nicknamed "Park-A-Lot".

Devices

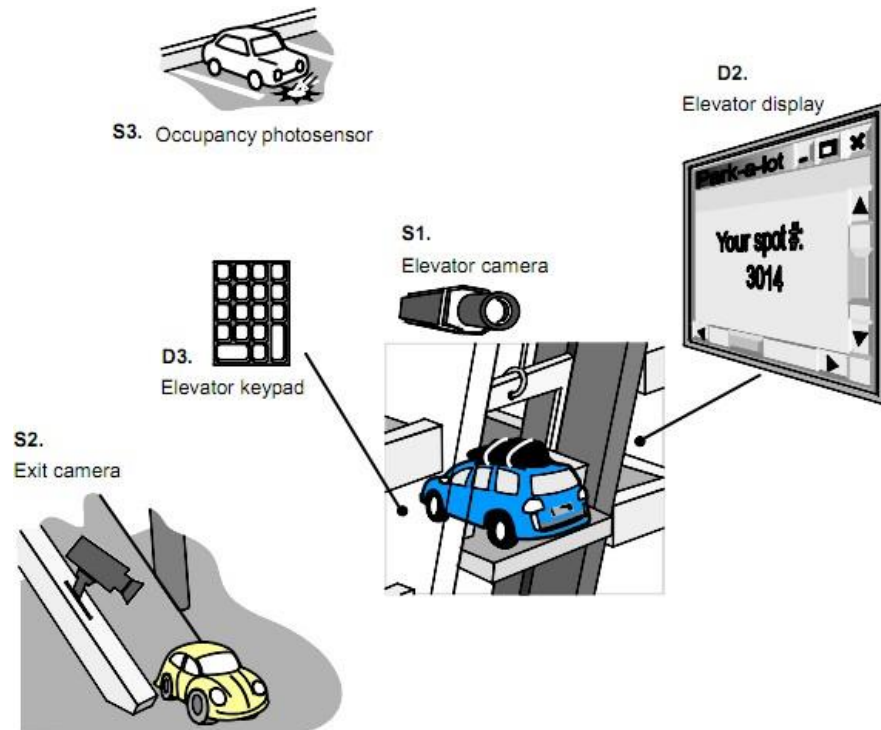
To accomplish the goals state above, Park-A-Lot will implement the following devices:

S1 & S2. The cameras will be installed to act as license-plate readers. S1 is the camera at the elevator and S2 is the exit camera. The cameras will be using the license-plate recognition system that are often used in tolls. The basic idea is that when a car arrives at the elevator platform, S1 reads the registration number and later on S2 will read the registration number of the vehicle leaving.

S3. There will be a sensor installed at the gate. This will help us determine whether the spot is available or not.

D1. The digital display at the elevator will display different messages according to the specific situation. The messages that might appear in this display are: denied access for non-registered persons or change/edit in the reservation of a registered person.

Although, this is not specifically a device, there will be a barrier at the gate so that no vehicles will try to enter.



Assumptions

Although our software solution will attempt to cover as many situations and scenarios as possible, the following general assumptions will be made.

A1. The camera's license-plate recognition system does not fail, meaning it is correct all the time, regardless if the plate is dirty or has damages. Also, if the registration number is not recognized by the system then it is assumed that the car does not correspond to any registered person.

A2. If the elevator camera's license-plate recognition system does not identify the registration number and the person fails to provide a correct one then the system will display a message on elevator display telling them to back up from the elevator. If this occurs then it is assumed that the person obediently leaves the elevator.

A3. The sensors that detect the occupancy of the spots work correctly all the time, disregarding any malfunctioning of the devices. Also, every time a sensor detects occupancy it is because a

vehicle is there and not another object.

A4. The elevator will lift the car to the corresponding deck and will not make any mistakes.

A5. The person will not fail to park at his or her assigned parking spot.

A6. If the system recognizes the vehicle's registration number then it is assumed that the person driving the car is a registered person

Image acquisition:

The first step is to acquire the input image of the vehicle. Images are captured by a digital camera at various distances from the camera. The better the quality of the input images are, the better conditions the number plate recognition algorithm has, and thus the higher number plate recognition accuracy can be expected to be achieved.

Image Resize:

The image to be segmented is rescaled. Resizing images involves reducing the pixel dimensions and using higher compression. Both of these actions reduce file sizes dramatically.

Gray processing:

Grayscale Image is known as an intensity, gray scale, or gray level image. Array of class `uint8`, `uint16`, `single` or `double` whose pixel values specify intensity values. For `single` or `double` arrays, values range from $[0, 1]$. For `uint8`, values range from $[0, 255]$. For `uint16`, values range from $[0, 65535]$. For `int16`, values range from $[-32768, 32767]$. Gray processing is a very important step in image processing, its result is the foundation of later steps. Resized image is converted into gray scale image.

Binary images might be too simple and cannot represent the picture character.

Color images are too complex and affect the processing speed and they do not help in identifying important edges or other features. The basic concept of gray conversion is to eliminate hue and saturation image while maintaining its luminance. The true color to gray-scale conversion is performed by
$$\text{Gray} = 0.299r + 0.587g + 0.114b$$

(1) Where Gray is the new pixel value and r, g, and b are red, green and blue values of the original pixel respectively.

Morphological operation:

Morphological image processing is a collection of non-linear operations related to shape or morphology of features in an image. Mathematical Morphology is a way of nonlinear filters, which could be used for image processing as well as noise suppression, feature extraction, edge detection, image segmentation, shape recognition, texture analysis, image restoration and reconstruction, image compression etc.

Dilation:

It is defined as the maximum value in the window. Hence the image after dilation will be brighter or increased in intensity. It also expands the image and mainly used to fill the spaces. It is the operation of lengthening or thickening in binary image.

Erosion:

It is just opposite to dilation. It is defined as the minimum value in the window. The image after erosion will be darker than the original image. It shrinks or thins the image.

Opening and Closing:

Both parameters are formed by using dilation and erosion. In opening, firstly image will be eroded and then it will be followed by dilation. In closing, the first step will be dilated and then the result of this is followed by erosion. Opening operation generally makes the contour of objects smoother, and disconnects narrow, discontinuous and remove thin protrusions. Closing operation makes an outline smooth, it usually eliminates discontinuity and narrows long, thin gap, clears up small holes and fills the ruptures of the contour line. Here morphologically open binary image is applied for the binary image from previous stage. It removes small objects. It removes from a binary image all connected components (objects) that have fewer than P pixels, producing another binary image BW2. This operation is known as an area opening. The default connectivity is 8 for two dimensions, 26 for three dimensions. To remove unwanted objects or regions, small dots and very big areas from an image, this operation is used here. We could have used close operation to perform removal of small and big objects from an image but comparatively this method gives better results.

Filled holes:

Hole filling may be defined as a background region surrounded by a connected border of foreground pixels. This process makes the detected regions from the previous step a solid object by removing black pixels on a white object. This helps in detecting the number plate region.

Feature extraction

Feature extraction in image processing is a technique of redefining a large set of data into a set of features of reduced dimensions. The result of the previous stage is the retention of a few candidate regions as possible number plates. Now we have to find which candidate is the true region and so two important features are used to discard the wrong candidate regions. These features are aspect ratio, and solidity.

1. Area:

The area is determined by counting the total number of non-zero pixels within the image. Area: $A = H \times W$

2. Aspect Ratio:

Aspect ratio describes the relationship between the width and height of an image. Aspect Ratio = H/W
Where H is Height and W is Width

3. Solidity:

The ratio of actual area and convex hull area is known as solidity and is an essential for true number plate detection. $S = \text{Area} / \text{Convex Area}$ The convex area is the area inside the convex hull of the object. Convex area is the product of Height and Width of the segmented region. The Aspect Ratio and

Solidity are calculated for each segmented regions or objects detected in the previous stage. These values help in detecting the true number plate region.

Filtering:

Based on these two feature values true number plate region is detected. The aspect ratio and solidity values are multiplied pixel by pixel level (AND operation). Thus true ROI is detected.

Extract Number Plate using bounding box technique: The bounding box technique is used to extract the number plate region. The minimum row, maximum row, minimum column and maximum column components are used to locate the number plate in terms of bounding box drawn over the binary image. Here in this step the number plate region is separated out from the whole vehicle image using these vertices or coordinate values.

Below is an overview diagram of the Park-a-Lot system concept.



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Pre-processing:

The detected number plate may contain noise, skew and there may be broken and degraded characters. So, the image is pre-processed to remove the noise, line skew, and to correct the broken and degraded characters. Firstly, the extracted number plate is converted into binary image for further processing. Then, morphological operations like filled holes are used with removal of noise to get a solid object. The noisy, broken characters can be easily detected and could be correctly recognized if the characters are in white pixels with black background. Therefore the black and white number plate image is inverted to get white characters on black background. This is called as complimented image or inverted image

Thresholding:

Thresholding is non-linear operation that converts a gray scale image into binary image where the two levels are assigned to pixels that are below or above the specified threshold value. The threshold of an image with correct gray scale value is calculated for the purpose of separating the object of interest from background. Thresholding is important to provide sufficient contrast of an image such that, different level of intensity between foreground and background are taken into consideration. The purpose of thresholding is to extract those pixels from some image which represent an object (either text or other line image data such as graphs, maps). For computational purposes gray scale improves the quality of an image and the later computational processes

Character bounding box for Segmentation:

Bounding boxes for connected components are the properties of the labeled connected components regions. A bounding box of a labeled region is a rectangle that just encloses the region completely. When a specific bounding box is determined for a connected region, the coordinates of the corners of the bounding box and its width and height are available. A bounding box completely specifies the boundaries of the corresponding connected component. Character Recognition using ANN: MLP Network: A Multi-layer perceptron is a feed-forward artificial neural network model that maps sets of input data onto a set of appropriate outputs. A MLP consists of multiple layers of nodes in a directed graph, with each layer fully connected to the next one. These networks have been applied to distinct areas, performing tasks such as function fitting and pattern recognition problems, by using the supervised training with an algorithm known as error back propagation. In this paper, we proposed an improved method based on MLP neural network and backpropagation algorithm for training to recognize characters & numbers in the Indian NP.

