Yarmouk Private University
Faculty of Informatics and Communication Engineering
Department of Software Engineering

Smart Parking System

Junior Project

By:

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Supervisor:

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Semester 2018/2

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ABSTRACT

In the rise of smart software systems, smart cities are presented utilizing smart software systems to organize the people's life and facilitate complicated things. One of the real world problems is traffic problems. In this project, a smart parking system (SPS) is proposed. SPS consists of a License Plate Recognition System (PRS), Database Management System (DBMS), and a website. PRS is the main component that is used to capture an image of a plate from fixed camera and produces a corresponding plate's number that is stored in DBMS for further processing. Many existing PRS works have proposed their solutions in different ways targeting a certain country's plates. Every country has its own license plates with a certain shape, color and numbers. Deep learning models and image processing techniques are demonstrated in this project as efficient solutions to various problems of plate recognition. Syrian vehicles are targeted including Arabic number recognition. DBMS is utilized to store information about bills, time in of a vehicle and time out, status of a park spaces. The website manages certain parks through internet of things (IOT) technology which includes a set of smart sensors distributed in different areas of parking. Data visualization tools are used to get statistics about all data movements in a park. The idea of bill automation is implemented to reduce the time and cost and gets the customer's satisfaction.

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1ST CHAPTER

Introduction
To Project

1.1. Introduction:

Parking is limited these days especially in big cities due to the increasing number of vehicles. Nowadays, drivers waste long time to find available space for their vehicles. Previously finding parking places was an easier task but now with the increasing of industries cars are produced in a great number, the prices of vehicles became cheap, a lot of people now own their private vehicles this led to park in random spaces and this raises the probability of crimes presence, SPS take its place to organize the parking process instead of parking in public roads and yield damage to vehicles, organizing vehicles' places provides the security by monitoring the records of the entering time of the vehicles and time out in the data base management system, SPS makes the vehicles near from the drivers in their activity places ,researchers are shown that greater than 85% are finding difficulties in finding an empty place for their vehicles in their activity places. Smart parking system came in various solutions:

- SPS based on IOT: Sensors are used in these systems to allow the driver to access to his vehicle by a camera real time, monitor the status of the vehicles in a park.
- SPS based on cloud computing: these systems are presented to handle the big number of requests of the users in addition to a web application/android application to allow the users to interact with the parks in terms of park place reservation processes, showing a park places.

We introduce our smart parking system which consists of a website to let the end user to check the availability of a spot in a park, manage the places in a park, automate bills using deep neural networks which extract a vehicle license number from the image of the vehicle. Extracting a vehicle license number from the image of a vehicle comes with two stages:

- Plate localization based on label connected component analysis and plate recognition.
- Digit segmentation based on label connected component analysis and digit recognition.

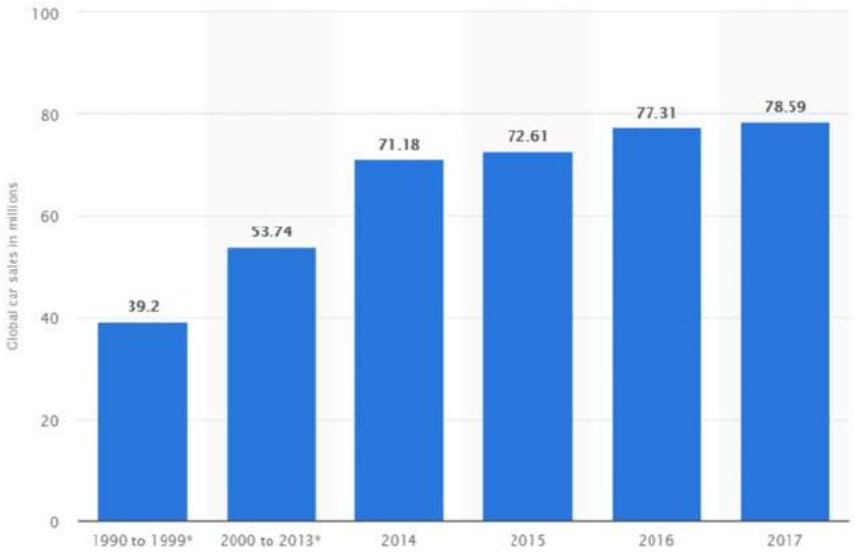

Figure 1.1: Number of cars sold (in million units)

1.2. Problem Statement:

The problem of messy parking is the main reason behind the emerging of smart parking system. License plate recognition system is the most important component in SPS. Computer vision (CV) algorithms have been applied to solve the task of the plate recognition. It was found that these methods suffer from different problems related to external factors such as lighting, noise, scale, variation in the background … etc. Computer vision algorithms are not able to be generalized to different tasks. The reason behind that is its need of domain experts to select a proper CV method related to specific application. On the other hand, deep learning models have been used to avoid these problems. Self learning of the model's parameters can learn discriminative representations which enhances the system's performance in the term of accuracy.

1.3. Project Objective:

The objectives of this project are:

- Design and implementation of plate recognition system that includes plate localization and arabic digit classification. This system utilizes deep models such as Convolutional Neural Network to outperform the performance of other existing PRSs.
- Results analysis by measuring performance metrices such as Training time and Accuracy.
- Design and implementation of Database Management System to manage data movements in SPS.
- Design and implementation of a website that manages all available parks. It can provide end users with services regarding to checking the availability in the parking spots and monitoring their own vehicles.
- Design and implementation of bills automating system that is able to calculate customer's bills without human intervention.

1.4. Project Block Diagram:

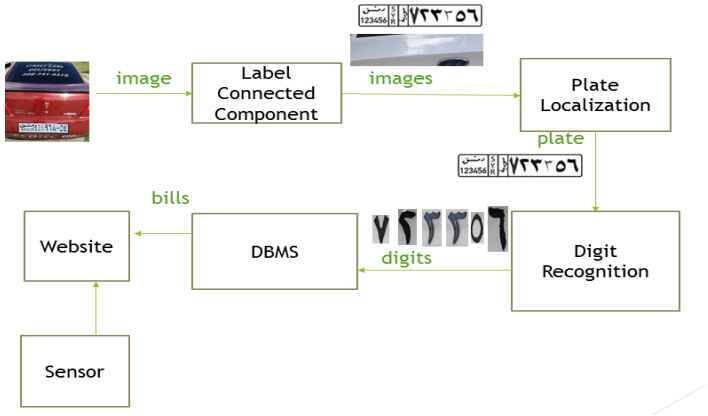

Figure 1.2: Block Diagram

The block diagram consists of the following components:

- Label Connected Component Block:The input of this module is an image of vehicle and the output is many non-connected patches of the image .
- Plate Localization Block:The input is the non-connected patches and the output is the plate image.
- Digit Recognition Block:The input is the plate image and the output is the extracted vehicle license number.
- Database Management System (DBMS) Block.
- Website Block.
- Sensors Block:This Block sends the parking availability information to the website page.

1.5. Methodology:

1.5.1. Convolutional Neural Network (CNN):

CNN is the most powerful deep learning model and widely used today in image recognition tasks, CNN is the state of the art in computer vision tasks.

The most important components in CNN are:

I. Convolutional layers.
II. Max Pooling layers.
III. Average Pooling layers.
IV. Classifier (Fully Connected Layer).

Feature learning

Classifier

See the architecture of CNN in figure (1.3):

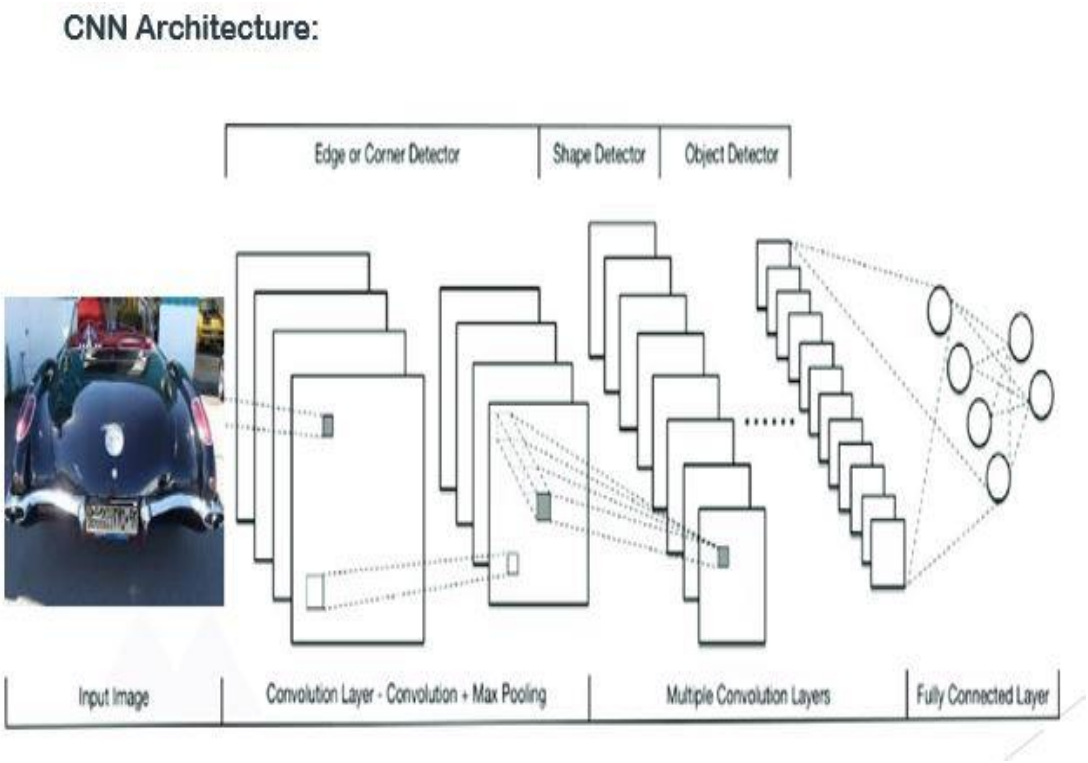

Figure 1.3: CNN Architecture

I. Convolutional layer: This layer learns various pattern from the input image such as edges, corners, this layer learns by a filter, the result from this layer is called “feature maps”.

