CMPE 281 – Cloud Technologies

Project Final Report

QuickPark - A Cloud Based Parking Assistant

Group 07

Team members

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Subject Instructor: Prof. Dr. Jerry Gao

I. Introduction:

Smart cities are becoming popular now a days because of the performance and quality improvement for urban services. Smart cities make use of technology to bring about significant improvement in an urban living environment. Digital technology or Information and Communication Technology (ICT) are utilized in smart cities in order to reduce the resource consumption and costs. The smart city program is becoming popular because of the ease of access to the services which are mainly concentrated through mobile applications. Mobile applications will have a great demand in the coming years. As every city is adapting itself to become smarter, it needs to accommodate a huge inflow of population, vehicular traffic and related issues. One such issue is that of parking availability. In our project we are going to integrate parking spaces with sensor nodes and retrieve the necessary information and store them. Based on the available parking spaces, users will be notified of viable parking options thus saving them time and effort. If we discuss in detail, a sensor node is placed at every parking slot in a parking garage or other places providing vehicular parking facilities. These sensor nodes inform us about the availability of the parking slots. These parking slots are continuously monitored by the sensors and update the server with their status. If a user requests a parking slot, then based on his\her locality the nearest available parking slot is mined from the database and the related information is provided to that particular user in real time.

II. System Architecture:

A. System Architecture: QuickPark’s architectural design is composed of three layers. The client service layer, the cloud layer and the sensor node layer.

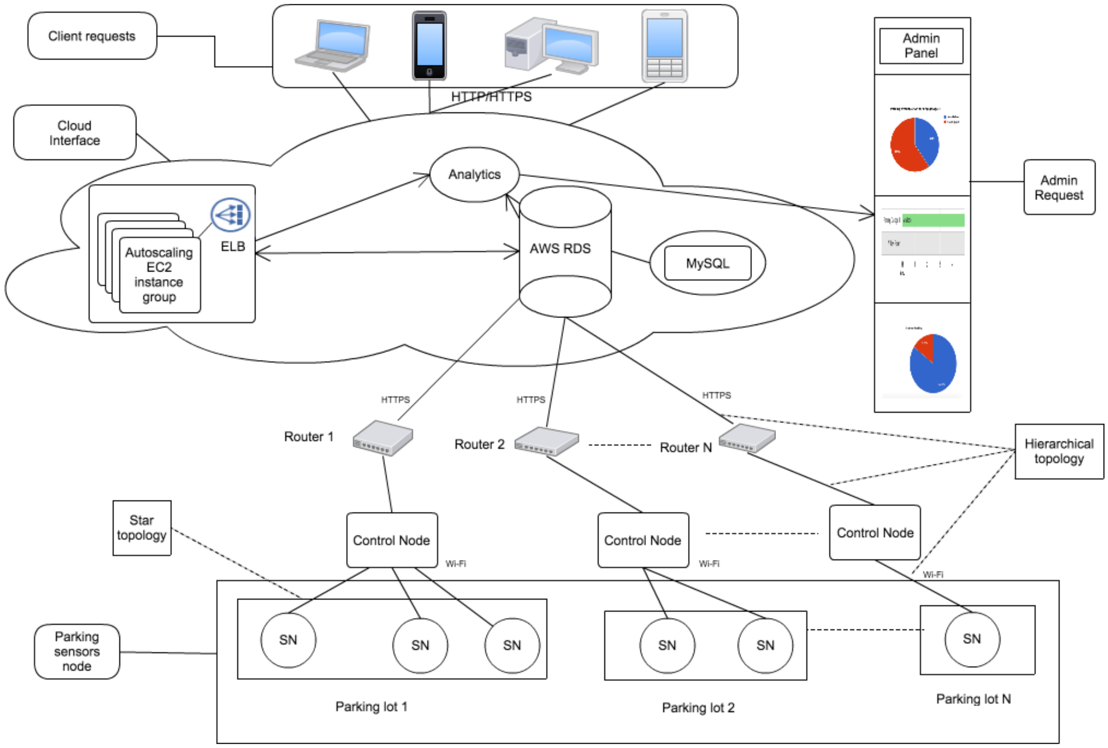


Figure 1: QuickPark System Architecture

Figure 1, shows the Architectural Diagram of QuickPark. Each of the three layers are responsible for a set of distinguishable functions and they work and interact with each other to bring the system to life.

1. Client Service Layer: This layer consists of all the users of the application and administrators, the Graphical User Interface and means by which the users will interact with the system. Through this layer, users are able to send requests to the cloud, set up their account, use navigation, etc. The admins have the ability to view analytical data, add new sensors and parking garages into the system. The user data will be fetched over the internet and this system will support a variety of smart devices like tablets, personal computers and smart phones.

2. Cloud Layer: The cloud layer consists all the cloud modules, including the compute node, the databases and the web servers. The server side logic, data analysis and analytics, control logic, etc. lies in this layer. The cloud layer is mainly responsible to analyze the unstructured sensor data and provide it to the users in an easily understandable form.

3. Sensor Node Layer: This layer is comprised of the sensor nodes, control nodes and routers. The sensors will collect data and send it to the control nodes using WLAN network, which will then transmit it to to the cloud via. Internet.

B. Tree Component partitions and their functions: The QuickPark system can be divided in 3 main components based on the 3 architectural layers. These components can then be divided into subcomponents and functions.

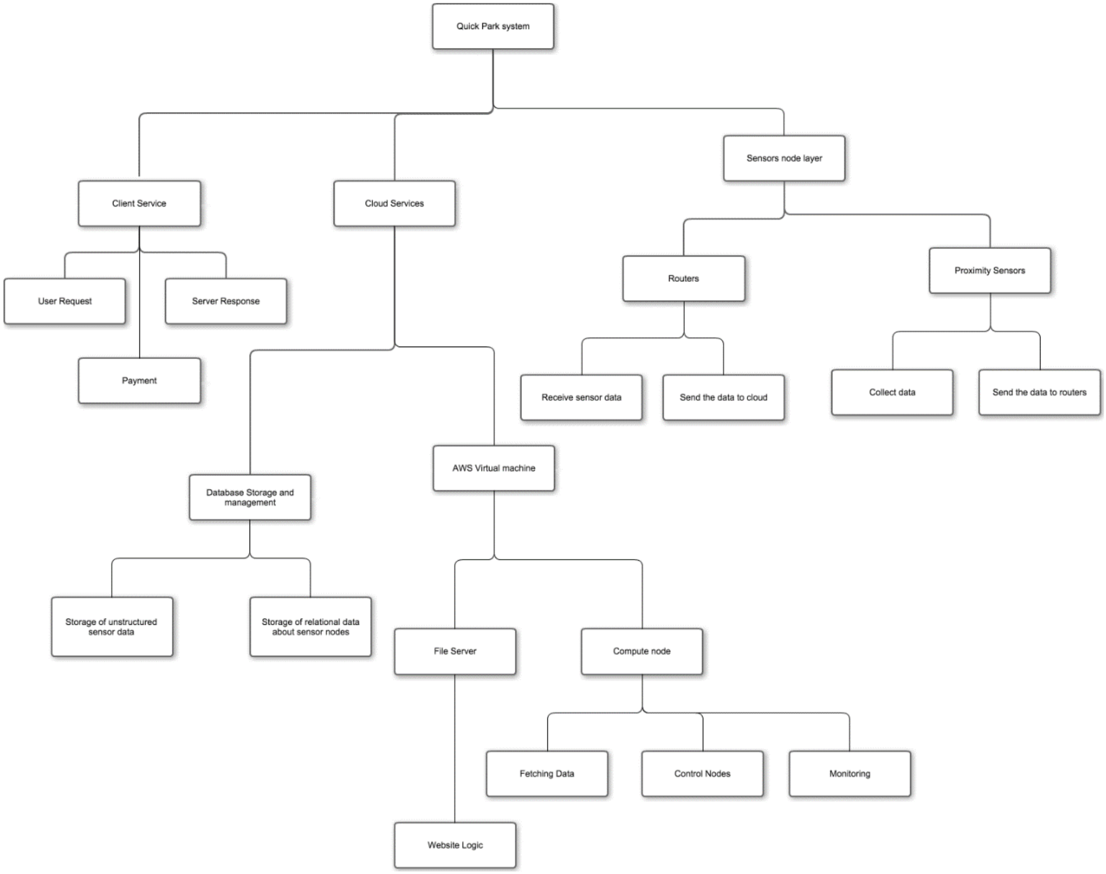


Figure 2: QuickPark System component tree diagram

The functions of the client service layer include providing UI to users, so that they can send requests, navigate using maps, and use the special features. The client service layer also provides analytics view to the administrator, node management facility, etc.

The Cloud layer consists of the AWS ELB, AWS Autoscaling Group, AWS RDS, Fileserver, Webserver, etc.

i. AWS Autoscaling Group: By using AWS autoscaling groups the EC2 instances are organized into groups so that they can be treated as a logical unit for the purposes of scaling and management.

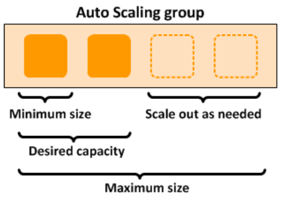
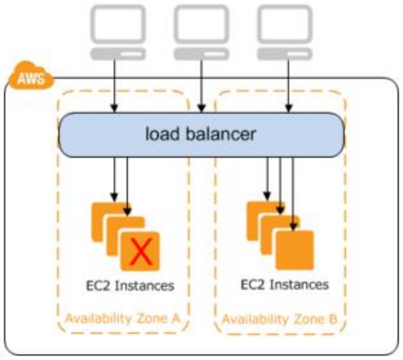
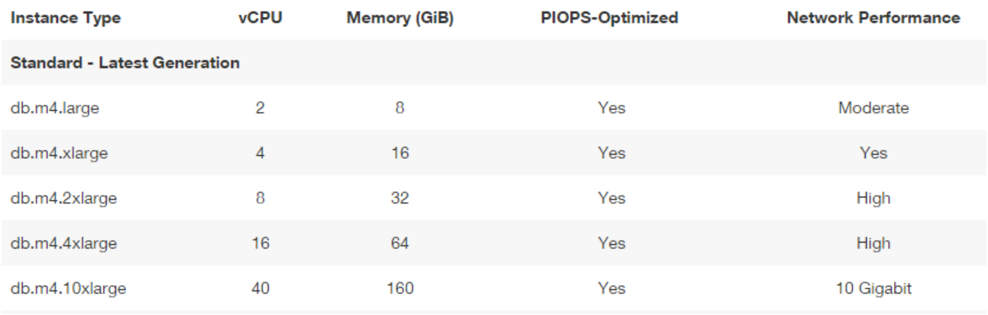


Figure 3: AWS Autoscaling groups

ii. AWS Elastic Load Balancer: AWS ELB is used along with the Autoscaling group. This helps distributes load over multiple instances in the group. AWS ELB uses health based triggers and works on a round robin algorithm for TCP Listeners.



iii. AWS RDS: A MySQL instance of the AWS Relational database services has been used for this project. It saves user as well as sensor data. All the analytics has been performed using this information stored here. It has been made secure using security groups, where only authorized traffic is let through. It is scalable via just a few clicks and hence very useful.