RBF Network:

Radial Basis Function Neural Network (RBF) is a local approximation neural network and it is better than Back Propagation (BP) Neural Network in such abilities as approximation



(a)



(b)



(c)



(d)



(e)



(f)



(g)

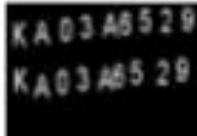
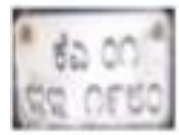
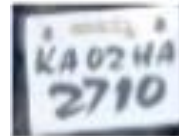


(h)

Input
No.plate

Detected
No.plate

Recognized
No.plate



Glossary of Terms

Person ID - the email address a person uses to register with the online Park-A-Lot system.

Elevator Camera - an image capturing camera capable of utilizing image recognition to determine the license plate number on a vehicle inside the parking parking area elevator.

Elevator Display - an LCD screen located inside the parking parking area elevator for displaying information.

Exit Camera - same as elevator camera, and capable of using image recognition on license plates of vehicles exiting the parking area.

No Vacancy - The parking area is full and is not walk-in parking at this time.

Rain Check Credit - it is a credit given to the person when he or she arrives at the parking parking area and no spots are available to park in.

Reservation - an arrangement to park in a parking parking area for a fixed amount of time at a certain fee per hour.

Recurring Reservation - a reservation, made in advance with a variable grace period, that occurs on some regularly repeating schedule.

Reservation Parking - when a person parks at the parking area to fulfill a pre-existing reservation (either recurring or confirmed).

Spot Sensors - sonar sensors capable of determining whether a parking spot inside the parking area is occupied with a car or not.

System Administrator - person who will have deep access to the system, and be able to alter business requirements such a parking prices.

Functional Requirements Specification

Stakeholders

A stakeholder is anyone who has interest in this system (users, managers, sponsors, etc.).

1. Registered Person
2. Unregistered Person
3. System Administrator
4. Security Personnel

Actors and Goals

An actor is anyone who will directly interact with the system. The two types of actors are initiating and participating.

1. Initiating
 - a. Registered Person
 - b. Unregistered Person
 - c. System Administrator
 - d. Timer
2. Participating
 - a. Elevator Keypad
 - b. Elevator Display
 - c. Elevator Camera
 - d. Spot Sensors
 - e. Exit Camera
 - f. Database
 - g. Event Log

Use Cases

Casual Description of Use Cases

If the person is an unregistered the system will check for open spots on the ground floor. The person will then swipe his/her credit card before driving though to park.

Finally, if the person arrives early to his or her reservation, the following applies:

1. Check their license plate for a future reservation, and if found ask if they are there for that reservation.
 - a. If yes, and if the upcoming reservation is within some time limit (30 minutes before the start time), then if there is available parking they may park, and be charged for the additional time at the rate per hour of their soon to be occurring reservation.
 - b. If the user arrives very early (more than 30 minutes before start time), they will have to park as a walk-in until the start time of their reservation. This would also require us to make a note that the walk-in reservation would coincide directly with their upcoming scheduled reservation, meaning that the person should not be expected to leave the walk-in parking and re-enter the parking area to fulfill their scheduled reservation. We will assume the walk-in parking will continue directly to the actual reservation scheduled. The billing should be at a walk-in rate for the walk-in, and at the regular rate for the reservation.
 - c. Finally, if no spots are available, the person will be told they cannot park at this time.
2. If the license plate isn't recognized, we prompt for credentials, and follow the instructions given in (1) if the person is registered with a reservation in the future for that day.

UC-1 Manage Account

A registered person wants to change their account details (email, password, address, credit card info, etc.).

UC-2 Manage Parking area

A system administrator wants to manage the parking area remotely. After being authenticated by the system, the administrator will be presented with options to set parking prices, inspect usage history, as well as view current usage. All options are sub-use cases described later.

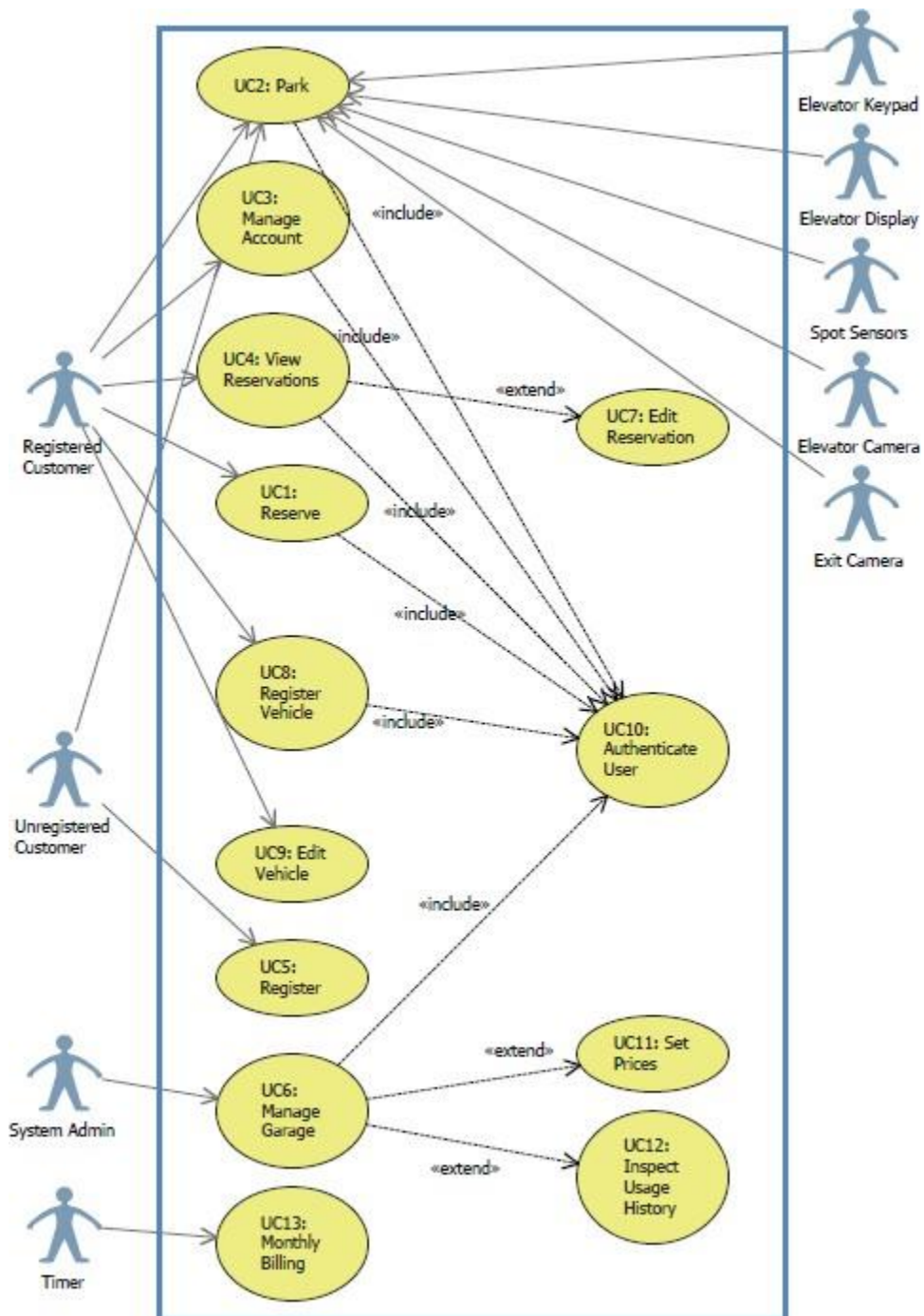
UC-3 Register Vehicle

A registered person wants to register a vehicle for his/her account. After first being authenticated by the system, the system will show a form, which the user will fill out and submit. The system will then validate the submitted information (license plate number, state, color) and store it in the database, assigning the user a unique vehicle id.