Each convolutional layer contains filters, filter is a matrix that detects edges or even objects, filters are learned by learning algorithms such as backpropagation. Figure (1.4) shows how convolutional layers work:

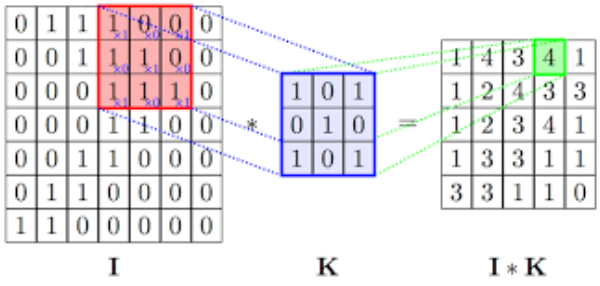

Figure 1.4: Convolutional Layer

II. Max Pooling layer: This layer reduces the dimensions of the feature maps to speed up the model's calculations, this is done by a filter with a certain size.

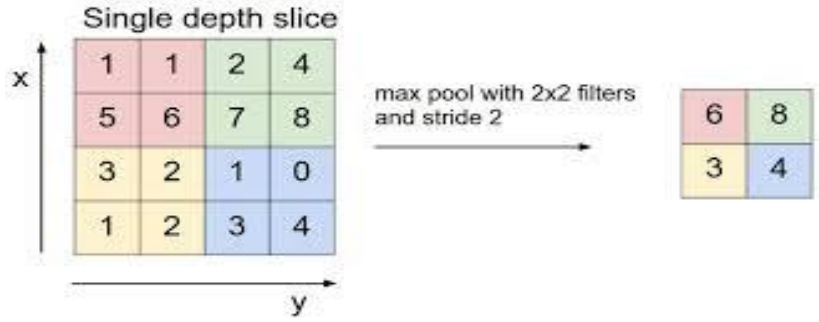

Figure 1.5: Max Pooling Layer

III. Average Pooling layer: This layer smooths the feature maps, this is done by a filter with a certain size.

IV. Neural Network Classifier(Fully Connected Layer):

Is a regular neural network that takes the learned features from the Convolutional, Pooling part and learns to classify several classes.

CNN is trained based on an error function, the most common error function in the classification task is the cross entropy function which is as follow:

$$\text{loss}(Y,\hat{Y}) = -\sum Y log\ (\hat{Y})$$

Where:

- Y is the actual output of an example in the dataset.
- $\hat{Y}$ is the predicted output from the CNN model.

  The loss function is calculated on every sample in the dataset then this loss is minimized through backpropagation algorithm.

1.5.2. Hierarchical Extreme Learning Machine (H_ELM) [1]:

H_ELM is very efficient sparse deep learning model in terms of training time and generalization performance, H_ELM does not need iterative learning algorithm to be trained such as backpropagation. We used H_ELM in this project as a reference model to our dataset.

H_ELM consists of two main components:

I. Sparse ELM Autoencoder: This part learns features from input, reduce the dimensions of the input.

Feature learning

II. ELM: ELM is a neural network that learns without tuning the weights of the neural network, ELM is a fast neural network in terms of learning, prediction.

Classifie

ELM is trained by this equation:

- $\boldsymbol{\beta} = \mathbf{H}\dagger\mathbf{T}$

Where:

- $\boldsymbol{\beta}$ is the output weights.
- $\mathbf{H}\dagger$ is the inverse of the random matrix **H**.
- **T** is the target label (y).

See in figure (1.6) the architecture of H_ELM in [1]:

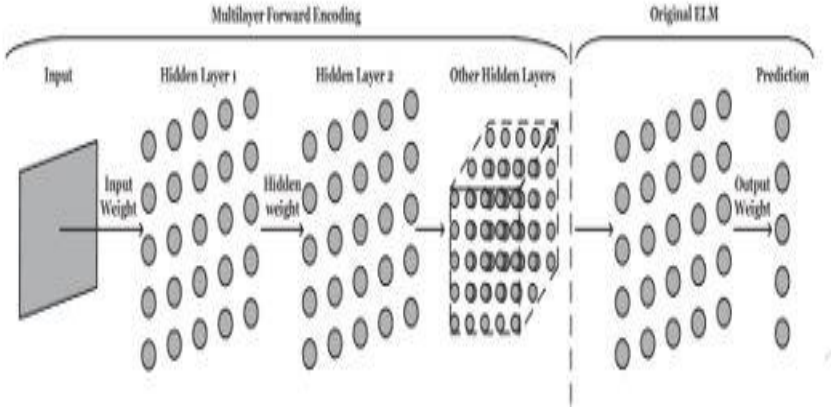

Figure 1.6: H_ELM Architecture

1.5.3. Label Connected Component (LCC):

LCC is an image processing algorithm that divides an image to sub images with similar pixel intensity value. See in figure (1.7) how (LCC) works:

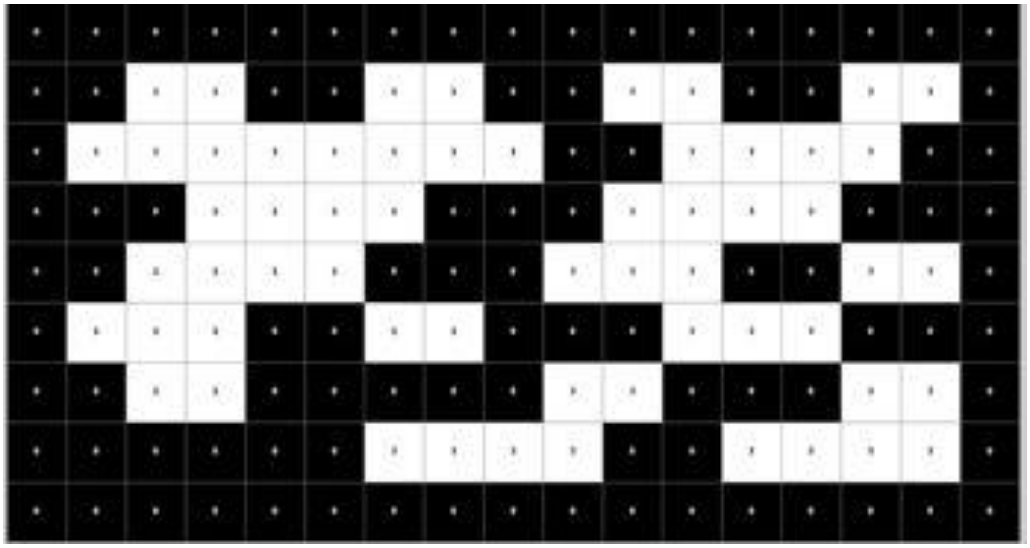

Figure 1.7: Local Connected Component

2ND CHAPTER

Machine Learning For Plate Localization And Digit Recognition

2.1. Plate License Recognition Application In Smart Park:

Let be a vehicle in front of the barrier of a park such as the image in figure(2.1) an image of the vehicle is captured via a camera then the image is sent to LCC to divide the image into sub images ,various components will be sent to our deep learning model CNN to locate the plate of the vehicle.

The located plate is sent to another deep learning model CNN to detect the digits in the plate,the detected digits are then sent to another deep learning model CNN which classifies the digits in the plate,the classified digits are then sent to our database server for further processing.

Figure 2.1: Vehicle In Front Of Barrier

2.2. Literature Review:

Plate license recognition is a challenging task in computer vision field. We introduce some of the solutions from research papers:

2.2.1. CONVOLUTIONALNEURALNETWORKSFORLICENSEPLATEDETECTIONINIMAGES [4]:

- What is image segmentation?

Image segmentation is dividing an image into sub regions with similar property such as color, shape…etc.

- What is regional proposals?

Regional proposals is an image segmentation algorithm which divides an image into sub regions with similar property.

The Convolutional Neural Network (CNN) based on regional proposals solution is working as follow: First an image of vehicle is captured by a camera then the image is divided into similar sub regions then every sub region is sent to the convolutional neural network to predict whether the sub region is plate or not plate. Regional proposals algorithm implemented in figure (2.2).

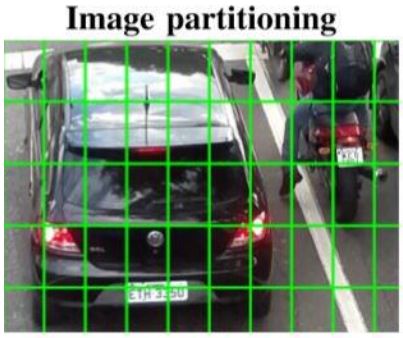

Figure 2.2: Regional Proposals

- Advantages:
  I. Utilizing the power of the features that are extracted from CNN makes the model generalize well.
- Disadvantages:
  I. CNN has a lot of computations to predict. Feeding CNN with many segments to locate the plate is time consuming.

2.2.2 ALPRS - A NEW APPROACH FOR LICENSE PLATE RECOGNITION USING THE SIFT ALGORITHM [5]:

- What is SIFT algorithm?

It is a computer vision algorithm that calculates the Gaussian gradient of an image to determine key points in the image, the key points are then compared with another key points in images to recognize

the digits see in figure (2.3) the calculated key points in an image:

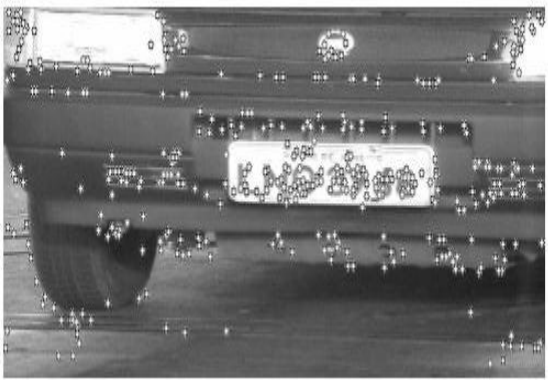

Figure 2.3: SIFT's Key points

Every key point is compared with template key points which are stored in a database to recognize the digit see in figure (2.4) an example to the template key points that are stored in a database to match with:

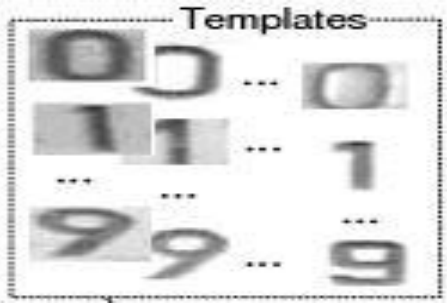

Figure 2.4: Template Of Keypoints

- Disadvantages:
  I. The above solution is susceptible to the external environment factors such as lighting changes,orientation changes,noise.
  II. the keypoints of a noise might be similar with the keypoints of a digit in the template that leads to wrong results.

2.2.3. License Plate Recognition Application using Extreme Learning Machines [2]:

- What is Extreme Learning Machine (ELM) ?

  ELM is a feedforward neural network with a single hidden layer.

- What is Histogram Of Oriented Gradient (HOG)? Is a feature discriptor that is used as features to feed a machine learning model.