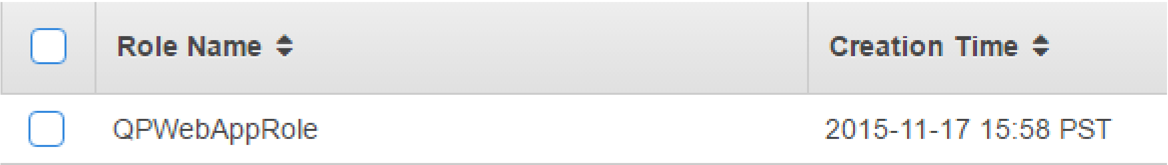


Instance Type	vCPU	Memory (GiB)	PIOPS-Optimized	Network Performance
Standard - Latest Generation				
db.m4.large	2	8	Yes	Moderate
db.m4.xlarge	4	16	Yes	Yes
db.m4.2xlarge	8	32	Yes	High
db.m4.4xlarge	16	64	Yes	High
db.m4.10xlarge	40	160	Yes	10 Gigabit

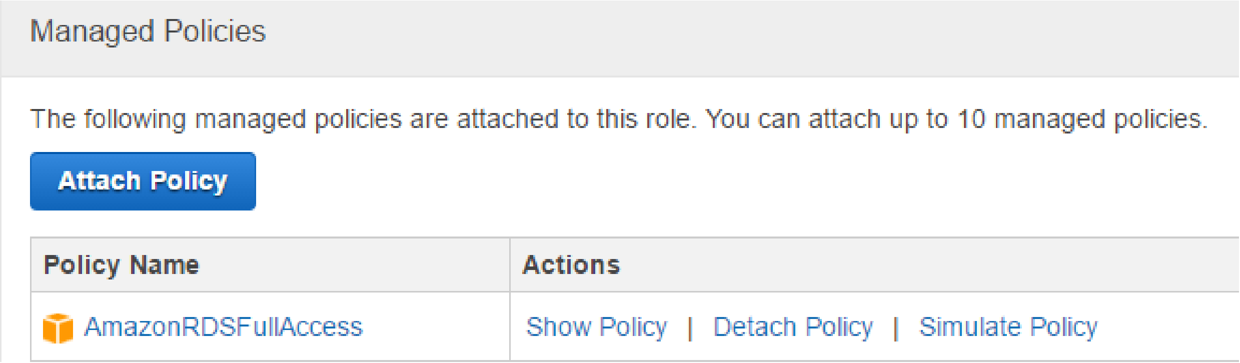
The Sensor Node layer consists of control nodes and the proximity sensors. The sensor node upload the data to the cloud through the routers, using WiFi. The control node can add new sensors, manage sensors, etc. The main responsibility of the control node is to relay the sensor data to the cloud.

A. Cloud Deployment Flow:

1. Setting up IAM: AWS Identity and Access Management is used to manage security and provide authorization to requesting parties. We setup a special IAM role, that had complete access to the specified RDS instance.



□	Role Name ⬍	Creation Time ⬍
□	QPWebAppRole	2015-11-17 15:58 PST

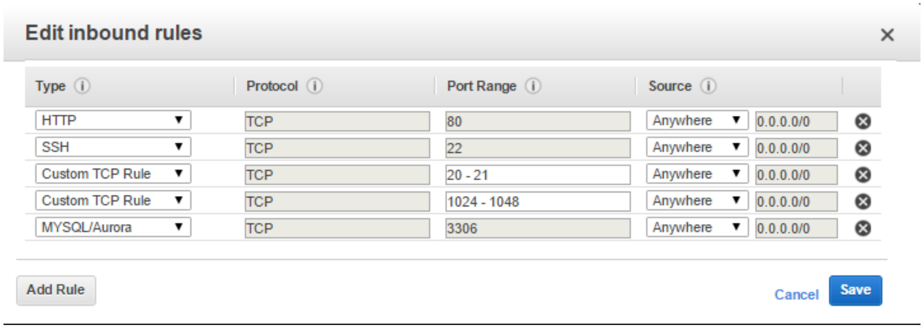


Managed Policies

The following managed policies are attached to this role. You can attach up to 10 managed policies.

Policy Name	Actions
AmazonRDSFullAccess	Show Policy | Detach Policy | Simulate Policy

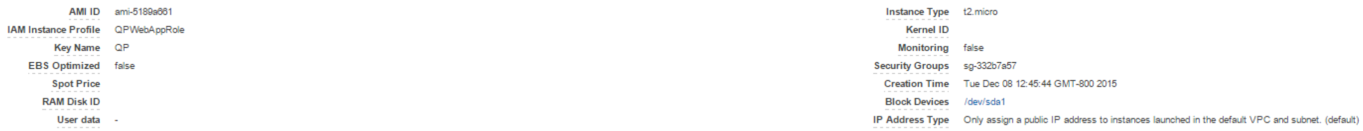
2. Setting up Security Group: AWS security group is essential to manage incoming traffic and determine if it has access to the said resource or not. As we are hosting a webserver, we allowed public traffic over specific ports.



Edit inbound rules

Type	Protocol	Port Range	Source	
HTTP	TCP	80	Anywhere	0.0.0.0/0
SSH	TCP	22	Anywhere	0.0.0.0/0
Custom TCP Rule	TCP	20 - 21	Anywhere	0.0.0.0/0
Custom TCP Rule	TCP	1024 - 1048	Anywhere	0.0.0.0/0
MYSQL/Aurora	TCP	3306	Anywhere	0.0.0.0/0

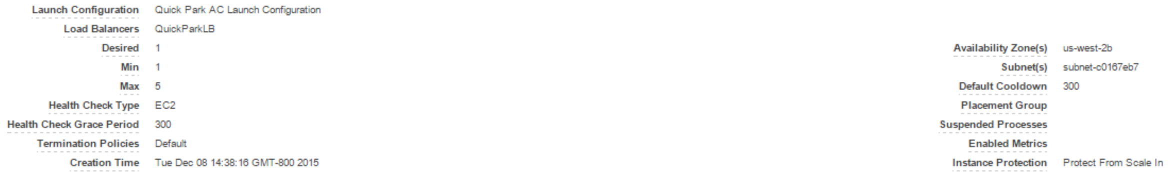
3. Setting up Launch Configurations: In order to setup the autoscaling group for our EC2 instances we need to setup the launch configurations first. Launch configuration basically tells AWS what kinda instance you wish to launch when the Autoscaling Group requires to. We've configured an Ubuntu based EC2 instance, that will launch on demand. The security group associated with this configuration is as mentioned above.



AMI ID	ami-5189a661
IAM Instance Profile	QPWebAppRole
Key Name	QP
EBS Optimized	false
Spot Price	
RAM Disk ID	
User data	-

Instance Type	t2.micro
Kernel ID	
Monitoring	false
Security Groups	sg-332b7a57
Creation Time	Tue Dec 08 12:45:44 GMT-800 2015
Block Devices	/dev/sda1
IP Address Type	Only assign a public IP address to instances launched in the default VPC and subnet. (default)

4. Setting up Autoscaling Group: An Autoscaling group helps in scaling of EC2 instances on demand. The group that we've set up will consist of 1 active EC2 instance at the minimum and the group can be scaled upto 5 EC2 instances at the most.



Launch Configuration	Quick Park AC Launch Configuration
Load Balancers	QuickParkLB
Desired	1
Min	1
Max	5
Health Check Type	EC2
Health Check Grace Period	300
Termination Policies	Default
Creation Time	Tue Dec 08 14:38:16 GMT-800 2015

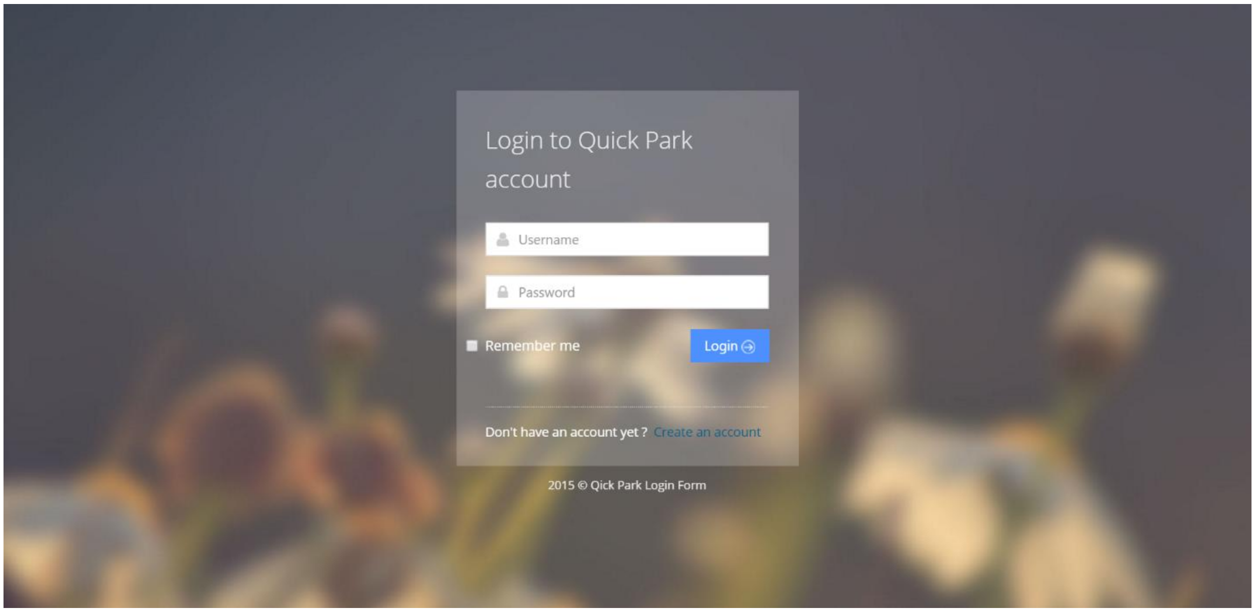
Availability Zone(s)	us-west-2b
Subnet(s)	subnet-c0167eb7
Default Cooldown	300
Placement Group	
Suspended Processes	
Enabled Metrics	
Instance Protection	Protect From Scale In

5. Setting up EC2 instance: Now after setting up the autoscaling group, we setup the EC2 instance. We've setup an ubuntu based EC2 instance that hosts apache webserver with php and mysql support. The security group associated with this instance is same as specified above. After instantiating the EC2 instance, we added it to the auto scaling group that we created in step 4.