UC-4 Authenticate User

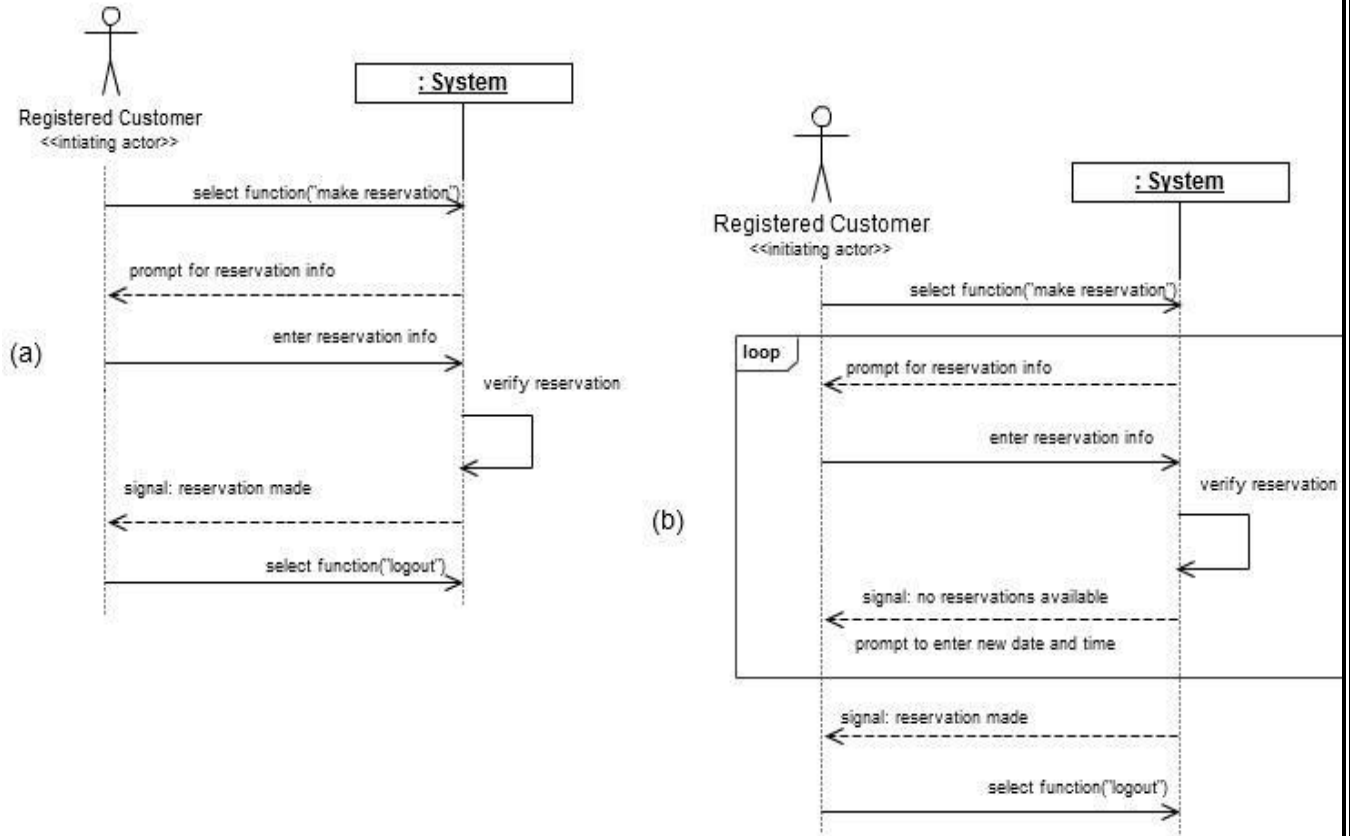
A registered person wants to log in to the system. The system will present a log in form (email, password) which the person will fill out and submit. The system will search for and find the person in the database. The system will then start a session for the user, which will last until the user logs out or closes his/her brows

Use Case Diagram



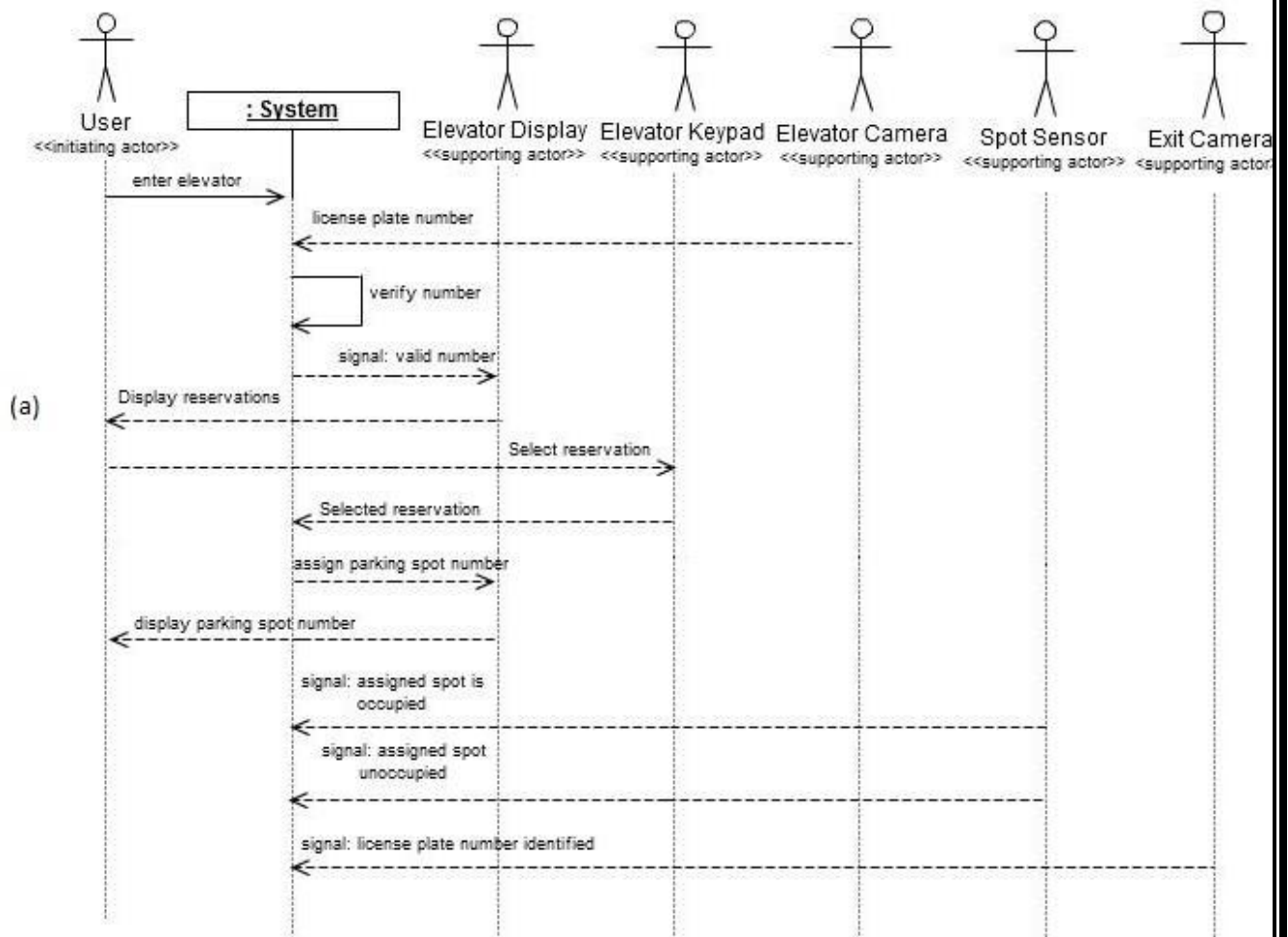
System Sequence Diagrams

System Sequence Diagram UC - 1



The System sequence diagram for UC-1 can be split up into two parts. Part (a) describes the sequence of events for the success scenario. The user requests a reservation and there are available reservations to be given out. Part b describes the sequence of events for the alternate scenario. The user requests a reservation at a specific date and time but there are no available reservations to be given out. The user will continue to enter in a new date and time until an available reservation can be given out.

Sequence Diagram UC - 2



The system sequence diagram for UC-2 can be split into three parts. Part a describes the sequence of events for the success scenario. The person enters the elevator, the elevator camera recognizes the person's license plate number, and the system assigns the user a parking spot number.

Non-Functional Requirements

Fault-tolerance

- Park-A-Lot should remember the details of a user's interaction if the user interface should disconnect from the system.
- Park-A-Lot should quickly recover from a malfunction when a person is inside the elevator.

Usability

- The interface should provide persons with access to all relevant use cases with the fewest number of mouse clicks and key strokes.

Reliability

- Park-A-Lot should function correctly even if a person inputs invalid entries into a reservation request form.
- Park-A-Lot should not lose a reservation through the use of persistent storage and regular backup.

Performance

- The Park-A-Lot elevator display should always display the correct output to the person.
- The Park-A-Lot system should minimize connection times to the database and provide a quick and painless experience to the person.
- Initially, Park-A-Lot can support at least 100 persons and 1,000 reservations. Over time should seek to increase these numbers ten-fold or more.

Security

- Other persons or unauthorized users should not have access to or be able to edit a person's account details or reservations.