The solution given above is as follow:

First an image of a vehicle is given to the connected component analysis which divides the image into subregions then each subregion is given to the HOG which extracts the features of the sub region then the features are given to the ELM neural network to recognize the plate.

- Disadvantages :

I. The above solution is that the HOG features of the subregions might be similar, this problem gives poor performance.

- Advantages :

I. ELM is very efficient in terms of training time and generalization performance.

2.2.4. License plate localization and recognition in camera pictures Halina Kwaśnicka and Bartosz Wawrzyniak Faculty Division of Computer Science, Wrocław University of Technology, Wybrzeże Wyspiańskiego 27, 50-370 Wrocław [6]:

- What is Label Connected Component?

Label connected component is an image processing algorithm that divides an image into sub regions with similar pixel intensity .

The solution given above is as follow:After image segmentation process, each segment is given to a regular neural network to predict each digit.

- Disadvantages:

I. Each sub region may contains similar features with another sub region that means the features are not discriminative and that gives poor performance see in figure (2.5) an example to the implementation of label connected component:

- Advantages:

I. Label connected component is a very simple and fast segmentation algorithm and is very helpful when the image is noise free

Figure 2.5: Label Connected Component's Patches

2.2.5. License Plate Recognition (LPR): A Review with Experiments for Malaysia Case Study [11]:

- What is Thresholding ?

Thresholding is a technique to segment the image into subsegments to extract meaningful informations in the image for example to do object recognition.

Thresholding segments an image through a value, this value determines regions that will be white regions and that will be black regions.

This paper tried to solve the license plate recognition task using image processing,filtering,features extraction techniques to enhance the recognition task.This paper tried to solve the problem through

extracting shapes with a certain properties such as shape,color.First, filtering techniques are applied to remove noise from the image after that Thresholding techniques are applied to segment the image to extract meaningful informations in the image .A simple neural network takes the segmented images to recognize the digits.

- Advantages:
    I. Using image processing algorithms it may be helpful in this task because it eliminates the unwanted objects in the image but not always.
- Disadvantages :
    I. The effect of the noise can be big, image processing algorithms may not do well in the segmentation task .
    II. The features that are extracted may not be distinct, that makes the neural network gives wrong results sometimes.

2.2.6. The Research and Design of Vehicle License Plate Recognition System in Traffic Management System [9]:

- What is Support Vector Machine (SVM) :is a traditional machine learning classifier model see in figure(2.6) the SVM classifier that classifies two classes.

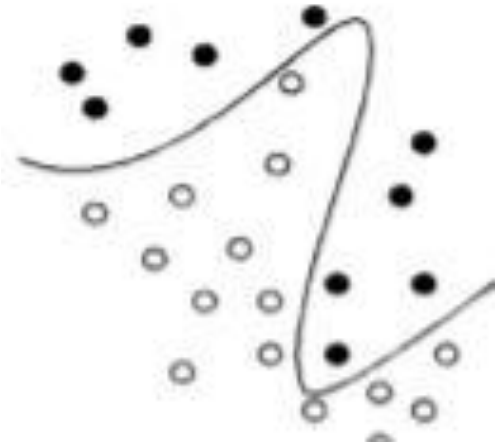

Figure 2.6: SVM Curve

This paper proposes a solution to the plate license recognition, the solution is as follow:

First, the image is processed using image processing techniques such as binarization then the processed image is segmented using contours of the image then bounding boxes are drawn on the contours every box is classified by SVM model to recognize the plate,characters are segmented with the same approach,each segment is recognized by CNN see in figure(2.7) the approach.

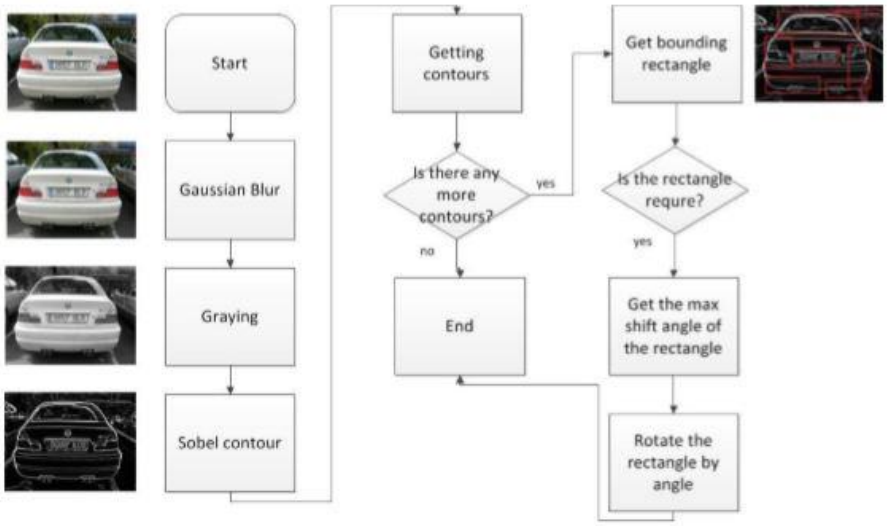

Figure 2.7: Paper (6) Solution

- Advantages:
  I. distinct features are taken from each segment image by CNN deep model that boosts the system performance.
  II. Non linear curve classifying the plate/non plate is efficient in terms of performance and training time.
- Disadvantags:
  I. The bounding boxes may not always drawn around each character because there are external factors such as noise,lighting conditions.

2.2.7. An Efficient Approach for Automatic Number Plate Recognition System under Image Processing [12]:

This paper proposes image processing solution to the license plate recognition problem .The solution contains two stages :

I. Plate extraction :Morphological operations,thresholding,edge detection,bounding box analysis are applied to the image to extract the plate .

II. Digit segmentation and recognition :Connected component analysis is applied to separate the digits .Recognition is implemented using template matching .

- Disadvantages :

I. Image processing techniques are very helpful in object localization task but not always specially if the noise has a big impact .

II. Using template matching to recognize the digits may gives wrong results because the digits have different forms in real world .

III. Connected component analysis may not always work .

2.2.8. Automatic Number Plate Recognition System [10]:

This paper proposes the solution of the license plate recognition using neural network with image processing algorithms .First The image is filtered using minimum filter then vertical projection and horizontal projection are applied to the filtered image,peaks are resulted from projection operations see in figure(2.8) the peaks of the image after applying horizontal projection:

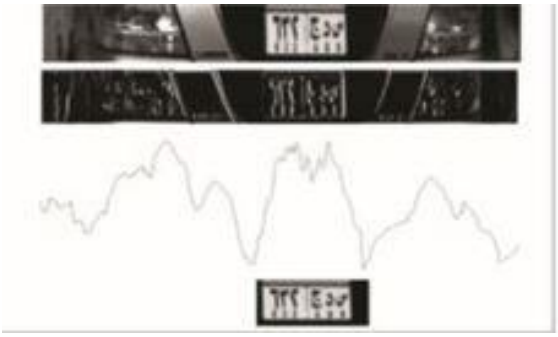

Figure 2.8: Horizontal Projection

The peak with highst bands is the plate.

The digits are segmented using connected component analysis then each component is recognized by a neural network figure(2.9) shows horizontal projection to separate the digits.

Figure 2.9: Horizontal Projection

- Disadvantages:
  I. The peak with the highst bands is supposed to be the plate .In the case where there is a noise with the highst bands will supposed to be the plate that leads to wrong results .
  II. Neural network may gives wrong results when the features are not distinct .
  III. Connected component analysis may not always work if the noise has a big impact.

2.2.9. A Review paper on Vehicle Number Plate Recognition (VNPR) Using Improved Character Segmentation Method [13]:

This paper proposes a solution to vehicle number plate recognition through image processing algorithms as follow:The image is localized based on its shape by edge detectors .Segmentation of the plate is achieved by edge detectors,connected component analysis.Digit recognition is achieved by template matching .

- Disadvantages :
  I. Noise may exists with the same shape of the target plate .
  II. Recognizing digits by template matching gives wrong results when the features of digits are similar.
  III. Connected component analysis may fails to draw bounding box around each digit.

2.2.10. A Vehicle License Plate Detection and Recognition System [7]:

- What is Radial Basis Funtion (RBF) :

RBF is a regular neural network which uses the gaussian activation function in the hidden layers. This paper proposes a solution to the license plate recognition targeting saudian plates using RBF with image processing techniques. First the image is converted to gray scale then noise is removed from the gray scale image through morphological operations,filling gaps then the plate is detected from the noise free image .

Digit segmentation is applied through connected component analysis then each digit is recognized through RBF neural network .Figure(2.10) shows the effects of image processing techniques in the last stage the plate is detected through RBF:

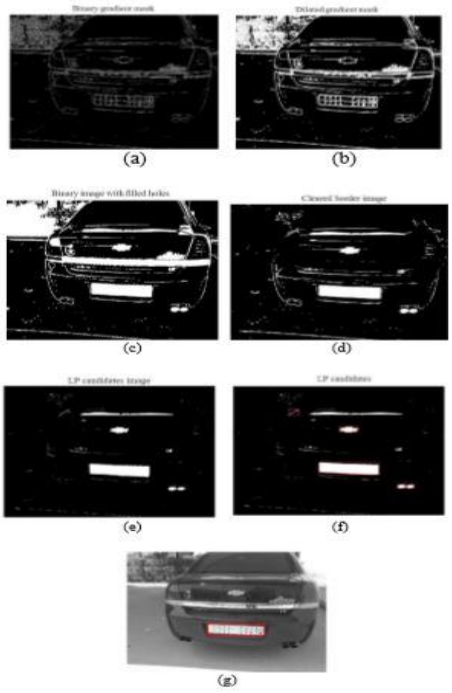

Figure 2.10 : Stages Of Solution

Figure(2.11),Figure(2.12) show the features that are used for digit recognition:

Figure 2.11: Features Of a Digit

Figure 2.12: Features Of a Digit

As shown in figure(2.11) and figure(2.12) each digit is converted to binary and the binary matrix is considered as features to recognize the digit.

- Disadvantages :

- The features are not strong enough this leads to wrong results.
- Connected component analysis may not always draw bounding box around each digit.

- Advantages :

- Image processing techniques are necessary to remove noise from the image.

2.3. Feature Engineering For Plate Localization And Digit Recognition:

- What is Feature Engineering ?

A feature in machine learning is a property that describes the set of samples in a dataset such as price of a house or the number of rooms in a house.

Feature engineering is to choose from the dataset a set of attributes that will describe the samples.Feature engineering requires an expert in the domain of the problem.Feature engineering determines the performance of the machine learning model .