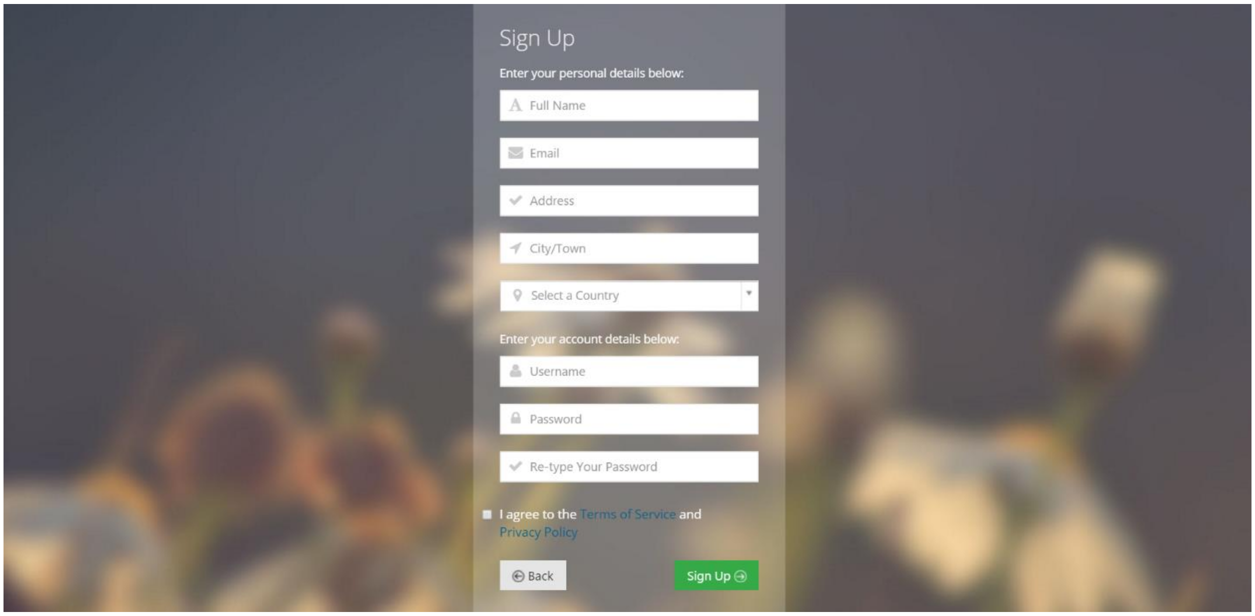
6. Setting up ELB: Elastic Load balancer for autoscaling group, helps distributes load over all the instances in the group. The security group associated with this Load Balancer is same as specified above. During setup we included all the instances associated with the autoscaling group with this load balancer.

B. User Work Flow for the QuickPark Application Website:

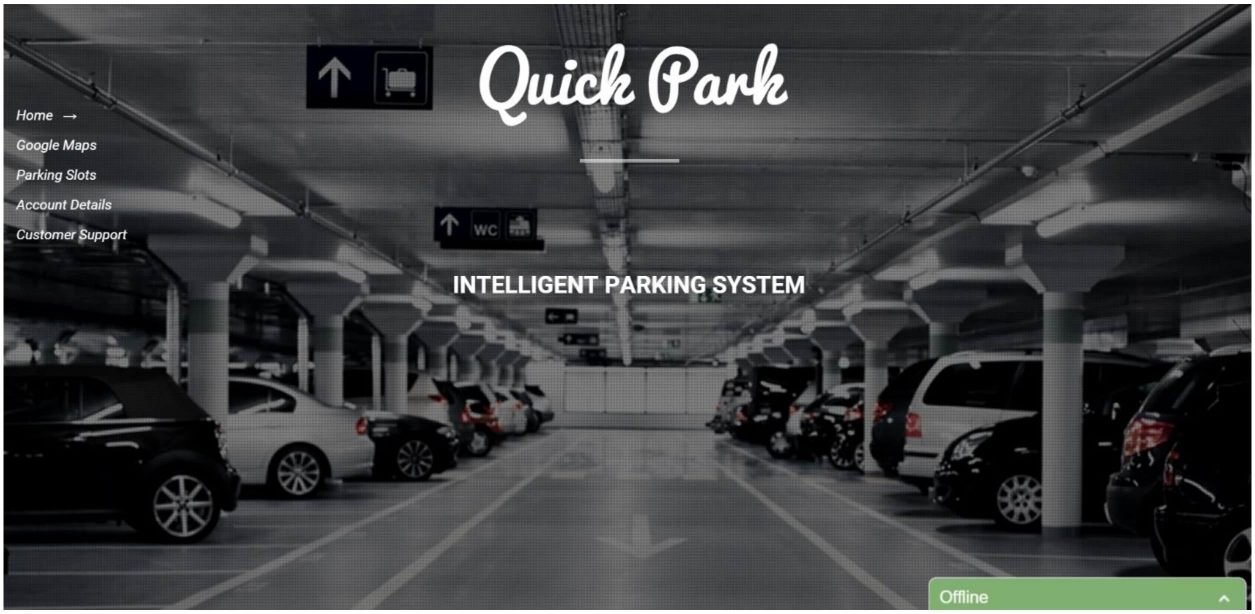
1. Visit the following URL: http://ec2-52-34-242-128.us-west-2.compute.amazonaws.com/ or the following IP Address: http://52.34.242.128/ you will be redirected to our website home page which appears as follows.


Login to Quick Park account
Username
Password
Remember me
Login
Don't have an account yet ? Create an account
2015 © Qick Park Login Form

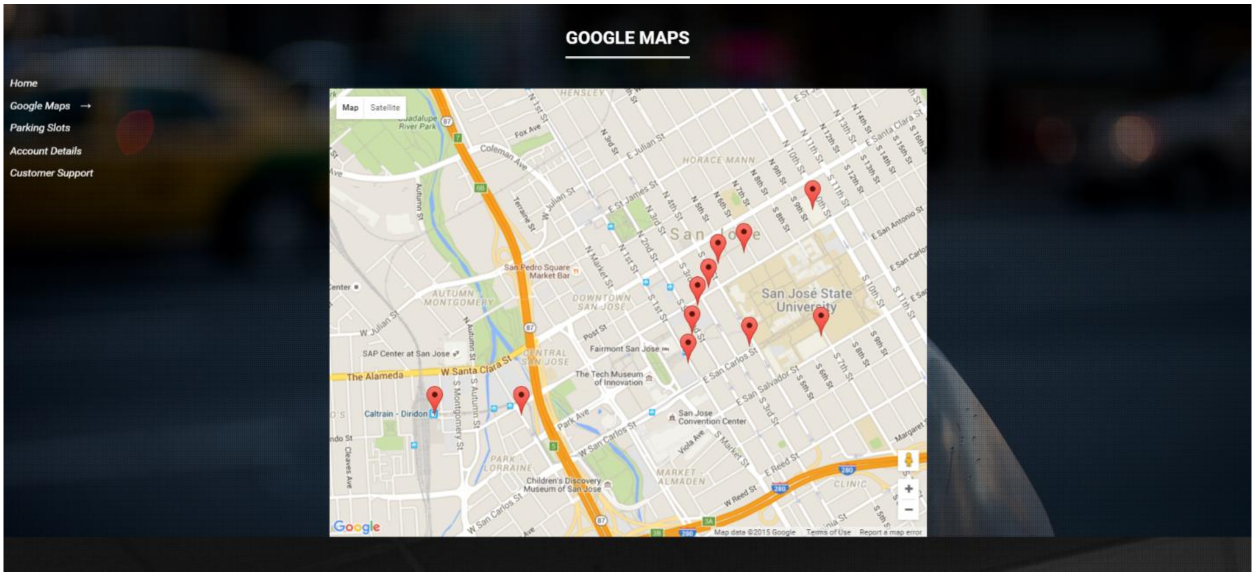
2. Now if you are registered user you can carry on with login process otherwise you need to register first for which you need to click on Create an account which appears on the bottom of the login model. The Registration form appears as follows.