Domain Models

Domain Model for UC-2

Reasons for model selection:

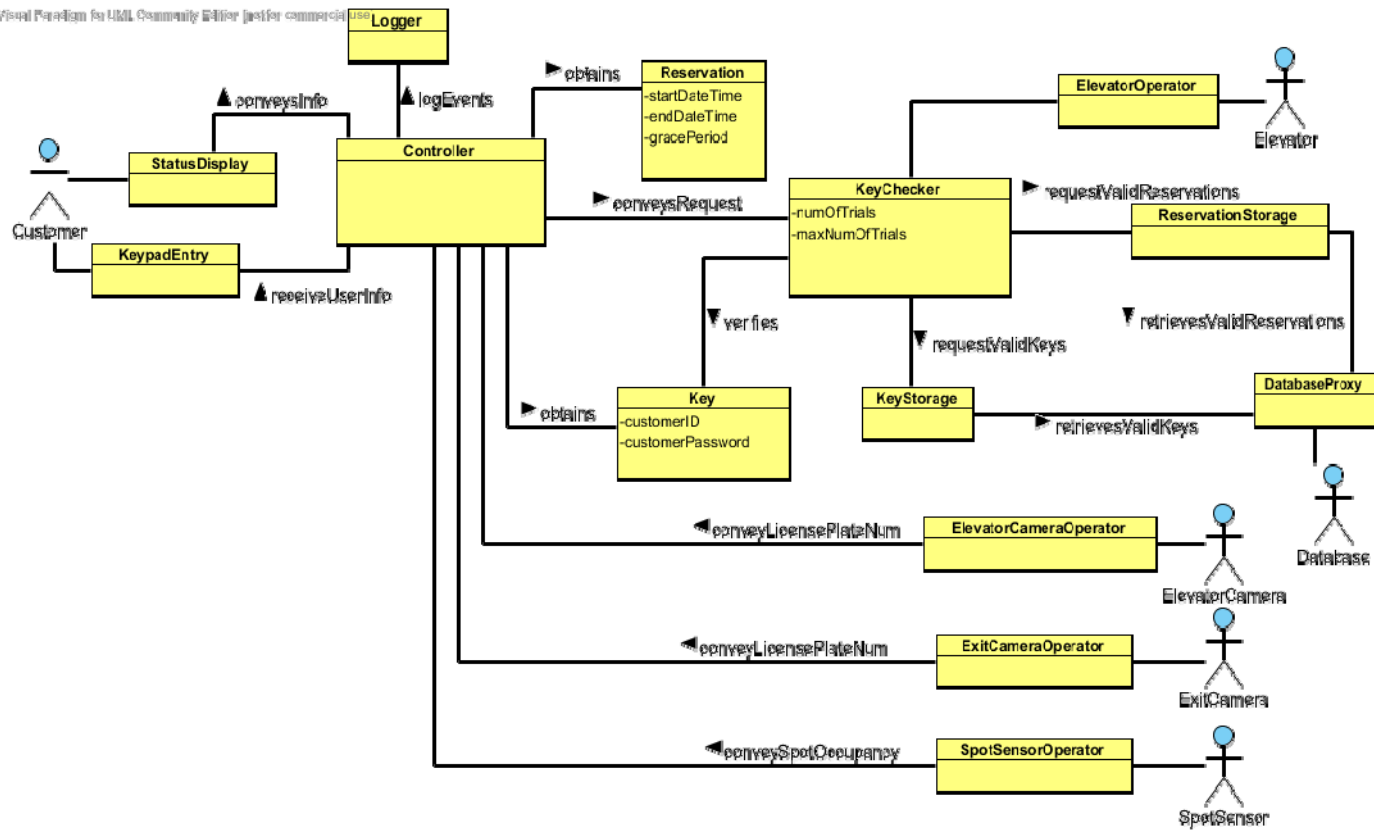
- **Cohesion** - The domain elements contain enough information to be completely independent objects (no overlap in knowledge between objects) and represent concrete ideas within the system. Therefore, our model has high cohesion since each object has several responsibilities, but does not attempt

to do too much work.

- **Coupling** - The coupling of objects in our diagram is low, mainly because we have separated the key checking ability out from the Controller object. Key checking is a main concern in this model, and therefore deserves its own object. The smaller objects surrounding KeyChecker help it accomplish its job. There is a high degree of coupling between Controller and many of the physical objects in the parking area, but that is impossible to avoid since the controller

needs to be in communication with all of the cameras and sensors in order to instruct other objects when to complete their tasks.

- **Expert Doer Principle** - The model satisfies this principle because it divides the task of checking keys and processing information about those checked keys into two distinct objects. The KeyChecker is the expert on checking person authentication info



UC-8: Register Vehicle

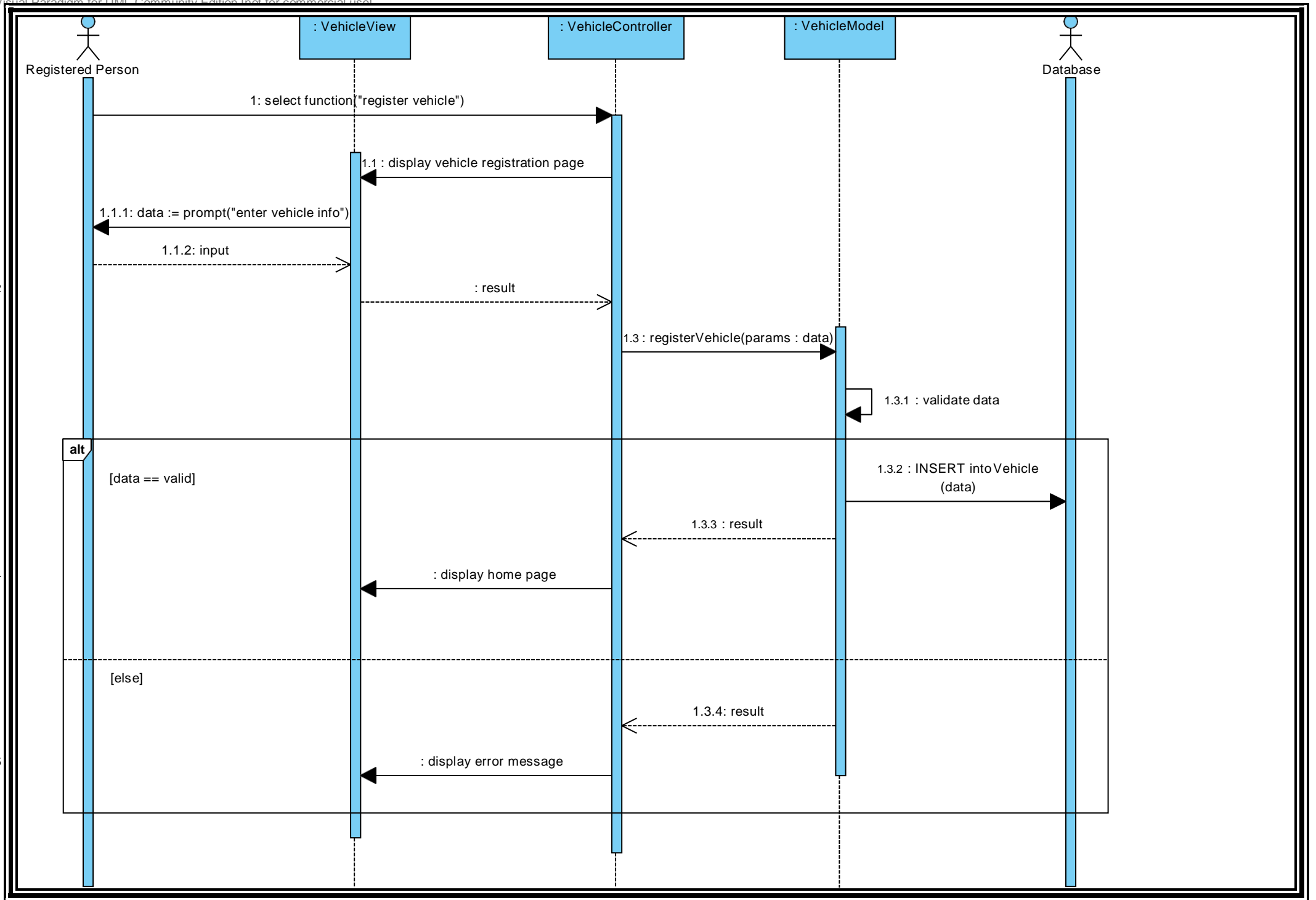
Goals: To create a vehicle for a Registered Person's account.

Process: The Registered Person enters the vehicle's license plate number and state. The Controller receives this information and then passes it to the Model which validates it and then makes the addition to the database. The View displays the successful creation of the vehicle.