- Feature engineering in plate localization and recognition :

As we saw previously how computer vision algorithms are used to solve plate recognition tasks, but computer vision algorithms gave poor performance, the reason for that is using algorithms such as SIFT or HOG which extracts features from an image, where the extracted features might be similar with other images which cause poor performance .

see in figure(2.13) how features from HOG feature descriptor gave similar features of various images :

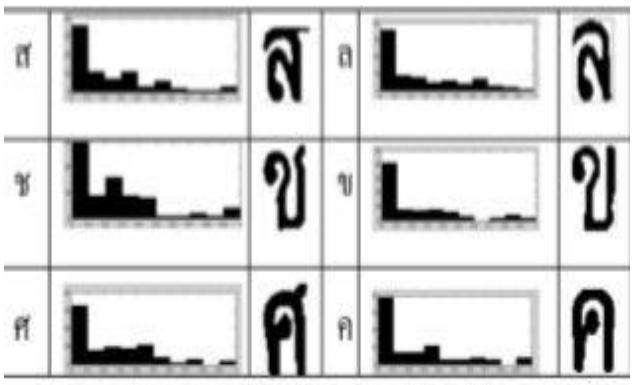

Figure 2.13: HOG Features

2.4. Feature Learning And Deep Learning For Plate Localization And Digit Recognition:

While the machine learning engineers confronting difficults with choosing features manually or extracting features from an algorithm, deep learning is rised to enhance the performance and to make the problems easier to solve by learning features from input.

We compared H_ELM deep learning model with CNN model in the plate recognition task.CNN model gave us higher accuracy than H_ELM model that the reason we chose the CNN model.

We utilized the power of convolutional layers in CNN model to learn features from the noise of the environment, plates and digits,the learned features are given to a neural network classifier.

2.5. Label Connected Component For Plate Segmentation And Digit Segmentation:

To locate the plate from the image of a vehicle, first we have to divide the image of the vehicle into sub images to feed each sub image to our deep learning model to locate the plate in the vehicle image.The plate is segmented by label connected component, each image segment is sent to our deep learning model to classify the digits. See in figure(2.14) how the image of a vehicle is divided into sub images:

Figure 2.14: Label Connected Component Patches

We took only the half of the plate because our targets are only arabic digits see in figure(2.15) how digits are segmented:

Figure 2.15: Digit Segmentation Stage

3RD CHAPTER

Experimental Results And Analysis

3.1. Features Normalization:

Features normalization is to make all the attributes in a dataset in the same scale that makes the deep learning model converge in a fast way in terms of training error.Before the training stage ,
we normalized our dataset images to (0-1) scale through dividing the pixels of each image onto 255 to converge faster.

3.2. Dataset Collection,Filtering,Preprocessing And Samples Number:

We’ve collected our dataset from j7 prime smartphone camera in different lighting conditions and orientation.

We’ve filtered our dataset in adobe photoshop progrm and saved the final version of our dataset in a file to upload it to the github website as a reference to be the first syrian plates dataset,load it to our deep learning model in a fast way. The number of samples for plate localization is 3736 samples 2510 samples were taken as trainset and 1226 samples as testset.

The number of samples for digit classification is 3125 samples 2600 samples were taken for trainset and 525 for testset.

We divide the pixels of the whole images onto 255 to normalize our dataset.

See in figure (3.1) a sample for plate localization :

Figure 3.1: A Sample In Our Plate Dataset

See in figure (3.2) samples for digit classification task :

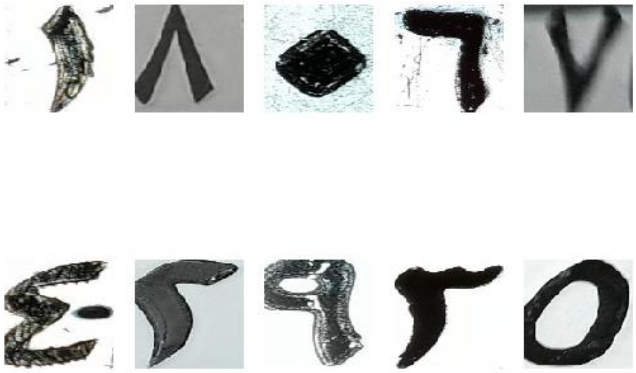

Figure 3.2: Samples Of Digits In Our Digit Dataset

Plate localization model have reached to 100% in term of train accuracy and 98.5% in term of test accuracy (unseen data).

The convergence curve of the plate localization model is shown in figure(3.3) :

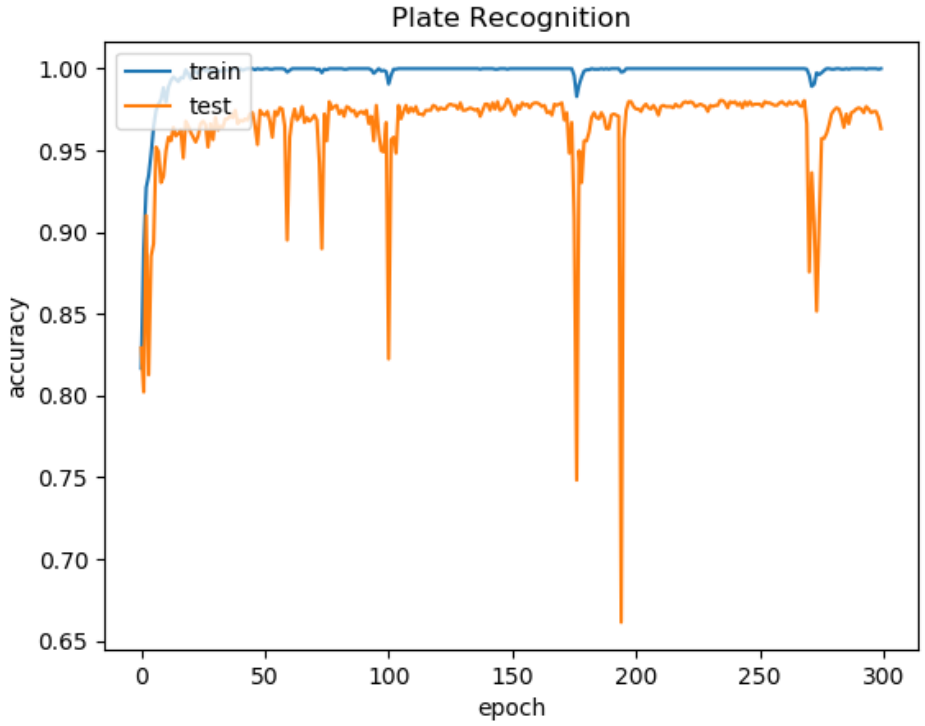

Figure 3.3: Plate Recognition's Convergence Curve

The confusion matrix of the plate recognition model is shown in figure (3.4) :

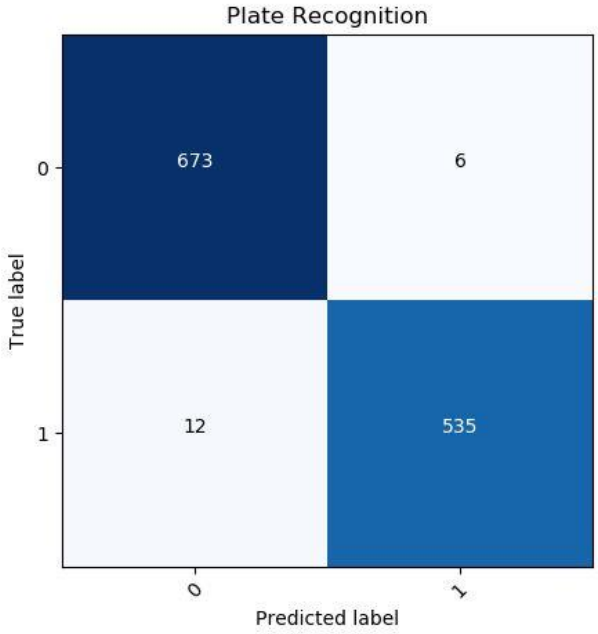

Figure 3.4: Confusion Matrix Of Plate Recognition Model

Figure (3.4) is the confusion matrix of the model that describes the performance in testset. Plate images are labeled as (1) whereas non plate images are labeled as (0), there are 1226 samples for plate samples, the model is correctly predicted 535 out of 547 for plate samples, the model is correctly predicted 673 out of 679 for nonplate samples.

The convergence curve of the digit recognition is shown in figure(3.5) :

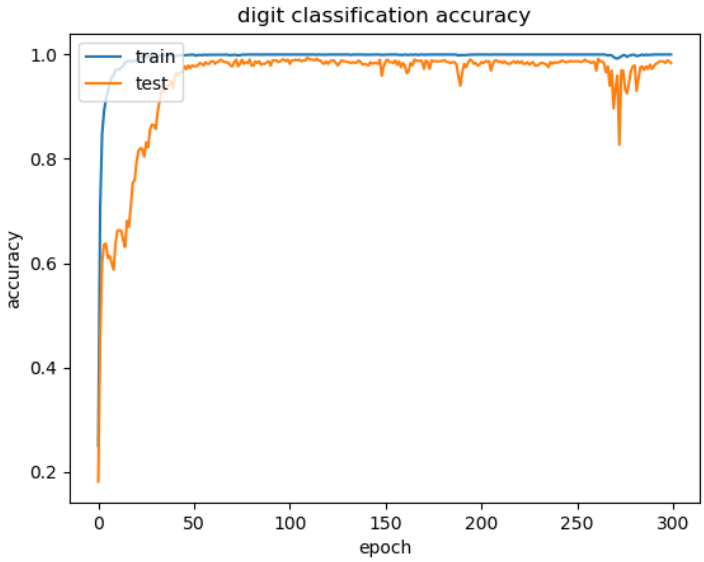

Figure 3.5: Digit Classification's Convergence Curve

Figure (3.6) is the confusion matrix of the digit recognition model that describe the performance in testset. digits images are labeled with (0…9).The digit classier model have reached to 99.14% in terms of testset and 100% in terms of trainset.