Sign Up
Enter your personal details below:
Full Name
Email
Address
City/Town
Select a Country
Enter your account details below:
Username
Password
Re-type Your Password
I agree to the Terms of Service and Privacy Policy
Back
Sign Up

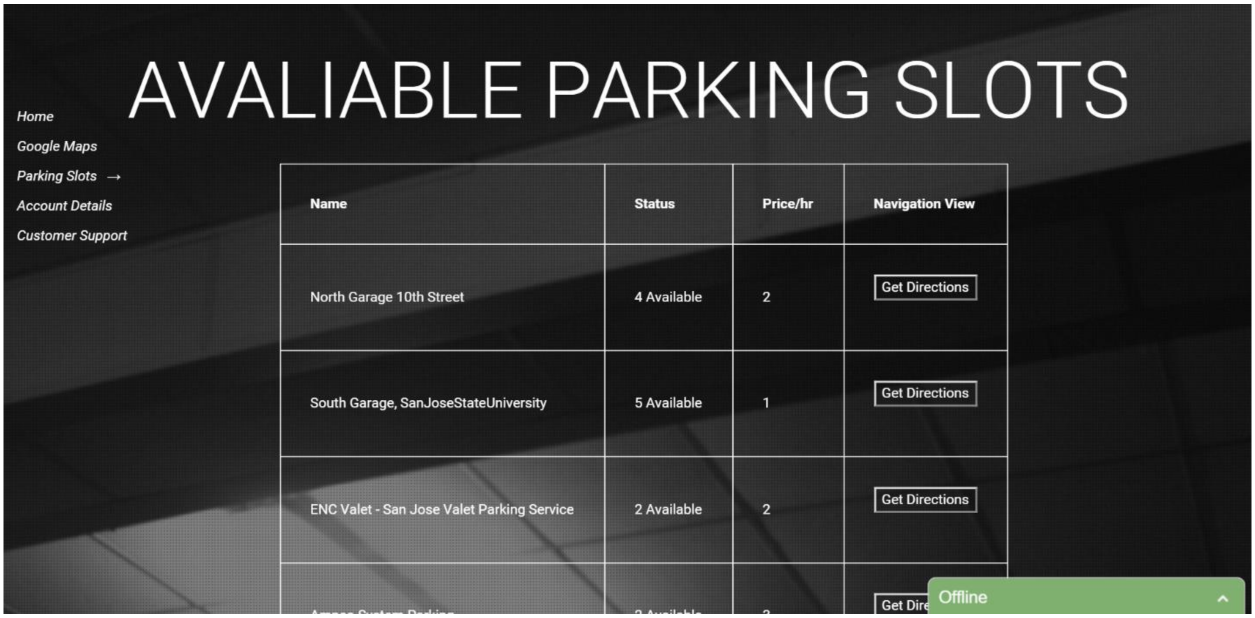
3. Now after the completion of the registration procedure you will be redirected to login page where you need to provide with the login credentials. If the credentials match you will enter the homepage of the website which appears as follows.



4. There are other pages which are Google Maps, Parking Slots, Account Details, Customer Support. You can navigate to the other pages by clicking on the titles or through an interactive button that shows the direction where it will navigate. The Google Maps page is as follows.



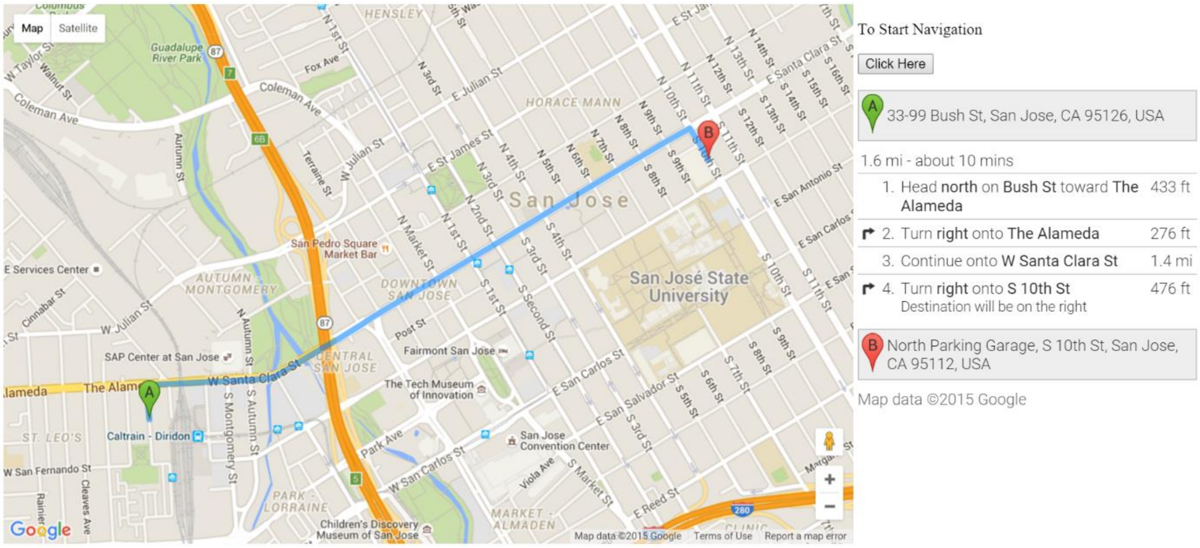
5. The next page provides you with details of parking garages, the number of available parking slots in one particular garage, price of the garage, and directions button.



AVALIABLE PARKING SLOTS

Name	Status	Price/hr	Navigation View
North Garage 10th Street	4 Available	2	Get Directions
South Garage, SanJoseStateUniversity	5 Available	1	Get Directions
ENC Valet - San Jose Valet Parking Service	2 Available	2	Get Directions
Ampco System Parking	2 Available	2	Get Dire

6. Once you click on the Get Directions button you will be redirected to a page where you will be provided with details on how to reach to the garage that you selected based on your preference. The directions page appears as follows.



To Start Navigation

Click Here

A 33-99 Bush St, San Jose, CA 95126, USA

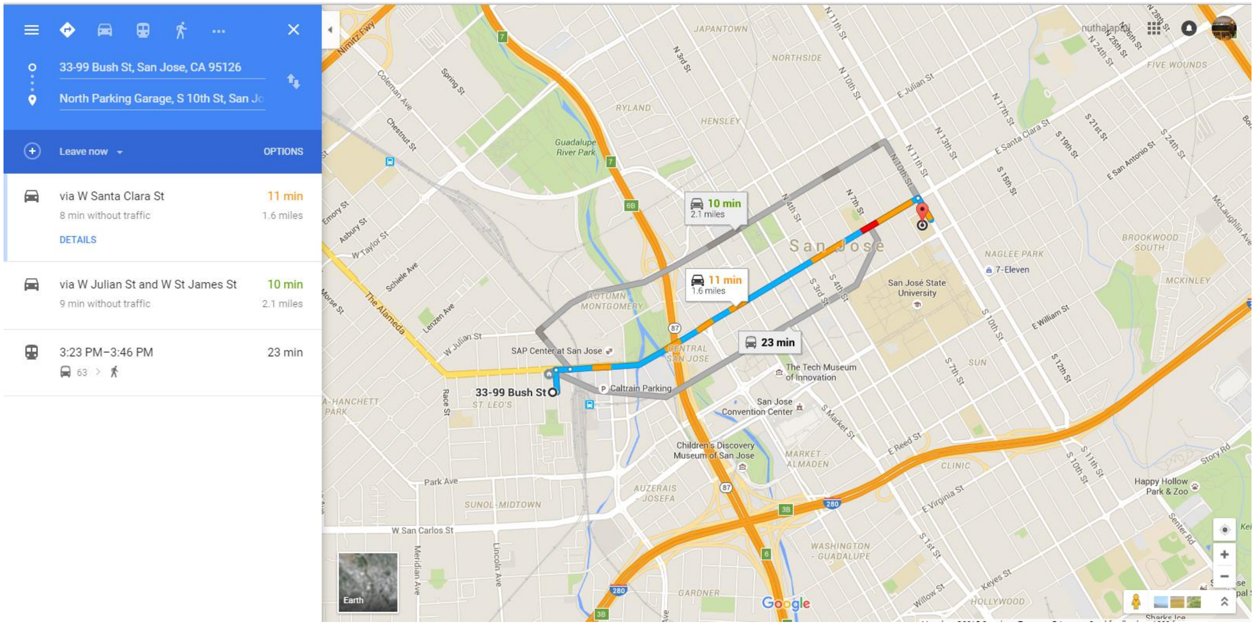
1.6 mi - about 10 mins

1. Head north on Bush St toward The Alameda 433 ft
2. Turn right onto The Alameda 276 ft
3. Continue onto W Santa Clara St 1.4 mi
4. Turn right onto S 10th St 476 ft
   Destination will be on the right

B North Parking Garage, S 10th St, San Jose, CA 95112, USA

Map data ©2015 Google

7. And if you want navigation instead of the written directions you can activate navigation by clicking on the to navigate click here button which redirects you to google maps with your start location and destination with navigation activated. If you open the website in mobile your google maps application will open automatically. The Google Maps navigation is as follows.



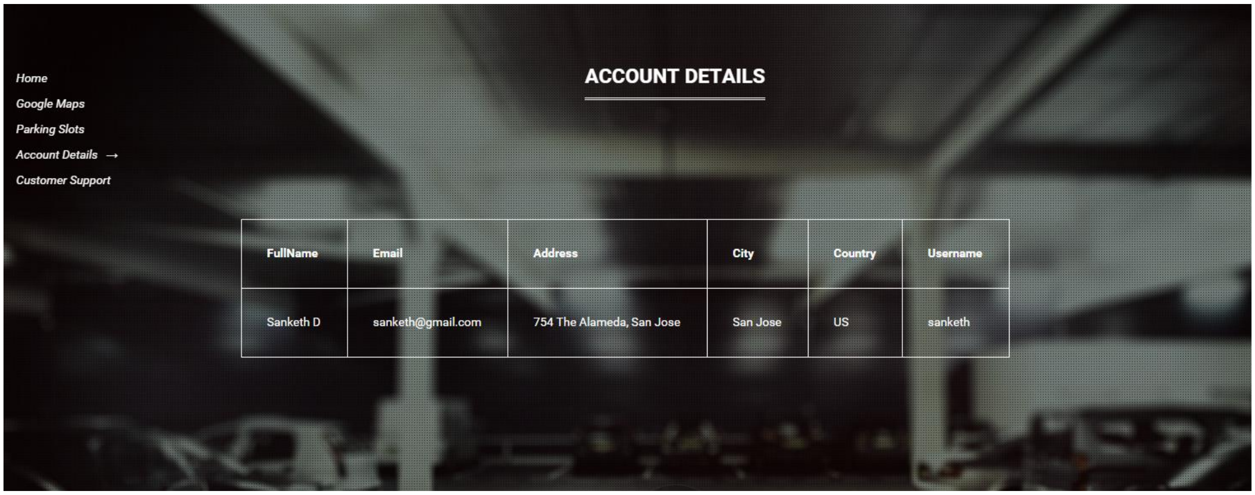
33-99 Bush St, San Jose, CA 95126

North Parking Garage, S 10th St, San Jo

Leave now OPTIONS

via W Santa Clara St 8 min without traffic DETAILS	11 min 1.6 miles	
via W Julian St and W St James St 9 min without traffic	10 min 2.1 miles	
3:23 PM–3:46 PM 63	23 min	