1.2

1.4

1.5



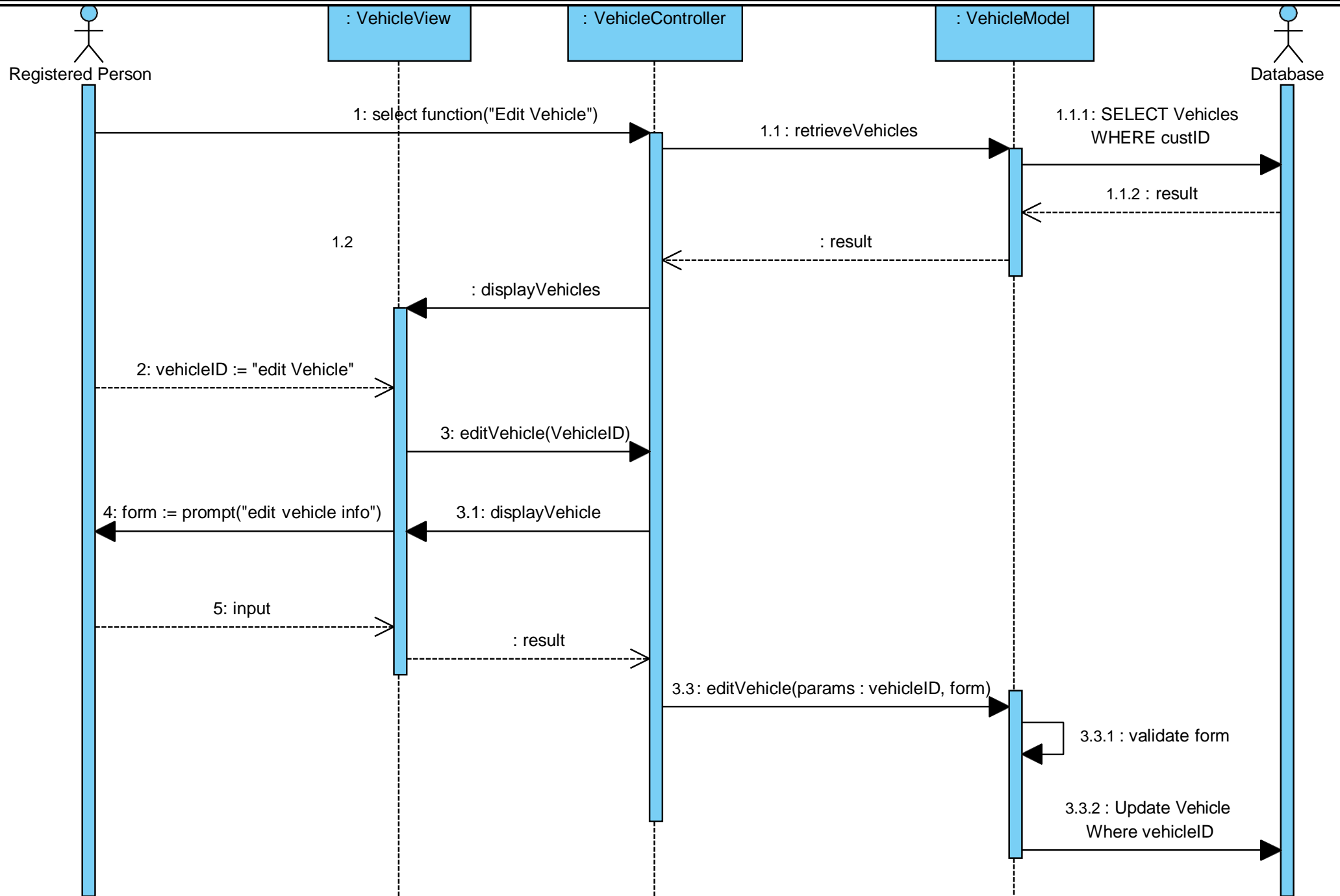
UC-9: Edit Vehicle

Goals: To edit a registered vehicle's license plate number or state..

Process: The Registered Person enters the vehicle's new license plate number and state. The Controller receives this information and then passes it to the Model which validates it and then makes the addition to the database. The View displays the successful change to the vehicle.

1.3

3.2



UC-10: Authenticate User

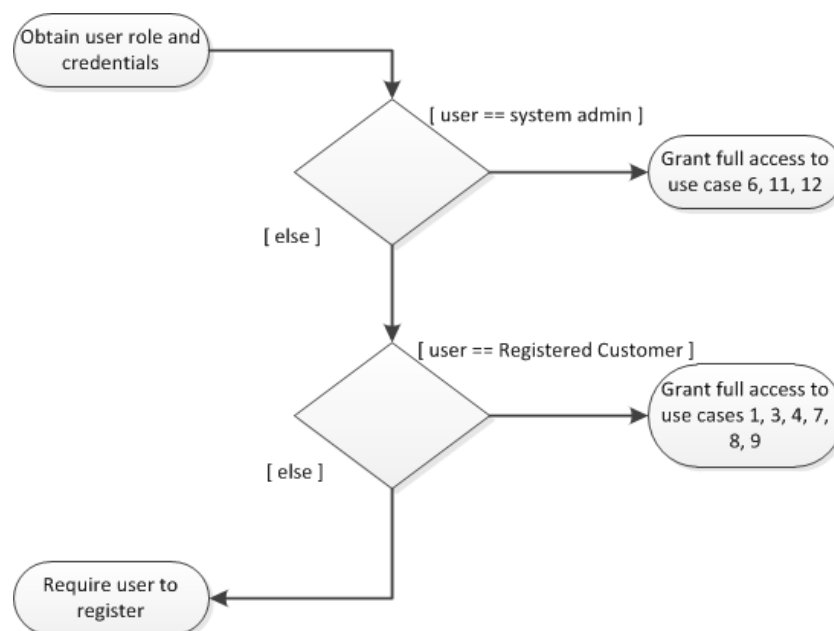
Goals: To determine if a user is registered with the system and has an account in the database.

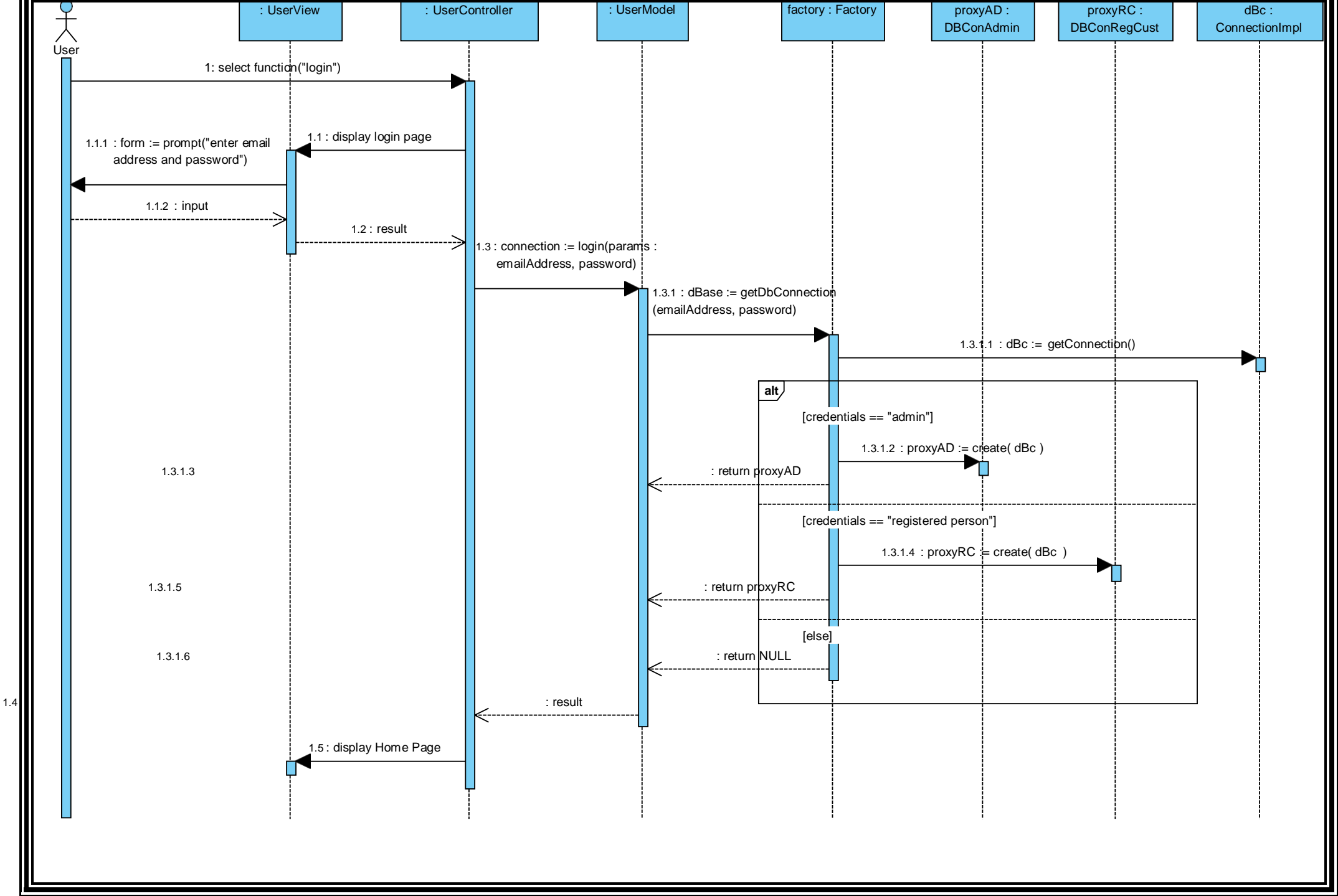
Process: The user accesses the Interface Page via a web browser, selects log in, and enters their credentials (email and password). The Controller passes the information to the Model which creates a protection proxy based on the user's privileges.