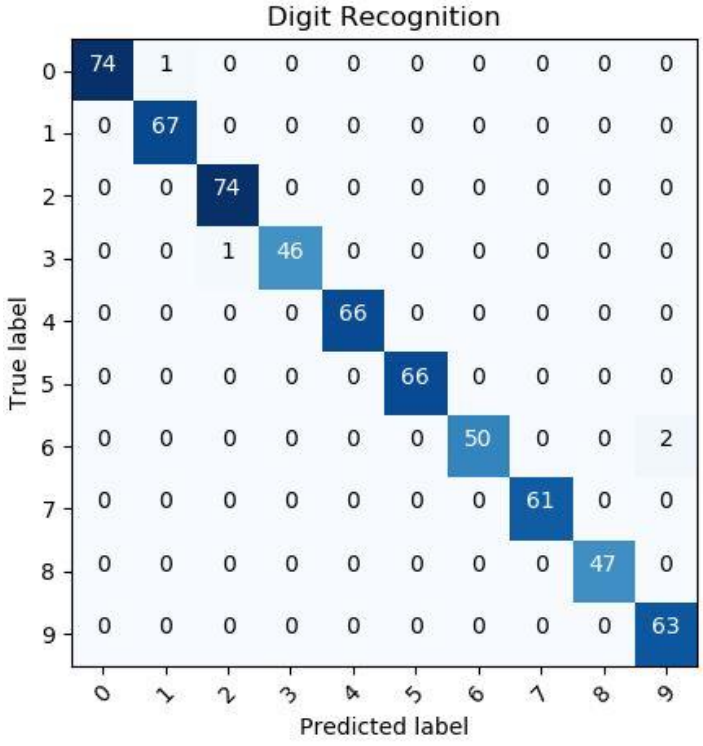

Figure 3.6: Confusion Matrix Of Digit Classification Model

We labeled each digit as follow in table(3.1):

Digit	Label	Samples
0	0	47
1	1	54
2	2	59
3	3	43
4	4	47
5	5	34
6	6	48
7	7	57
8	8	37
9	9	63

Table 3.1:Encoding&Number Of Samples In Each Class

3.3. Experiemental Results:

- Experiement (1) :

Orginal car image in figure(3.7) :

Figure 3.7: Orginal Image

Applying component analysis to the orginal car image in figure (3.8) :

Figure 3.8: Label Connected Component In Plate Localization Stage

Applying component analysis to the located plate in figure (3.9) :

Figure 3.9: Label Connected Component In Digit Segmentation Stage

- Experiement (2) :

Orginal car image in figure (3.10) :

Figure 3.10: Orginal Image

Applying connected cmponent analysis to the orginal car image in figure (3.11) :

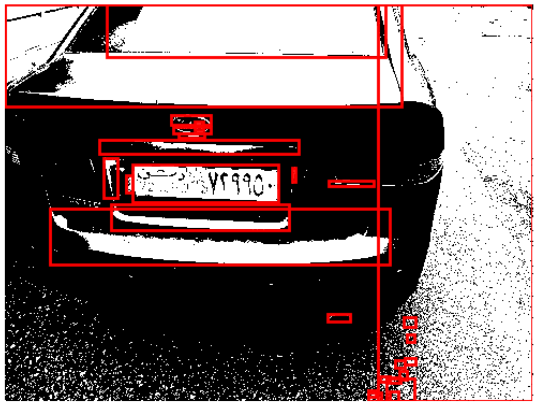

Figure 3.11: Label Connected Component In Plate Localization Stage

Applying connected component analysis to the located plate in figure (3.12) :

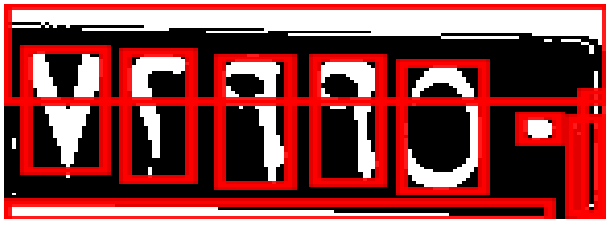

Figure 3.12: Label Connected Component In Digit Segmentation Stage

- Experiement (3) :

Orginal car image in figure (3.13) :

Figure 3.13: Orginal Image

Applying connected component analysis in figure (3.14) :

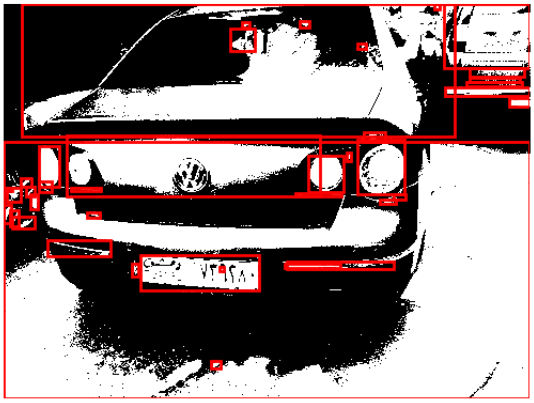

Figure 3.14: Label Connected Component In Plate Localization Stage

Applying connected component analysis to the located plate in figure (3.15) :

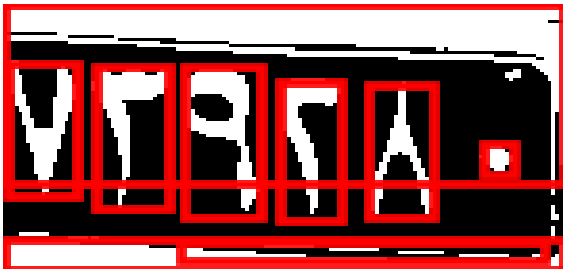

Figure 3.15: Label Connected Component In Digit Segmentation Stage

- Experiement (4) :

Orginal car image in figure (3.16) :

Figure 3.16: Orginal Image

Applying connected component analysis in figure (3.17) :

Figure 3.17: Label Connected Component In Plate Localization Stage

Applying connected component analysis to the located plate in figure (3.18) :

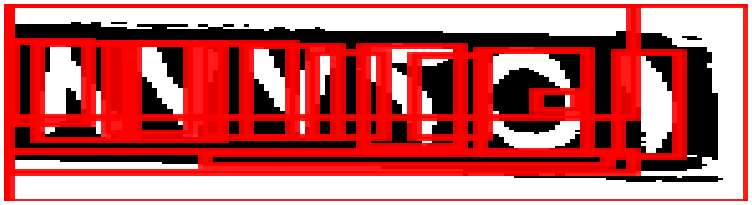

Figure 3.18: Label Connected Component In Digit Segmentation Stage

- Expierement (5) :

Orginal car image in figure (3.19) :

Figure 3.19: Orginal Image

Applying connected component analysis to the orginal car image in figure (3.20) :

Figure 3.20: Label Connected Component In Plate Localization Stage

Applying connected component analysis to the located plate in figure (3.21) :

Figure 3.21: Label Connected Component In Digit Segmentation Stage

- Experiement (6) :

Orginal car image in figure (3.22) :

Figure 3.22: Orginal Image

Applying connected component analysis to the figure (3.23) in figure (3.24) :

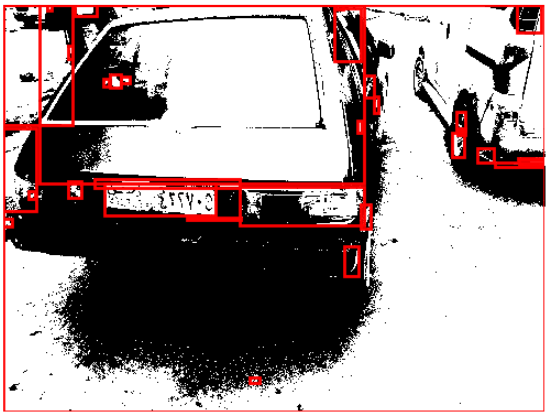

Figure 3.23: Label Connected Component In Plate Localization Stage

Applying connected component analysis to the located plate in figure (3.24) :

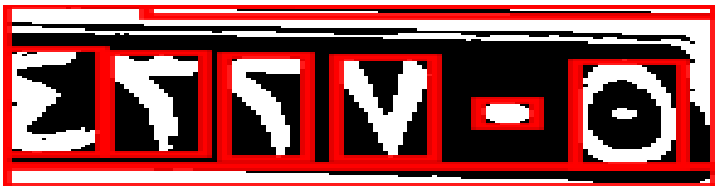

Figure 3.24: Label Connected Component In Digit Segmentation Stage

3.4. Evaluating Metrics For Machine Learning Models:

In addition to the accuracy metric,there are 5 metrics that are widely used to evaluate the model performance on the test set :

- Precision = TP/(TP+FP)
- Recall = TP/(TP+FN)
- F-score = 2×(Precision×Recall)/(Precision+Recall)
- AUC(Area Under Curve)
- K fold cross validation

where TP (True Positive) is the number of samples that are correctly classified as plate imagesTN (True Negative) is the number of samples that are correctly classified as non plate images,FP (False Positive) is the number of samples that are incorrectly classified as plate,FN (False Negative) is the number of samples that are incorrectly classified as non plate.Table(3.2) shows the evaluating metrics for plate/non plate task :

Precision	0.98
Recall	0.97
F-score	0.97

Table 3.2: Plate Recognition Evaluation Metrics

Figure (3.25) shows the AUC for plate recognition task :

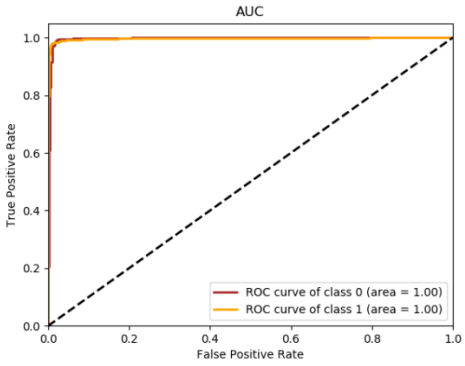

Figure 3.25: AUC For Plate Recognition Model

high AUC means that the model can distinguish between classes plate/non plate.

- K fold cross validation : K fold cross validation is a technique to evaluates the performance of our model ,the idea of the K fold cross validation is a value must be chosen first for (k) ,the dataset is divided then onto (k) subsets then a random subset is taken as test set and the rest of the subsets are taken as training set then we must train our model (k) times considering the test set accuracy each time ,the average of the (k) experiements is taken as the final accuracy for the model .

The value of (k=5) is chosen in the plate recognition task after training our model 5 times the experiements are shown in table (3.3) :

Experiement	Accuracy
Experiement (1)	97%
Experiement (2)	97%
Experiement (3)	98%
Experiement (4)	98%
Experiement (5)	98%
Average	97.6%

Table 3.3: Results When K=5

4TH CHAPTER

Database Management System And Website Design

4.1. Database Management:

Data management is an administrative process that includes acquiring, validating, storing, protecting, and processing required data to ensure the accessibility, reliability, and timeliness of the data for its users.