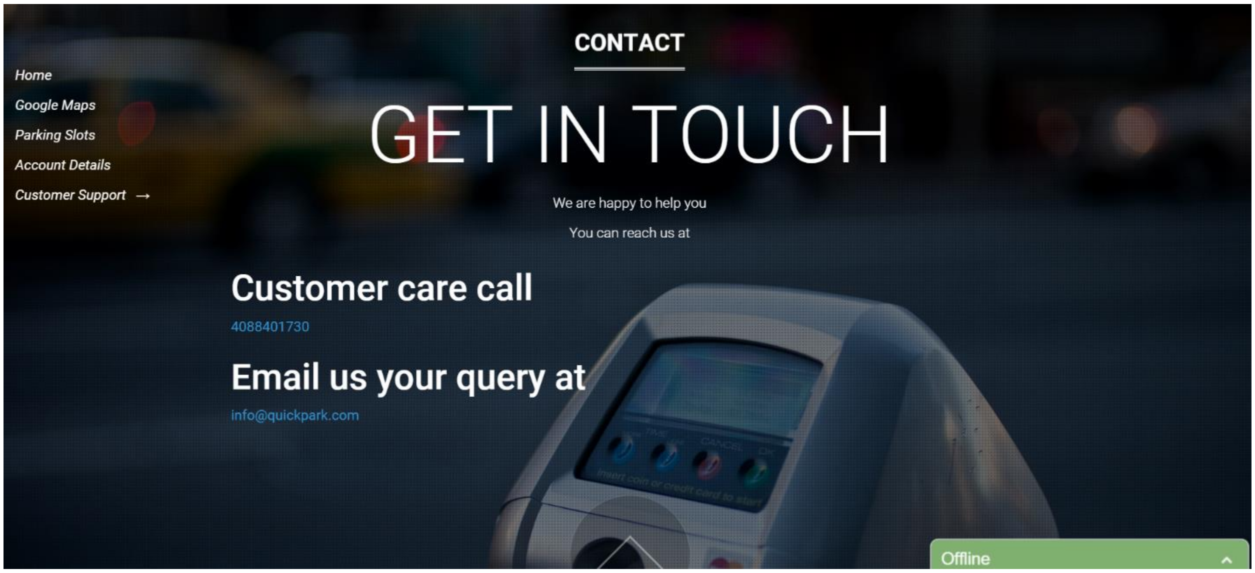
8. The fourth section in our website is account details where the registered user account details will be shown to him once he logins. The account details page is as follows.



ACCOUNT DETAILS

FullName	Email	Address	City	Country	Username
Sanketh D	sanketh@gmail.com	754 The Alameda, San Jose	San Jose	US	sanketh

9. The fifth section is the customer support feature where a customer can use to get clarified with his doubts or can inform his problems. The customer support page appears as follows.



GET IN TOUCH

We are happy to help you

You can reach us at

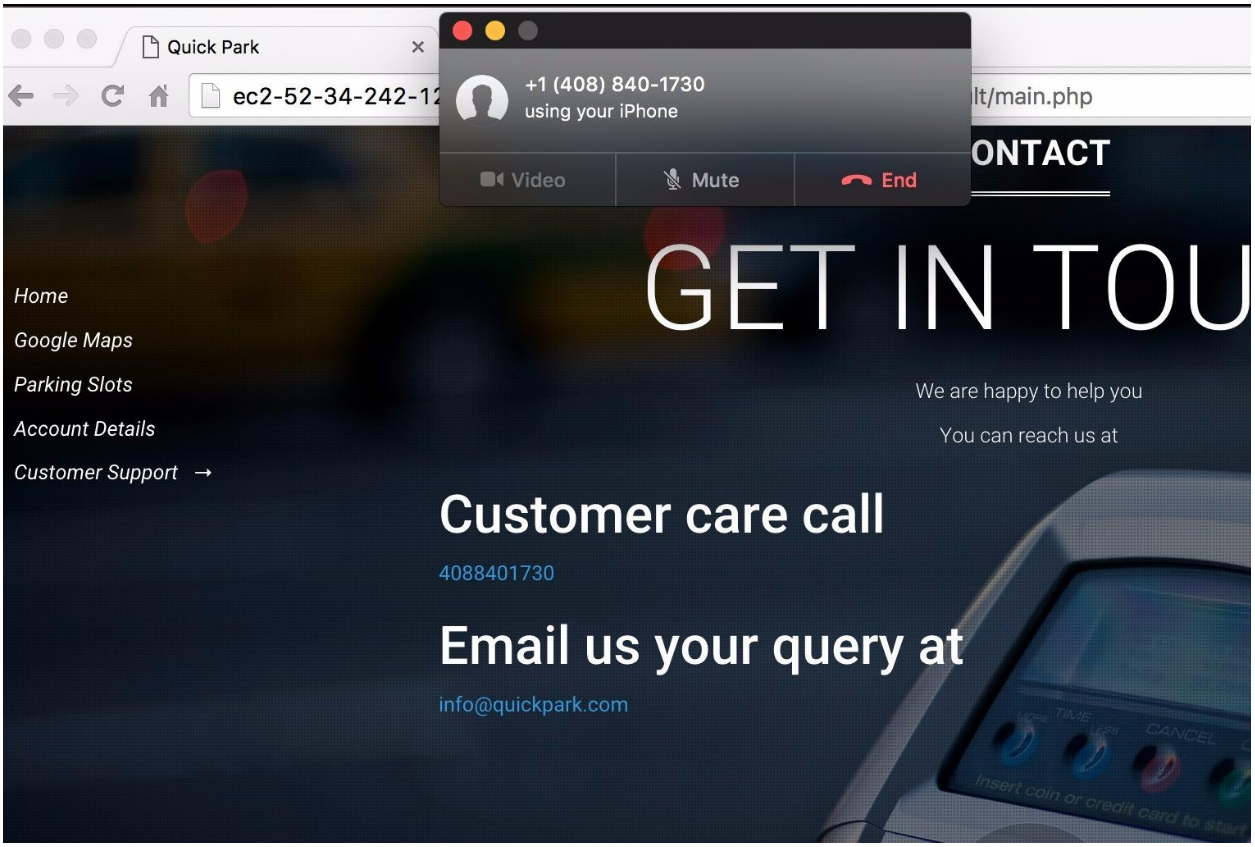
Customer care call

4088401730

Email us your query at

info@quickpark.com

10. We have provided you with features like you can call us to that particular number provided to you when you select the particular option you will call to the respected number and the screen appears as follows.



GET IN TOU

We are happy to help you

You can reach us at

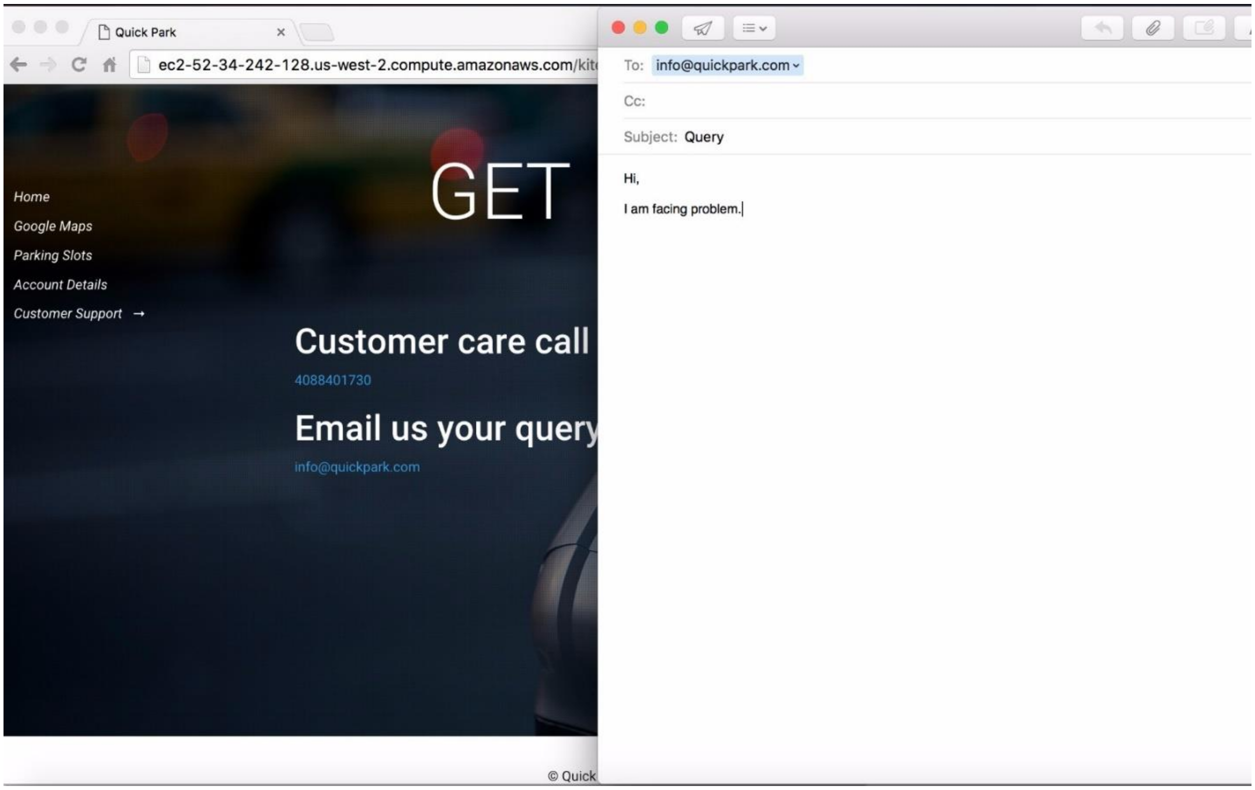
Customer care call

4088401730

Email us your query at

info@quickpark.com

11. You can even email us with your problems and we will provide you with a solution. When you choose the email us option you will observe the following screen.