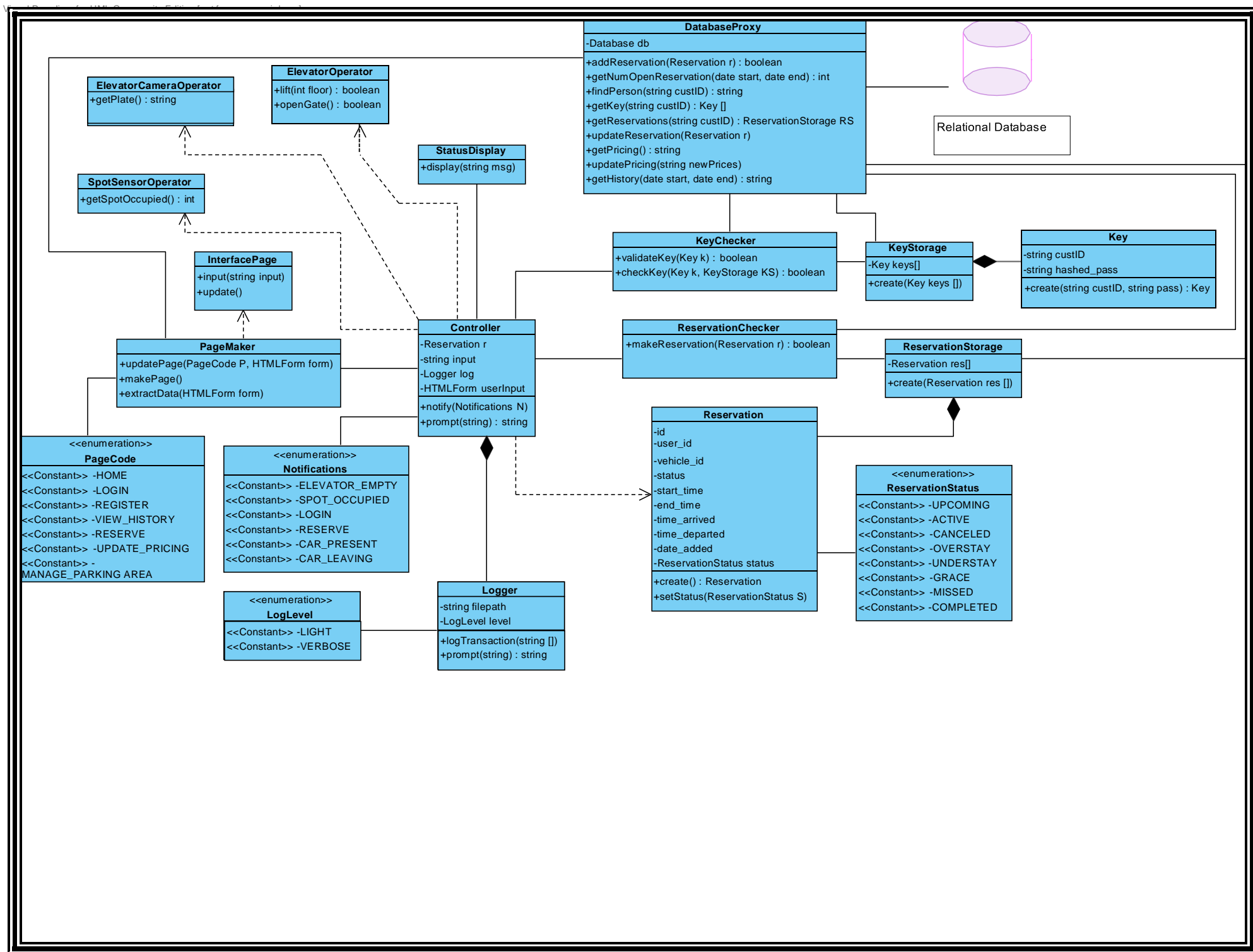
Design Pattern:

We have employed the protection proxy pattern in use case 10, Authenticate User. We decided to use this pattern because different users with different roles log into the system and it would be helpful to assign each user their privileges through a protection proxy. The two roles for the protection proxy are system admin and Registered Person. The diagram below shows which use cases the two different roles have a privilege to participate in.

The advantages to using the protection proxy are that we are able to take the logic for granting privileges away from the models and into a proxy. By doing this, it will be easy in the future to add additional roles and privileges. If we were to keep the system the way it was, then it would be a daunting task to make any changes because all of the complex logic and IF-THEN-ELSE statements involved. Also, the roles and privileges serve as a distraction from the main task of the client and server objects, so adding a protection proxy removes side responsibilities away from the objects and into their own proxy. The protection proxy is also able to protect an object from unauthorized access better than in our previous system because of its simplicity.







User Interface Design and Implementation

A few significant additions/edits were made to the user interface to increase the user experience. All mock-ups can be seen live at [The design is meant to reduce user effort to a minimum](#), by providing a sleek and reduced graphical interface that is simple to understand (no screen clutter or extraneous information).

The differences between our previous design and our current design go as follows:

Home Page

Since we did not actually implement the multi-parking area feature, we've removed the Google Map from our homepage. We've also added a price breakdown on our home page so persons can easily see our current prices for members and guests alike.

The screenshot displays the 'Park a Lot' homepage. At the top, the logo 'Park a Lot' is in blue, followed by navigation links: Home, Reserve, Login, Register, and Simulation. The main content area is divided into three sections. The left section contains a welcome message: 'Welcome to Park a Lot. Park with Confidence!' followed by a paragraph about the parking service in downtown New Brunswick, NJ, and a note that there are currently 287 available spots. The right section features a 'Sign in' form with fields for Email and Password, and a 'Sign in' button. The bottom section, titled 'Garage Pricing', shows two price boxes: a red box for 'Guest Price' at 20.00/hr and a green box for 'Member Price' at 15.00/hr. At the bottom of the page, there is a copyright notice '© Park a Lot Inc. 2010 - 2011' and links for 'Help', 'Contact', and 'About Us'.

Park a Lot Home Reserve Login Register Simulation

Welcome to Park a Lot. Park with Confidence!

Park a lot is an efficient, effective solution for parking, in the busy area of downtown New Brunswick NJ. Whether you need a place to park on your daily commute to work, or you just need parking for a night out on the town, Park a Lot is here to help you. **Walk Ins Welcome.**

There are currently **287** available spots in our garage.

Sign in

Email

Password

Sign in

Garage Pricing

20.00/hr	15.00/hr
Guest Price	Member Price

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User Registration

We've eased up on our user registration form, making it easier and quicker for users to sign up. We no longer require any credit card information at sign up.

Park a Lot

[Home](#) [Reserve](#) [Login](#) [Register](#) [Simulation](#)

Sign up for an account, it's quick and painless.

First Name

Last Name

Email

Password

Confirm Password

Terms of service

This user agreement needs to be updated to resemble the actual user agreement of the site. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Sed rhoncus accumsan nibh, ut consectetur elit bibendum id. Fusce tristique lacinia tortor, id tincidunt risus ullamcorper sed. Ut porttitor, libero a pretium feugiat, magna turpis.

By clicking Sign up and creating an account, you agree to the terms of service, listed directly above. It's strongly recommended that you read and understand the terms because violation of the above terms could lead to your account being cancelled.

Sign up

Already have an account? [Login](#).

Why sign up?

As a registered user, you get to reserve parking in any one of our Park-a-Lot parking lots. Don't have enough time to reserve parking ahead of time? Just stop in for on the spot parking and we'll add it to your monthly bill.

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User Login

We did not change much with user login, except added a few site-wide tips to our login screen. The login screen as seen from our home page remains the same, but we added a few helpful tips and FAQ to our main login screen.

Park a Lot

[Home](#) [Reserve](#) [Login](#) [Register](#) [Simulation](#)

Sign in to manage your account

Email

Password

Remember Me

☒ valid for 2 weeks

Sign in

 or [Sign up](#)

Did you know?

When creating a reservation, there's no need to type in a date for any date fields, plain english works just fine. For example, when reserving a spot for tomorrow, just type "tomorrow".

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User Profile

The user profile page contains links to all important pages from a users standpoint. From there, they can go to the create reservation page, create vehicle page, list reservations page, list vehicles page, as well as view any reservations for a specific day by clicking on a date from the calendars shown, which summarize which days the user has a reservation in the next 2 months. Also, from the home page, the user can see how much they have on their current monthly bill to date. Every action that the user takes, whether it be add a new reservation, cancel an existing one, etc. they are redirected back to their profile and a popup notification is shown at the very top of the page to provide feedback.

Your reservation has been created successfully.

Park a Lot

HomeReserveLogoutSimulation

Upcoming Reservations

May 2011

Sun	Mon	Tue	Wed	Thu	Fri	Sat
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

June 2011

Sun	Mon	Tue	Wed	Thu	Fri	Sat
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

View All

John Doe

Member since: May 5, 2011
Total reservations: 30
Current tally: \$52.50

Reservations
List all reservations
Create a new reservation

Vehicles
List all vehicles
Add a new vehicle

Create Reservation

The create reservation page was updated to add popup calendars to each field that takes a date input to make it easier for the user.

What time do you plan on arriving?

Date of arrival

Start time :

Duration 30 minute blocks (hours:minutes)

Recurrence

Recur until

Please Note: There is a 30 minute grace period given to every reservation. If for some reason you cannot make it, you will still be charged for your reservation, you will not be able to cancel before hand if you cannot make it. Be

< May 2011 >

Su	Mo	Tu	We	Th	Fr	Sa
18	1	2	3	4	5	6
19	8	9	10	11	12	13
20	15	16	17	18	19	20
21	22	23	24	25	26	27
22	29	30	31	1	2	3
23	5	6	7	8	9	10

Clear

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How to reserve a spot

1. Choose your date of arrival. This can be set in plain english. For instance, when making a reservation for tomorrow, you can just type "tomorrow".
2. Choose your duration. Reservations are set in 30 minute blocks.
3. If you'd like for your reservation to occur on multiple occasions, set your level of recurrence.
4. If you do set your reservation on a recurring schedule, set the date you want the reservations to stop.

[Help](#) [Contact](#) [About Us](#)

List Reservations

The list reservations page lists in more detail all of the users reservations, past, present, and future. From here, they can choose to edit/cancel any reservation which can still be edited/updated. each reservation is color coded to easily distinguish between past/present/future/cancelled reservations.