4.1.1. Different types of DBMS

Different types of Database Management Systems based in data models are as follows:

- Relational Database Management Systems
- Hierarchical Database Management Systems
- Network Database Management Systems
- Object-oriented Database Management Systems

4.1.2. Hierarchical DBMS

A DBMS is said to be hierarchical if the relationships among data in the database are established in such a way that one data item is present as the subordinate of another one or a sub unit. Here subordinate means that items have "parent-child" relationships among them. These are good for storing data with items describing attributes, features and so on. For e.g., a book with information on chapters and verses.

4.1.3. Network DBMS

A DBMS is said to be a Network DBMS if the relationships among data in the database are of type many-to-many. The relationships among many-to-many appears in the form of a network. Thus the structure of a network database is extremely complicated because of these many-to-many relationships in which one record can be used as a key of the entire database. These have mainly been replaced by Relational database management systems in today's modern computing.

4.1.4. Object-oriented DBMS

OODBMS represent significant advance over other DBMS. While other DBMS are designed to handle structured data, an OODBMS is designed to store data from variety of media sources, such as photographs and text, and produce work, as output, in a multimedia format.

4.1.5. Relational DBMS

A DBMS is said to be a Relational DBMS or RDBMS if the database relationships are treated in the form of a table. The data can be related to other data in the same table or other tables which has to be correctly managed by joining one or more tables. Data in this type of model is stored is fixed predefined structures and are usually manipulated using Structured Query Language (SQL).

4.1.6. The Benefits of DBMS

The benefits of a database management system (DBMS) include its ability to handle huge volumes of data and multiple concurrent users. Unlike flat file systems, a DBMS maintains data integrity, consistency, security, and appreciable system performance.

4.2. Structured Query Language SQL:

SQL, **S**tructured **Q**uery **L**anguage, is a programming language designed to manage data stored in relational databases. SQL operates through simple, declarative statements. This keeps data accurate and secure, and it helps to maintain the integrity of databases, regardless of size.

SQL is incredibly powerful, and like every **well-made development tool**, it has a few commands which it's vital for a good developer to know. Here are a few of the most important ones – each of these queries is consequential to almost every system that interacts with an SQL

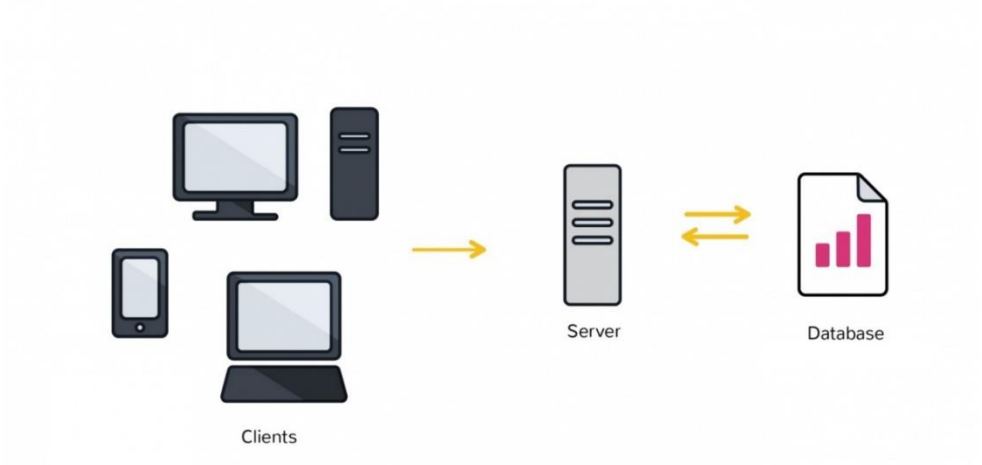

Figure 4.1: SQL Server

4.3. Laravel:

Figure 4.2: Laravel Version

Laravel Philosophy is a web application framework with expressive, elegant syntax. We believe development must be an enjoyable, creative experience to be truly fulfilling.

Laravel attempts to take the pain out of development by easing common tasks used in the majority of web projects, such as authentication, routing, sessions, and caching.

Laravel aims to make the development process a pleasing one for the developer without sacrificing application functionality. Happy developers make the best code. To this end, we've attempted to combine the very best of what we have seen in other web frameworks, including frameworks implemented in other languages, such as Ruby on Rails, ASP.NET MVC, and Sinatra.

Laravel is accessible, yet powerful, providing powerful tools needed for large, robust applications. A superb inversion of control container, expressive migration system, and tightly integrated unit testing support give you the tools you need to build any application with which you are tasked.

It’s a backend (PHP) MVC framework that runs on composer/symphony components if that’s what you mean. You of course have to build a front end of the website as the whole point is to output html data (or at least data to a front end service), Laravel facilitates this, but it’s comparable to ruby on rails, Django etc.

The **Model-View-Controller (MVC)** is an architectural pattern that separates an application into three main logical components: the **model**, the view, and the controller. Each of these components are built

to handle specific development aspects of an application. MVC is one of the most frequently used industry-standard web development framework to create scalable and extensible projects.

4.3.1. MVC Components:

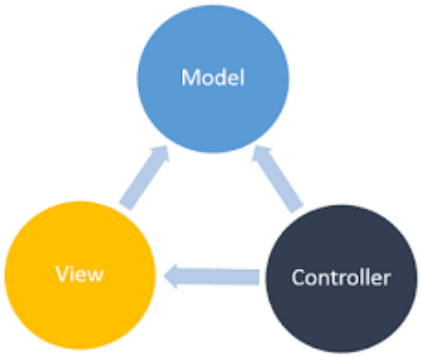

Figure 4.3: MVC Model

Following are the components of MVC:

- **Model**

The Model component corresponds to all the data-related logic that the user works with. This can represent either the data that is being transferred between the View and Controller components or any other business logic-related data. For example, a Customer object will retrieve the customer information from the database, manipulate it and update it data back to the database or use it to render data.

- **View**

The View component is used for all the User Interface (UI) logic of the application. For example, the Customer view will include all the UI components such as text boxes, dropdowns, etc. that the final user interacts with.

- **Controller**

Controllers act as an interface between Model and View components to process all the business logic and incoming requests, manipulate data using the Model component and interact with the Views to render the final output. For example, the Customer controller will handle all the interactions and input from the Customer View and update the database using the Customer Model. The same controller will be used to view the Customer data.

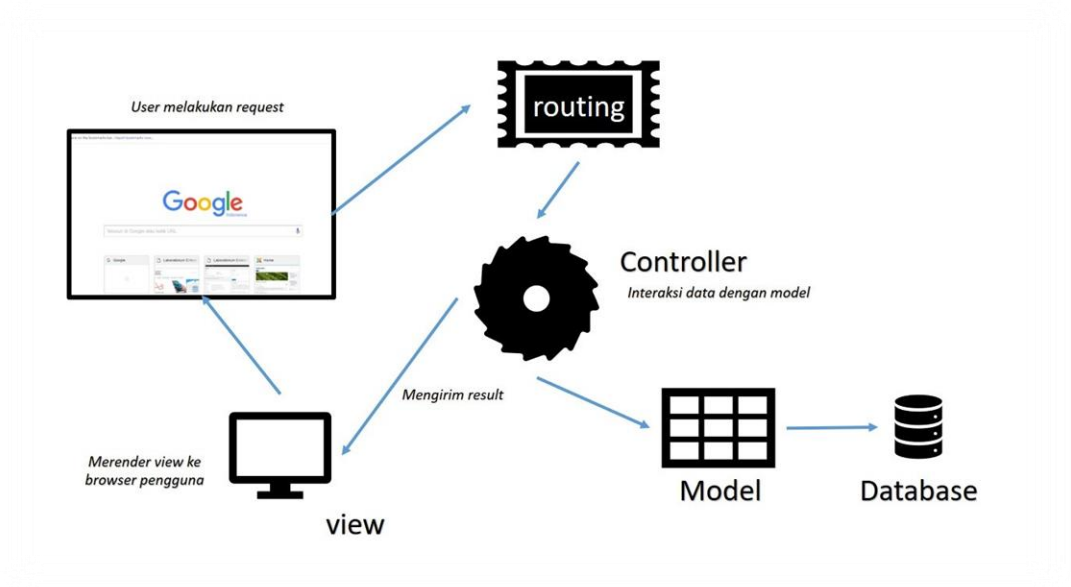

Figure 4.4: MVC Architecture

4.3.2. Bootstrap:

Bootstrap is a framework to help you design websites faster and easier. It includes HTML and CSS based design templates for typography, forms, buttons, tables, navigation, modals, image carousels, etc. It also gives you support for JavaScript plugins.

Also we use Bootstrap, because is an open-source framework that combines HTML, CSS, and JavaScript code to help developers build web applications. Bootstrap can be used for desktop and mobile development. It contains HTML and CSS-based design templates for typography, forms, buttons, navigation and other interface components, as well as optional JavaScript extensions.

Figure 4.5: Bootstrap Templates

- **Advantages of bootstrap:**

The speed of development is one of its major advantages. If you want to develop an application or a website promptly, it is imperative to consider using Bootstrap. It helps to save your coding effort by offering less CSS functionality and pre-built blocks of code rather than structuring code from the scratch.

Bootstrap will help you to build an attractive, responsive website, but some mobile users could be turned away by the slow loading time and battery drain issues. Bootstrap comes with a lot of lines of CSS and JS, which is a good thing, but also a bad thing because of the bad internet connection.

4.3.3. Personal Home Page PHP:

PHP is a script language and interpreter that is freely available and used primarily on Linux Web servers. PHP, originally derived from **Personal Home Page** Tools, now stands for PHP: Hypertext Preprocessor, which the PHP FAQ describes as a "recursive acronym.".

PHP is mainly focused on server-side scripting, so you can do anything any other CGI program can do, such as collect form data, generate dynamic page content, or send and receive cookies. You can access the PHP program output with a web browser, viewing the PHP page through the server.

The Future of PHP:

- Why PHP will not die in 2018 (PHP Future): If we look at another reason than it is it provides dynamic access and execution of data. It allows developers to create dynamic websites.

PHP threads: The language has the ability to run different threads with the help of threads.

PHP is written in PHP as it's known today is actually the successor to a product named PHP/FI. Created in 1994 by Rasmus Lerdorf, the very first incarnation of PHP was a simple set of Common Gateway Interface (CGI) binaries written in the C programming language.

- The Reasons of PHP Usage:

There are many reasons to use PHP for server side programming, firstly it is a free language with no licensing fees so the cost of using it is minimal. A good benefit of using PHP is that it can interact with many different database languages including MySQL.

PHP can also run on Windows, Linux and UNIX servers.

- The Advantages of PHP:

One of the important advantages of PHP is that it is Open Source. Therefore, PHP is readily available and is entirely free. In contrast to other scripting languages used for web development which requires the user to pay for the support files, PHP is open to everyone, anytime and anywhere.