Customer care call

4088401730

Email us your query

info@quickpark.com

To: info@quickpark.com

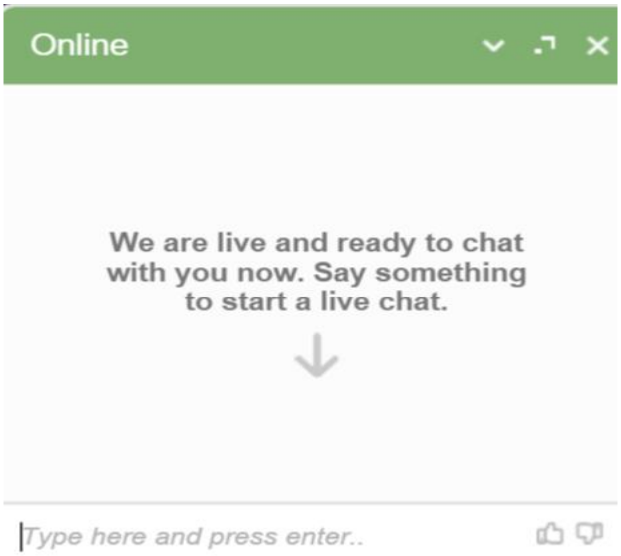
Cc:

Subject: Query

Hi,

I am facing problem.

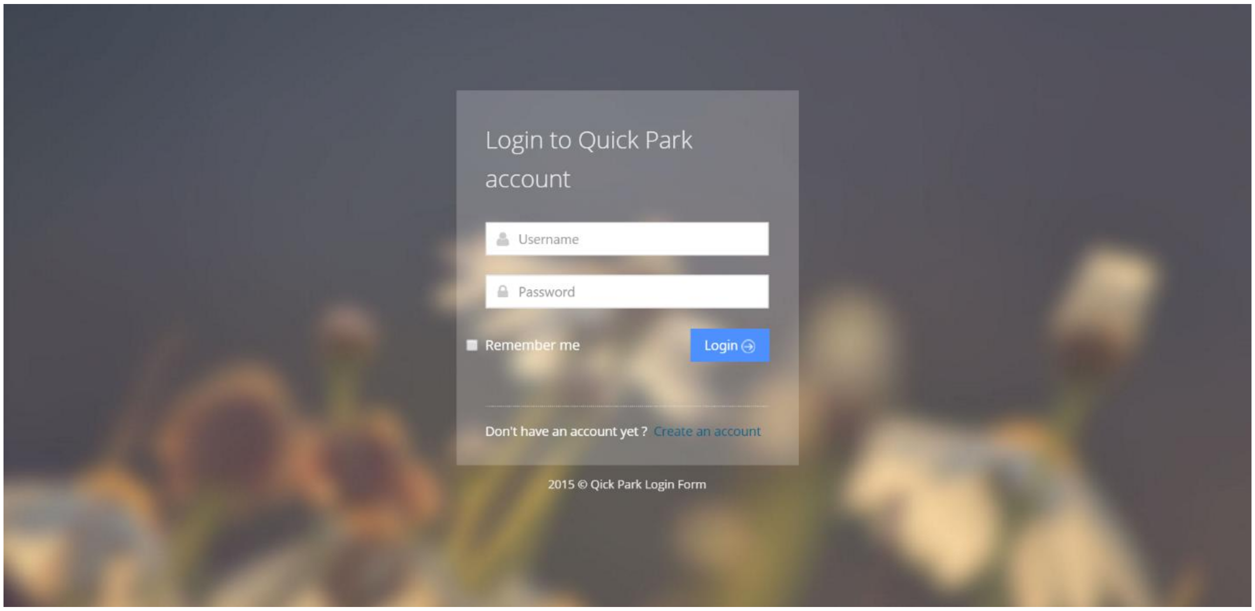
12. Even we have a live chat feature which might help you with your queries. The live chat feature appears as follows.



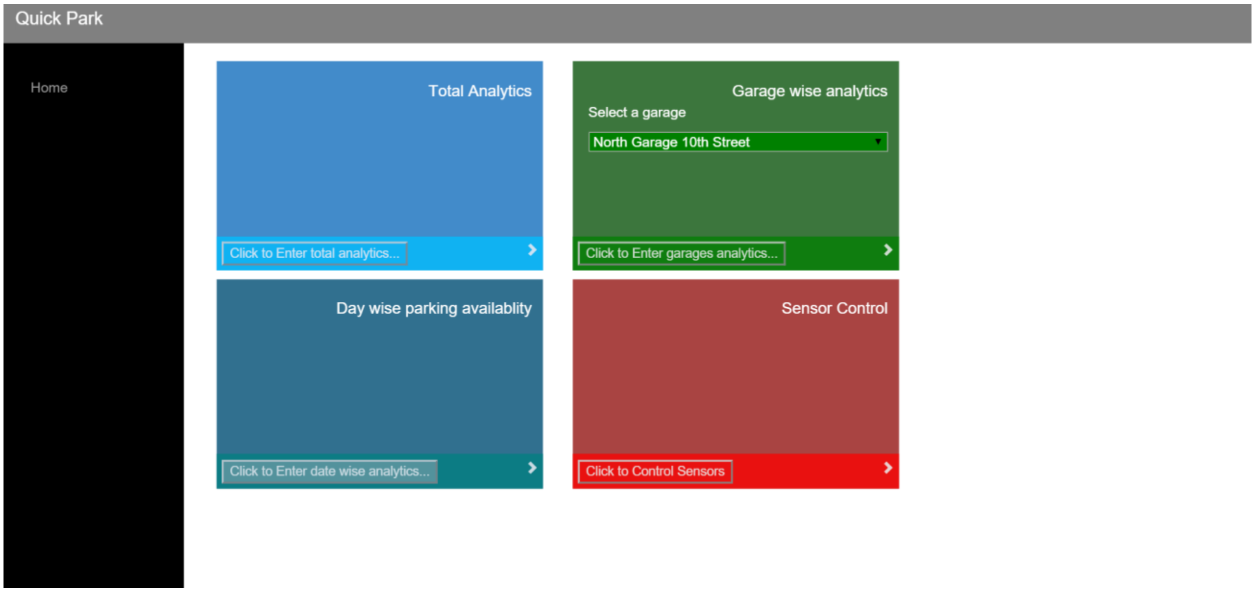
We are live and ready to chat with you now. Say something to start a live chat.

C. Admin Work Flow for QuickPark Application Website:

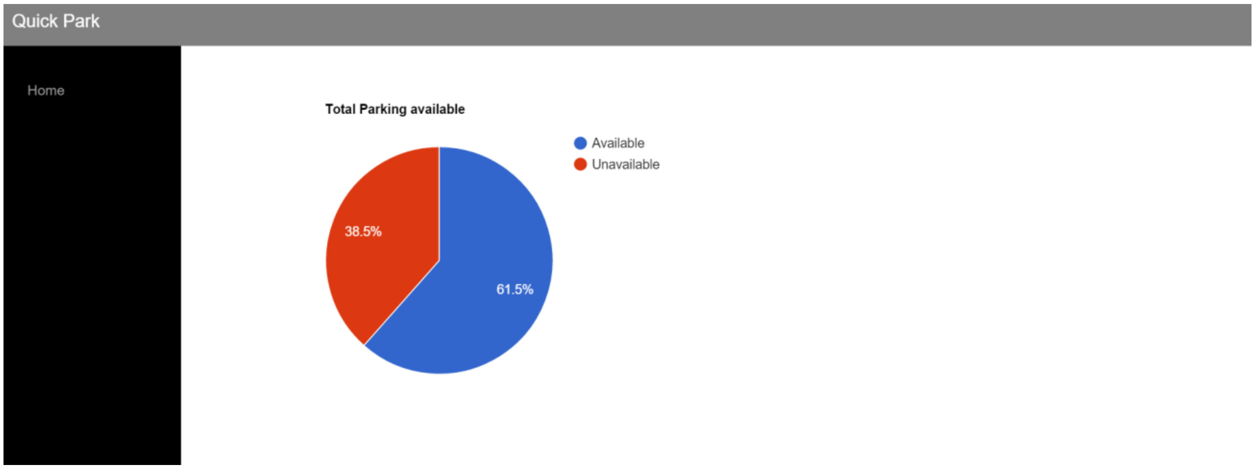
1. Visit the following URL: http://ec2-52-34-242-128.us-west-2.compute.amazonaws.com/ or the following IP Address: http://52.34.242.128/ you will be redirected to our website home page which appears as follows.