View Reservations

[past](#) [current](#) [future](#) [cancelled](#) [view all](#)

Starts	Ends	Duration	Recurr	
Wednesday May 4th, 7:00 am	Wednesday May 4th, 9:00 am	2h 0m	N	---
Wednesday May 4th, 7:00 am	Wednesday May 4th, 10:00 am	3h 0m	N	---
Wednesday May 4th, 9:00 am	Wednesday May 4th, 5:00 pm	8h 0m	Y	---
Wednesday May 4th, 10:30 am	Wednesday May 4th, 12:30 pm	2h 0m	N	---
Wednesday May 4th, 11:00 am	Wednesday May 4th, 12:00 pm	1h 0m	N	---
Wednesday May 4th, 11:30 am	Wednesday May 4th, 2:30 pm	3h 0m	N	---
Thursday May 5th, 9:00 am	Thursday May 5th, 5:00 pm	8h 0m	Y	---
Friday May 6th, 9:00 am	Friday May 6th, 5:00 pm	8h 0m	Y	edit
Saturday May 7th, 9:00 am	Saturday May 7th, 5:00 pm	8h 0m	Y	edit
Sunday May 8th, 9:00 am	Sunday May 8th, 5:00 pm	8h 0m	Y	edit
Monday May 9th, 9:00 am	Monday May 9th, 5:00 pm	8h 0m	Y	edit
Tuesday May 10th, 9:00 am	Tuesday May 10th, 5:00 pm	8h 0m	Y	edit
Wednesday May 11th, 9:00 am	Wednesday May 11th, 8:00 pm	11h 0m	N	edit
Thursday May 12th, 9:00 am	Thursday May 12th, 5:00 pm	8h 0m	N	---
Friday May 13th, 9:00 am	Friday May 13th, 5:00 pm	8h 0m	Y	edit
Saturday May 14th, 9:00 am	Saturday May 14th, 5:00 pm	8h 0m	Y	edit
Sunday May 15th, 9:00 am	Sunday May 15th, 5:00 pm	8h 0m	Y	edit
Monday May 16th, 9:00 am	Monday May 16th, 5:00 pm	8h 0m	Y	edit
Tuesday May 17th, 9:00 am	Tuesday May 17th, 5:00 pm	8h 0m	Y	edit
Wednesday May 18th, 9:00 am	Wednesday May 18th, 5:00 pm	8h 0m	Y	edit
Thursday May 19th, 9:00 am	Thursday May 19th, 5:00 pm	8h 0m	Y	edit
Friday May 20th, 9:00 am	Friday May 20th, 5:00 pm	8h 0m	Y	edit
Saturday May 21st, 9:00 am	Saturday May 21st, 5:00 pm	8h 0m	Y	edit
Sunday May 22nd, 9:00 am	Sunday May 22nd, 5:00 pm	8h 0m	Y	edit
Monday May 23rd, 9:00 am	Monday May 23rd, 5:00 pm	8h 0m	Y	edit
Tuesday May 24th, 9:00 am	Tuesday May 24th, 5:00 pm	8h 0m	Y	edit

Edit/Cancel Reservation

From this page, users can edit or cancel a reservation. Reservations can only be cancelled if done so at least 30 minutes prior to the beginning of the reservation, where as reservations can be edited if done so at least 30 minutes before they end. If a user comes to this page after the allowable cancellation period, the cancel action will not be shown. We also added options to edit/cancel all reservations following the one being edited/cancelled if the one being edited/cancelled is a recurring reservation.

Park a Lot Home Reserve Logout Simulation

Change duration

- Start time: May 18th, 9:00 am
- End time: May 18th, 5:00 pm
- Duration: 6h 0m
- Recurring: Y

Extension: 30 minute blocks (hours:minutes)

Update Recurrence: YES ☐ NO ☒ - only reservations occurring after this one will be affected

Cancel reservation

Can't make your reservation? It's better to cancel now than to pay for the mandatory grace period.

Are you sure?

Cancel Recurrence YES ☐ NO ☒
only reservations occurring after this one will be affected

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Add Vehicle

The add vehicle page is where the user goes to register a new vehicle with their account. These vehicles are recognized when the user arrives for quick and easy entrance into the parking area.

Park a Lot Home Reserve Logout Simulation

Register a new vehicle

Plate Number please double check this

State

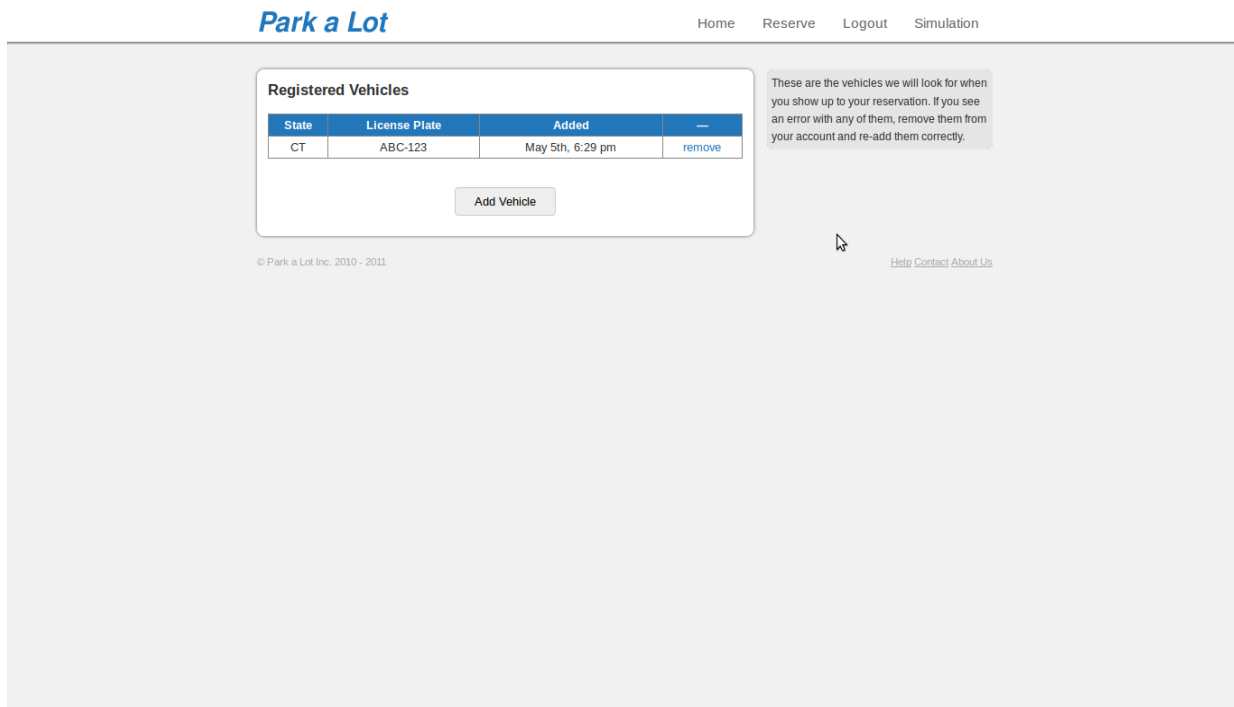
Why is this necessary?

Registering a vehicle helps us recognize you when you arrive at one of our parking lots. It allows us to streamline the parking process for you.

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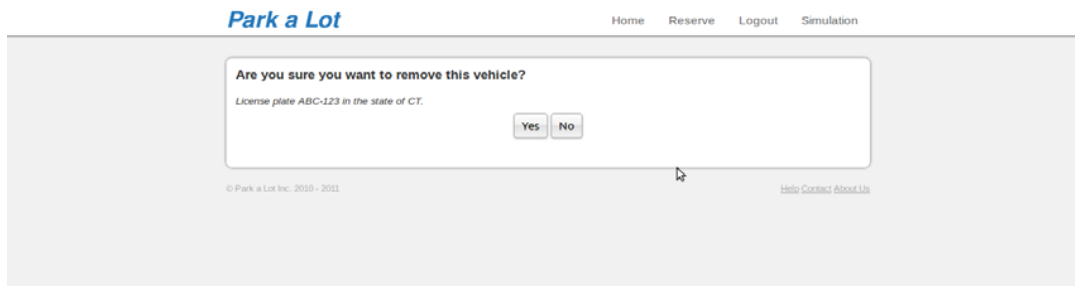
List Vehicles

The list vehicles lists all vehicles currently registered with the users account.