PHP is still useful**,** PHP makes up over 83% of server side languages used on the internet. Much of that is made up of PHP-based content management systems such as WordPress, but even if you remove pre-built CMS from the equation, PHP still makes up over 54% of the web.

4.3.4. HTML & CSS:

Html (the hypertext Markup Language) and CSS (Cascading Style Sheets) are two of the core technologies for building Web pages. HTML provides the structure of the page, CSS the (visual and aural) layout, for a variety of devices.

- **The Html Usages:**

  Short for Hypertext Markup Language, the authoring language used to create documents on the World Wide Web. HTML is similar to SGML, although it is not a strict subset. HTML defines the structure and layout of a Web document by using a variety of tags and attributes.

- **The CSS Usages:**

  CSS is the language for describing the presentation of Web pages, including colors, layout, and fonts. It allows one to adapt the presentation to different types of devices, such as large screens, small screens, or printers. CSS is independent of HTML and can be used with any XML-based markup language.

4.3.5. JavaScript:

A high-level, dynamic, untipped, object-based, multi-paradigm, and interpreted programming language. Alongside HTML and CSS, JavaScript is one of the three core technologies of World Wide Web content production. It is used to make webpages interactive and provide online programs, including video games. The majority of websites employ it, and all modern web browsers support it without the need for plug-ins by means of a built-in JavaScript engine the two features of JavaScript that we used in our MVC projects are.

4.3.6. JQuery:

JQuery is a fast and concise JavaScript Library created by Joh-Resig in 2006 with a nice motto: Write less, do more. JQuery simplifies HTML document traversing, event handling, animating, and Ajax interactions for rapid web development. JQuery is a JavaScript toolkit designed to simplify various tasks by writing less code.

4.4.Data Visualization:

Data visualization is a general term that describes any effort to help people understand the significance of data by placing it in a visual context. Patterns, trends and correlations that might go undetected in text-based data can be exposed and recognized easier with **data visualization** software. Today's data visualization tools go beyond the standard charts and graphs used in Microsoft Excel spreadsheets, displaying data in more sophisticated ways such as infographics, dials and gauges, geographic maps, spark lines, heat maps, and detailed bar, pie and fever charts. When data has been updated or predefined conditions occur can also be included.

The images may include interactive capabilities, enabling users to manipulate them or drill into the data for querying and analysis. Indicators designed to alert users.

Figure 4.6: Data Visualization Charts

The data visualization charts that are used in our website are shown in figures:

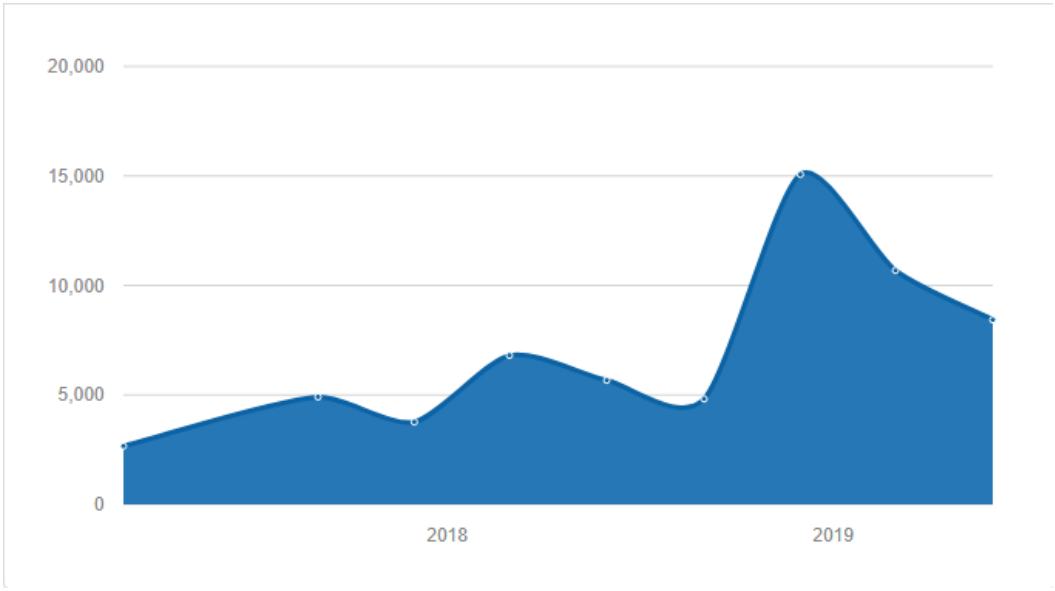

Figure 4.7: Used Chart In Our Website

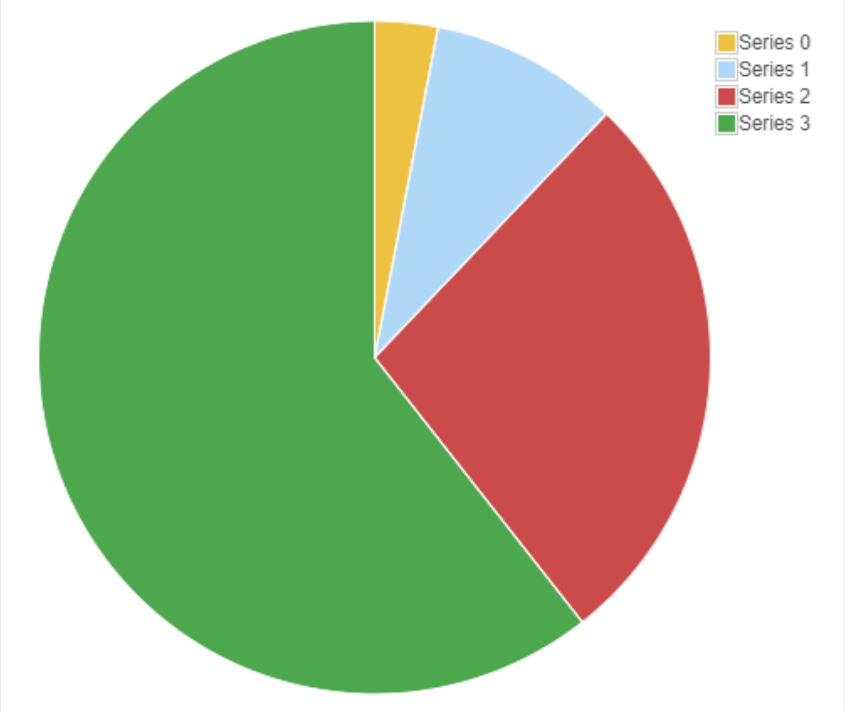

Figure 4.8: Used Chart In Our Website

4.5. Billings Automation:

Billings Automation is to save the records in a database server. For example, records of houses, people's informations, employees, vehicles. This is done by recording the entry time of each vehicle and the exit time of the vehicle then by estimating the difference between the time in and time out of the vehicle, we can calculate the total cost of this bill, the bill is stored in the DBMS for statistics purpose, providing offers to the end user such as discounts based on the number of presence times of this vehicle, these processes can provide more profits to the owner of a park.

4.6 Web Usage:

- **Client UI:**

This UI provides the client to check the availability of a park, other services that are specified by the owner of the park.

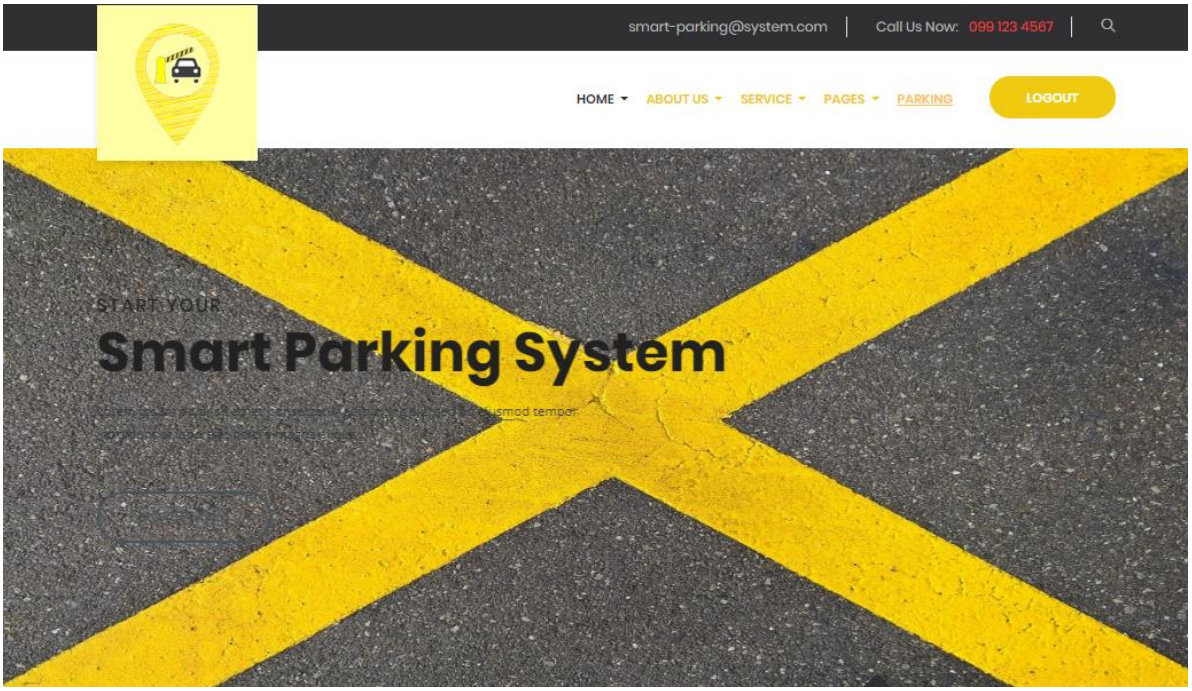

Figure 4.9: Client UI In Our Website

- **Admin UI:**

This UI contains the following functions:

- Admin can add new slots to his park in a certain level/floor.
- Admin can add new level/floor to his park.
- Admin can delete slots/levels in his park.
- Admin can update slots/levels in his park.