Login to Quick Park account
Username
Password
Remember me
Login
Don't have an account yet ? Create an account
2015 © Qick Park Login Form

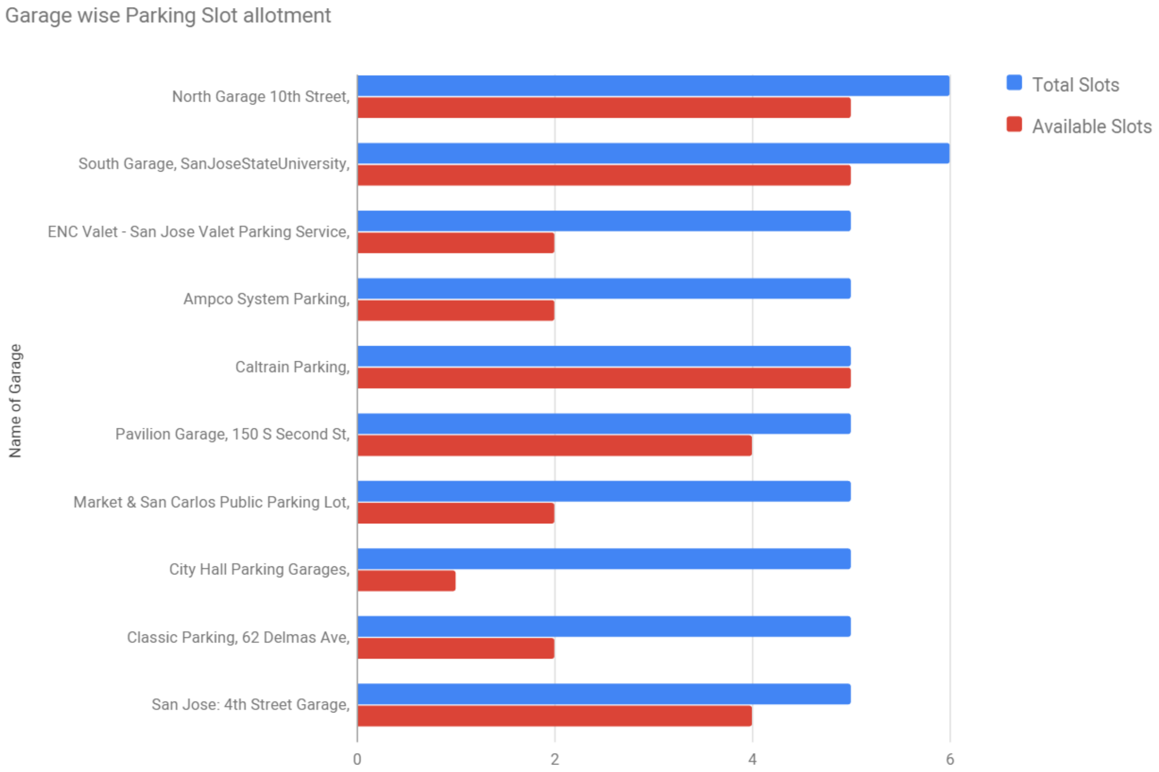
2. When you provide the details of the admin you will be redirected to the admin panel. As per now we have only one admin.


Quick Park
Home
Total Analytics
Click to Enter total analytics...
Garage wise analytics
Select a garage
North Garage 10th Street
Click to Enter garages analytics...
Day wise parking availablity
Click to Enter date wise analytics...
Sensor Control
Click to Control Sensors

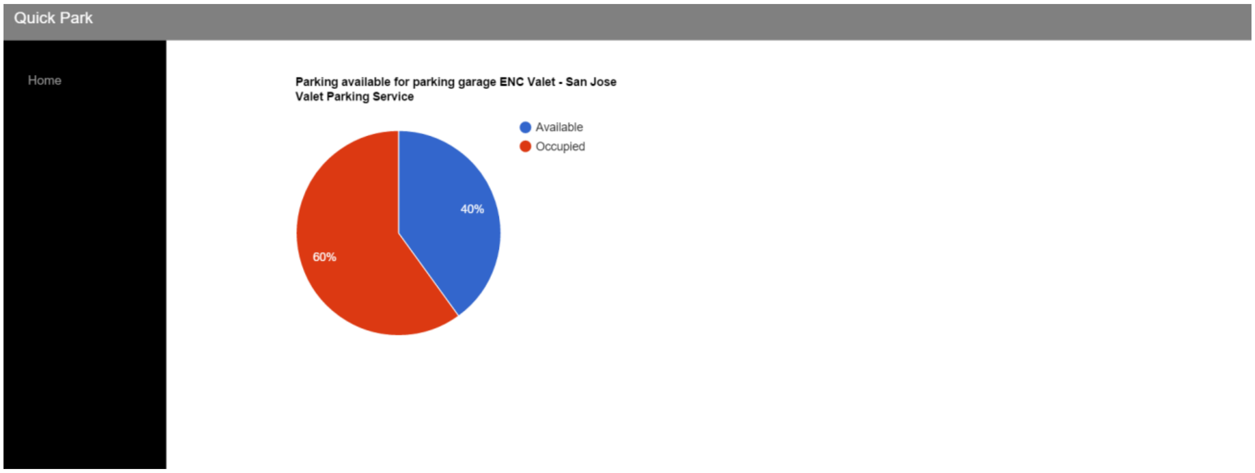
3. You are provided with four basic operations which are Total Analytics, Garage wise analytics, Day Wise Parking availability and Sensor control. If you select the Total analytics you will be provided with a page that shows a pie chart and bar graphs of the total analytics of the parking garages and bar graph of each garage which appears as follows.



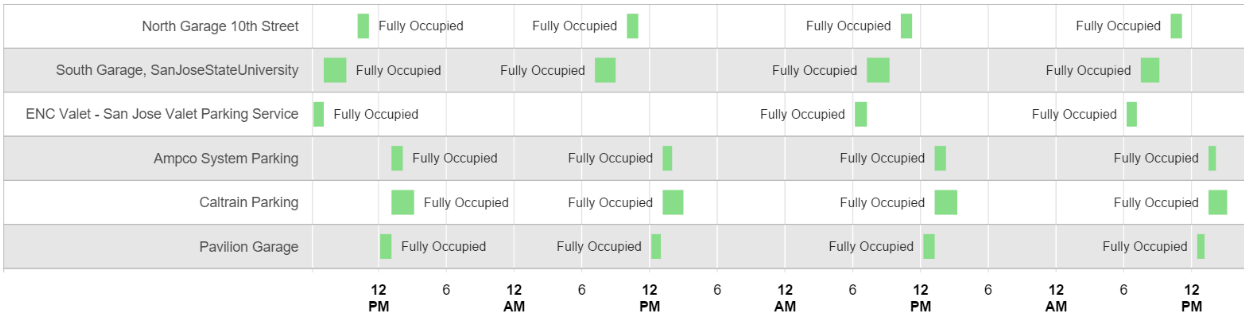
The bar graph appears as follows.



4. The second option available for administrator is viewing garage wise analytics for which we need to select a particular garage from the dropdown menu and we can view analytic of that particular garage.

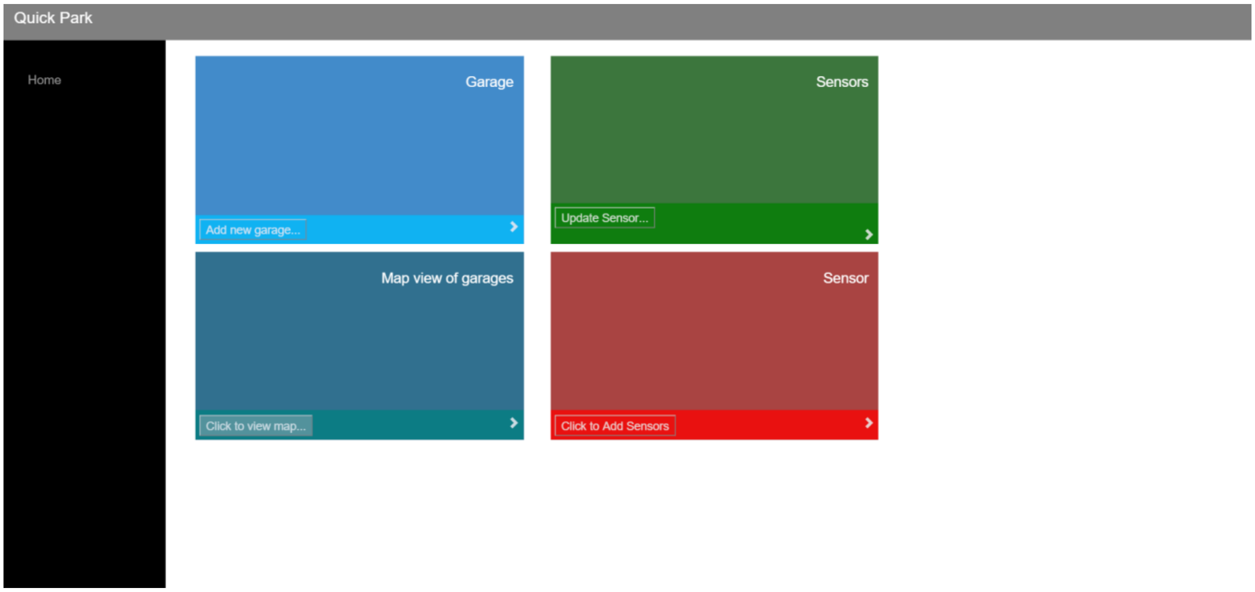

Quick Park
Home
Parking available for parking garage ENC Valet - San Jose Valet Parking Service
Available
Occupied
40%
60%

5. The third feature provided to the admin is to view day wise analytics in which he will be provided with details of the garages around the clock. The day wise analytics will be shown as follows.

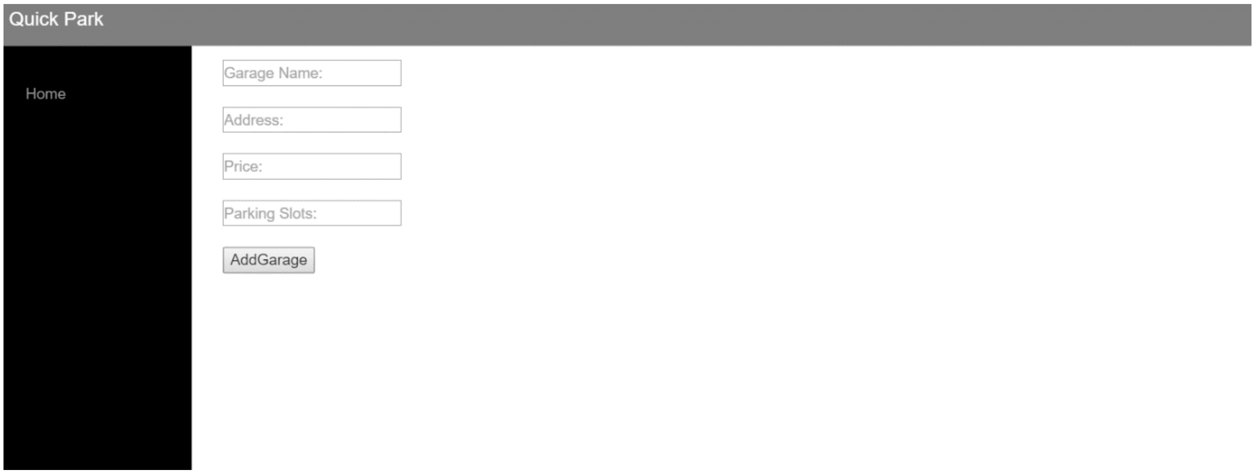


When you hover over the green filled parts you will be provided with the time slots of the day at which that particular garage was occupied.