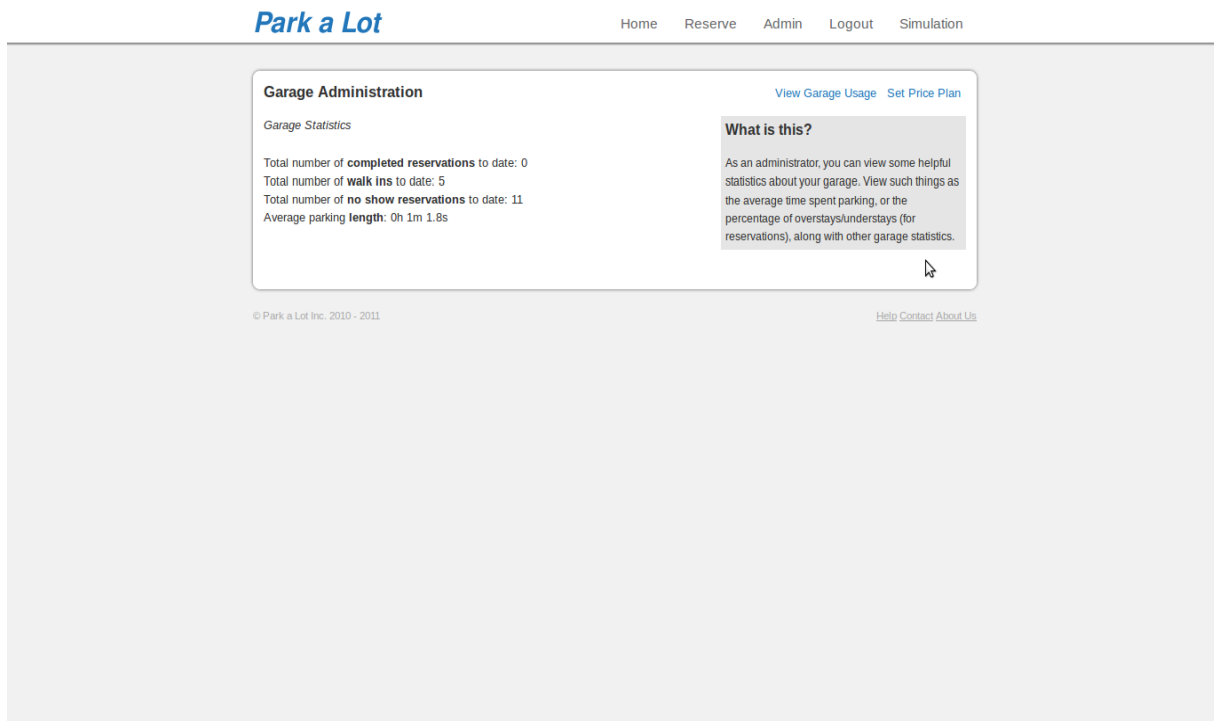
Remove Vehicle

From this page, users can de-register any of their vehicles. This page just asks for confirmation, as well as shows information about the vehicle being removed.



View Parking area Usage

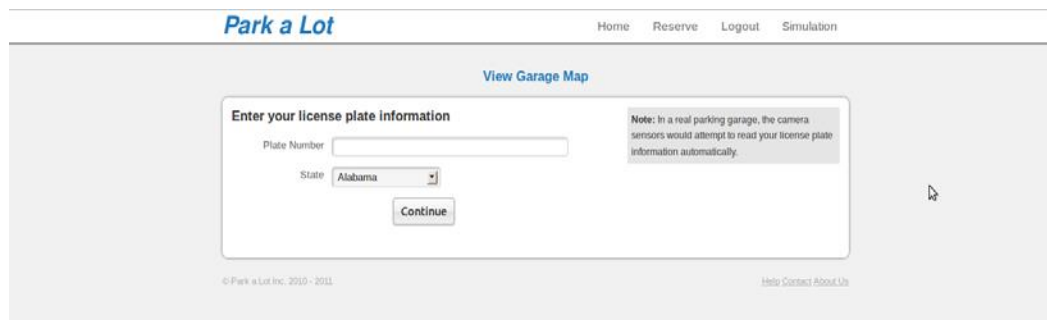
From this page, **administrators** can view a few statistics about the parking area, such as the average time spent parking, the percentage of overstay/understay, the number of no-shows, etc.



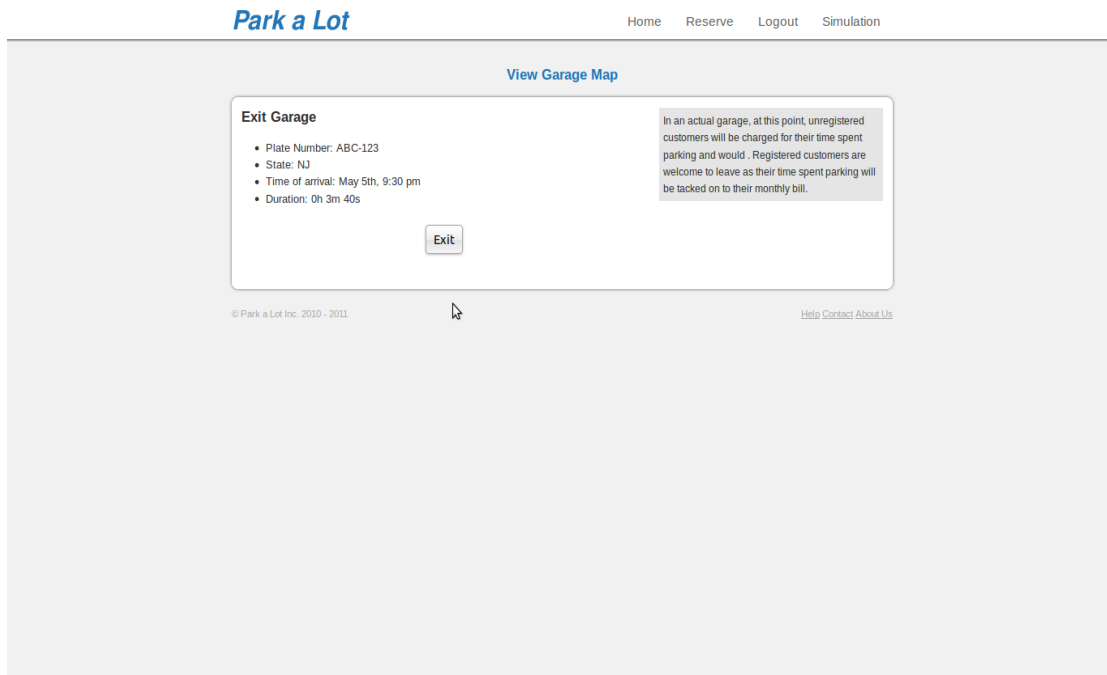
Simulation

To test our system, we implemented a simulation test bench. The simulation is to emulate as close as possible the process of physically parking in our parking area. Below are a few screenshots of our simulation.

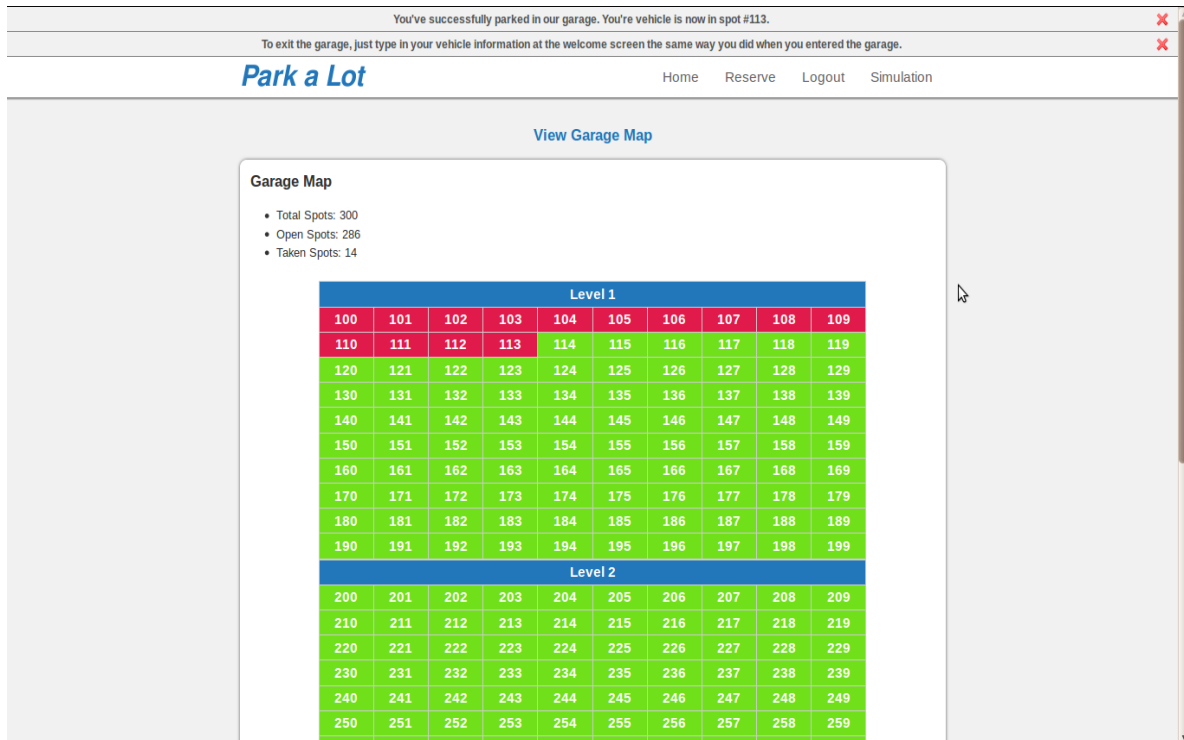
Welcome Screen



Exit Screen



Parking area Map



Our entire user interface is aimed at an ease-of-use for the user. We've accomplished this by limiting the number of options on each page to the minimal, only the necessary actions to be taken are shown on a page. Our longest form is our user registration form, which only requires 5 input text fields. Our average form only requires 3 input fields, making form completion very simple for the user. Our most complicated form, our create reservation form, is already filled in with the basic information, such as the start date and start time (which we take as starting 3 hours from the current time).

Conclusion and Future Work

This project was difficult from the beginning, mainly because none of our group members had ever worked on a full-scale software project like this before. We had all coded applications, but the planning aspect of it and the formulation of such length reports proved somewhat a challenge.

However, at the conclusion of the semester we now have a functioning software system in place, and a long list of documentation and design reports supporting it. Although it was not simple or easy to put together, our careful design process and extremely clean coding style helped to create a powerful and easy to understand piece of co