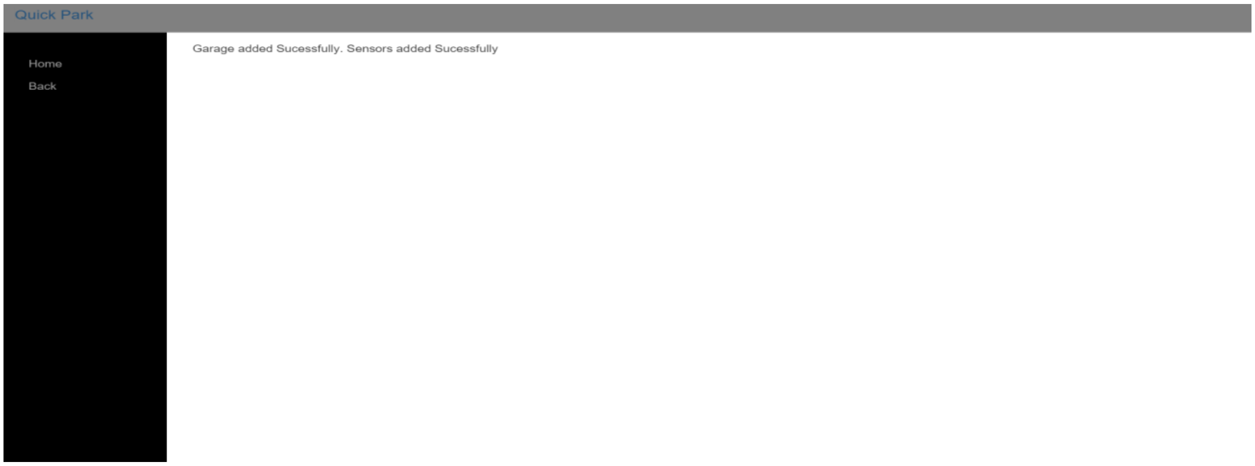
6. The fourth feature provided to admin is the sensor control which future has 4 more operations that can be performed. The fourth feature has the following sub categories.



7. Now if we select the category add garage you will be redirected to a particular page where you need to provide with the details of the garage that you want to add. The garage add feature page appears as follows.

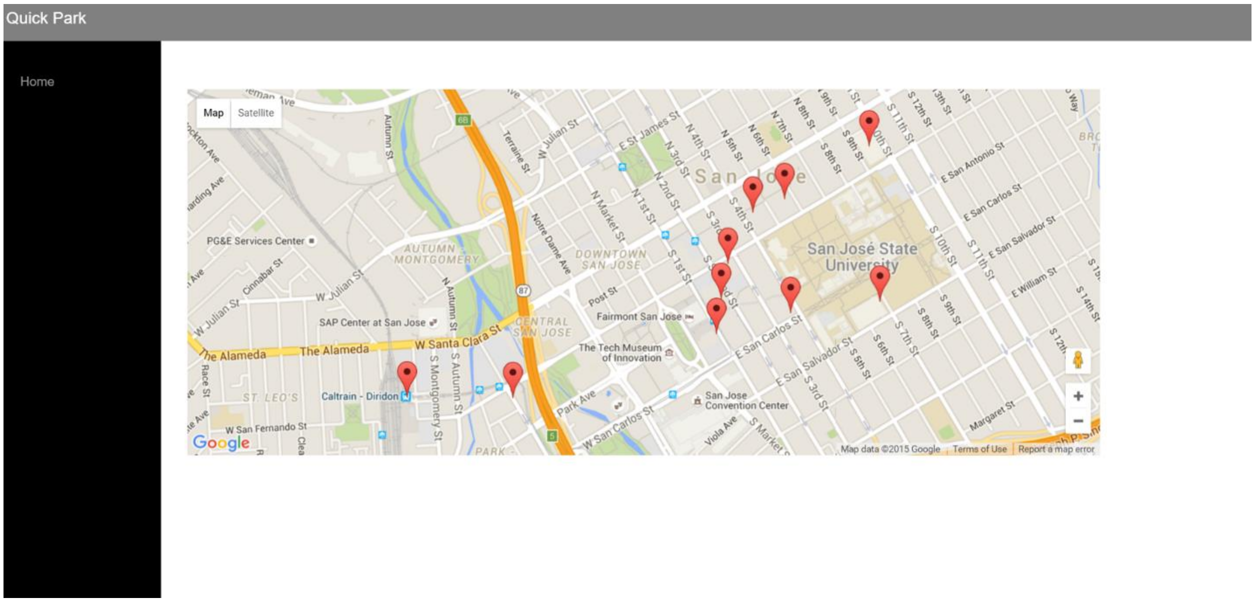


After you provide with the details and click on addgarage you will be provided with a message garage added successfully if the garage is added.

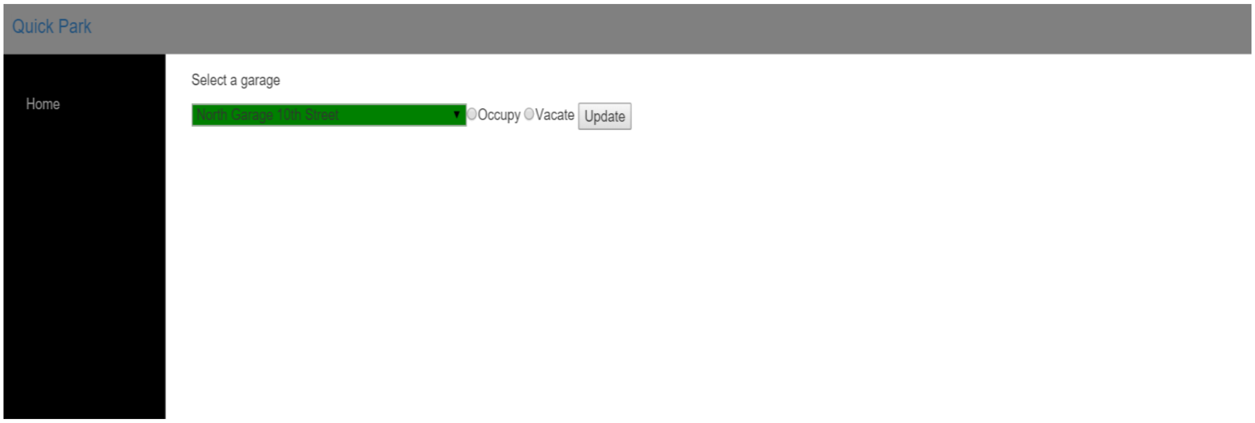


Garage added Sucessfully. Sensors added Sucessfully

8. Now you can check whether the garage is added or not in the next feature which is map view of garages on clicking it you will be provided with a map with markers spread over the garages that are added to the database.

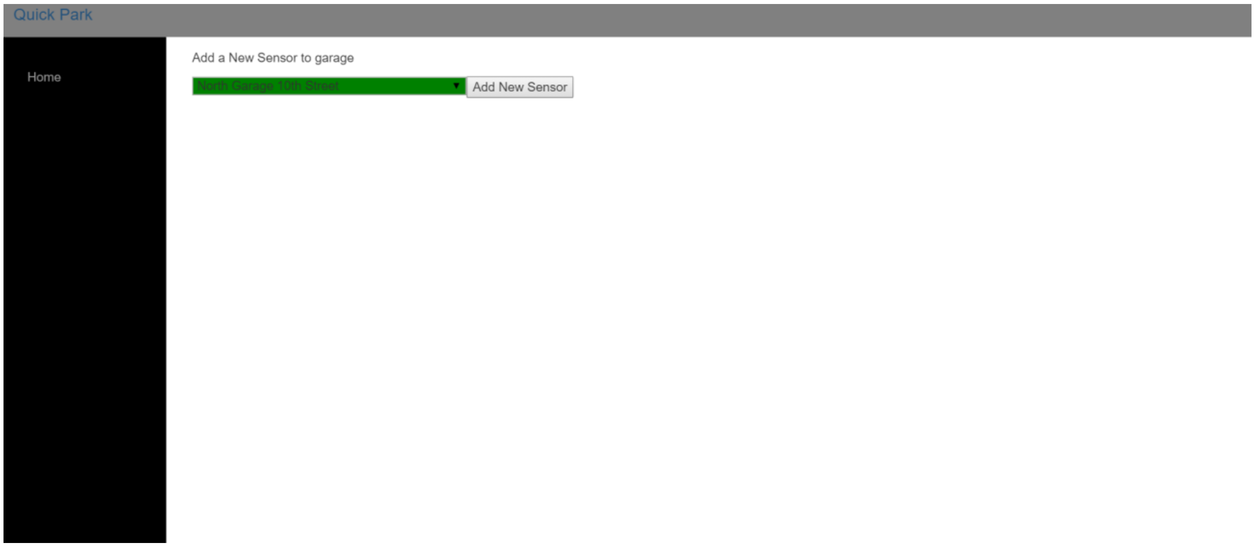


9. The Next feature is update sensor which is used to update the status of a particular sensor if you provide the option as occupied then the number of available slots in a particular garage gets reduced and similar is the case with vacate. The sensor update page appears as follows.



Select a garage
North Garage 10th Street

10. The last feature is the add sensor in a particular garage for which you need to select a particular garage and add the sensor which updates the total sensors in the selected garage. The add new sensor page appears as follows.



Add a New Sensor to garage
North Garage 10th Street

And these are the features that we implemented in admin panel. This completes the work flow of admin panel in quick park.

D. Conclusion: With QuickPark, we provide a comprehensive system, for users to look for all possible parking places near them, know beforehand how many places are available at that parking garage and how much it will cost. We also provide functionalities like navigation, analytics, support calling, etc. QuickPark server is deployed on an AWS EC2 instance which is a part of an auto scaling group and is balanced using AWS Elastic Load Balancer.