- Admin can view statistics of his park
- Admin can add new services to his park

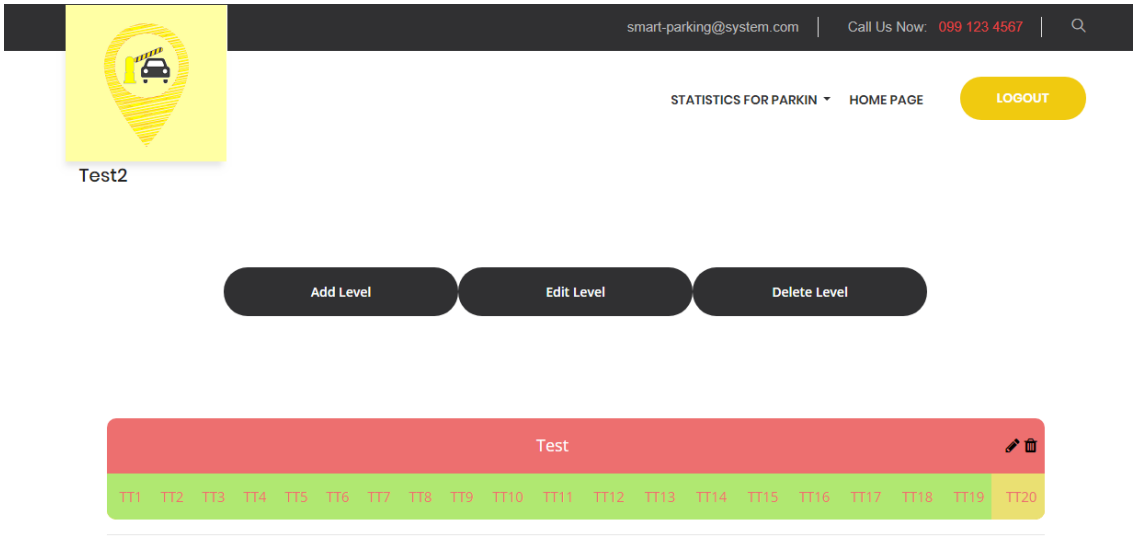

Figure 4.10: Admin UI In Our Website

➢ **Super Admin:**

This UI contains the following functions:

- Super Admin can add/edit/delete Admin account.

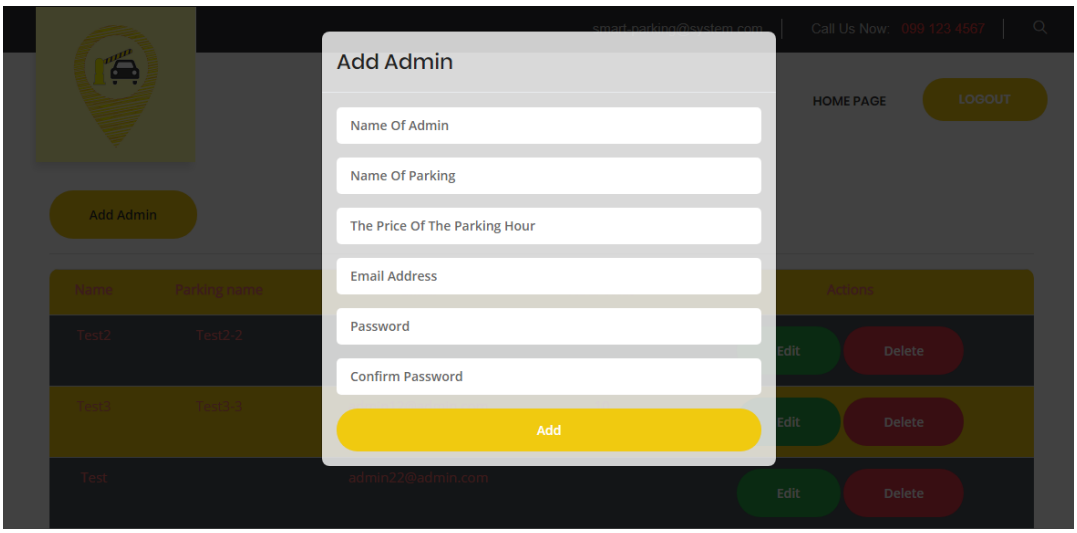

Figure 4.11: SuperAdmin UI In Our Website

5TH CHAPTER

Software Requirements & Design

5.1. Use Case Diagram:

SPS has two subsystems:

- Website & Database Management System.
- Plate Recognition System.

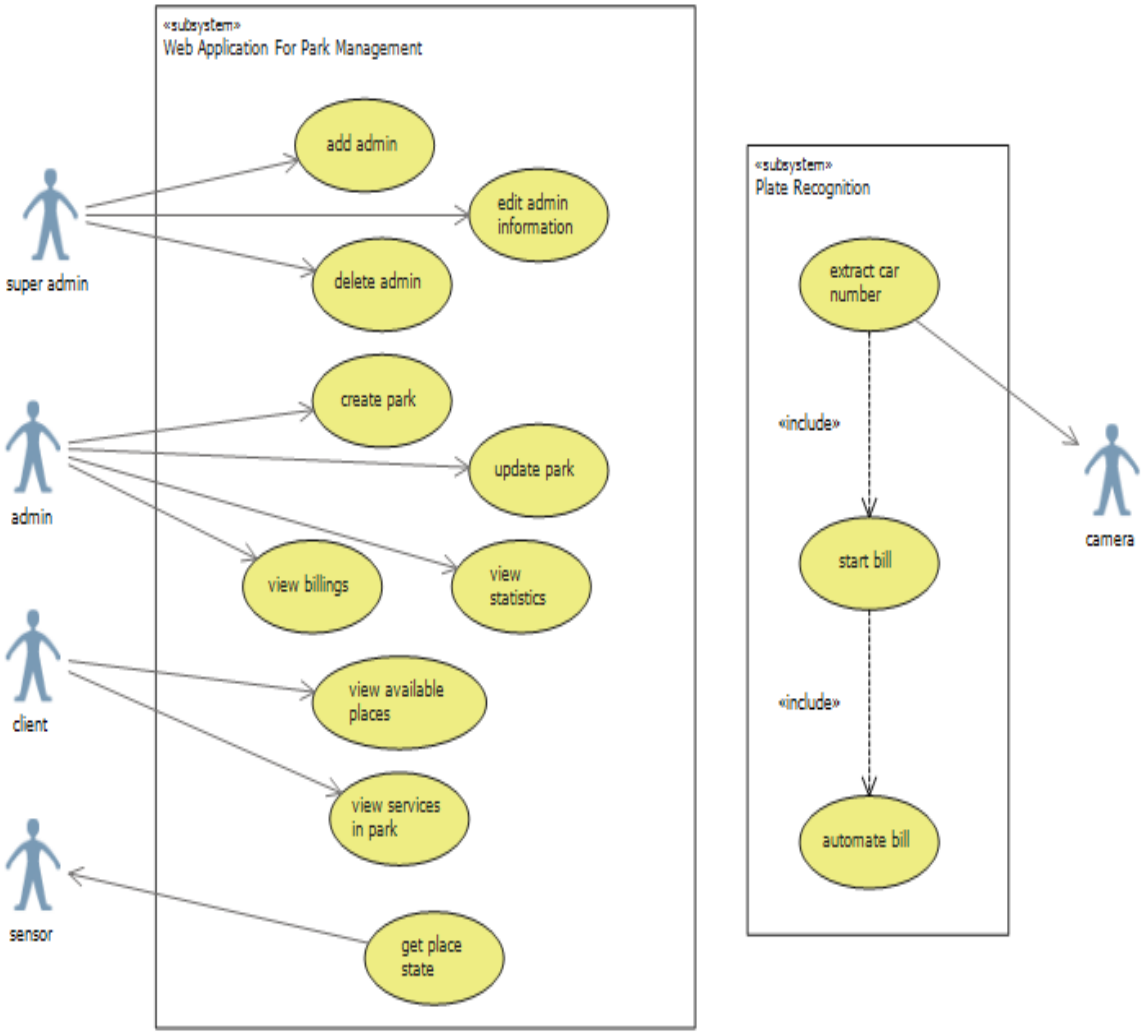

Figure 5.1: Use Case Diagram

5.2. Sequence Diagrams:

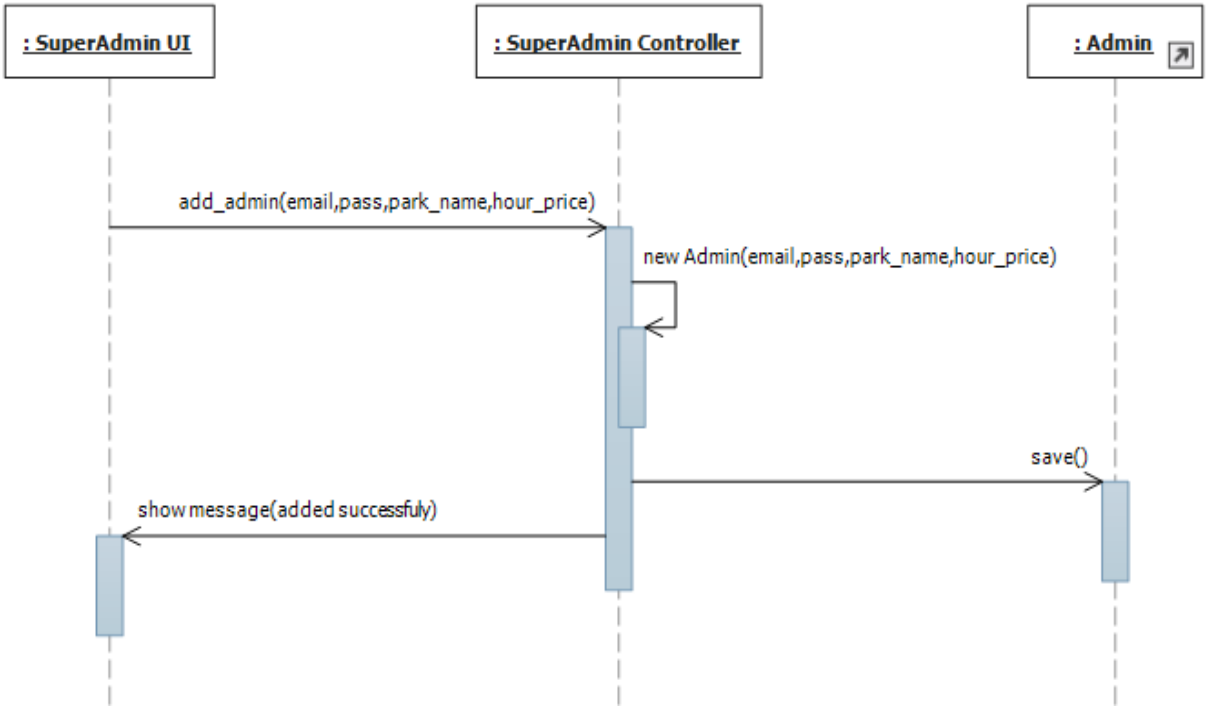

Figure 5.2: Sequence Diagram For Add Admin

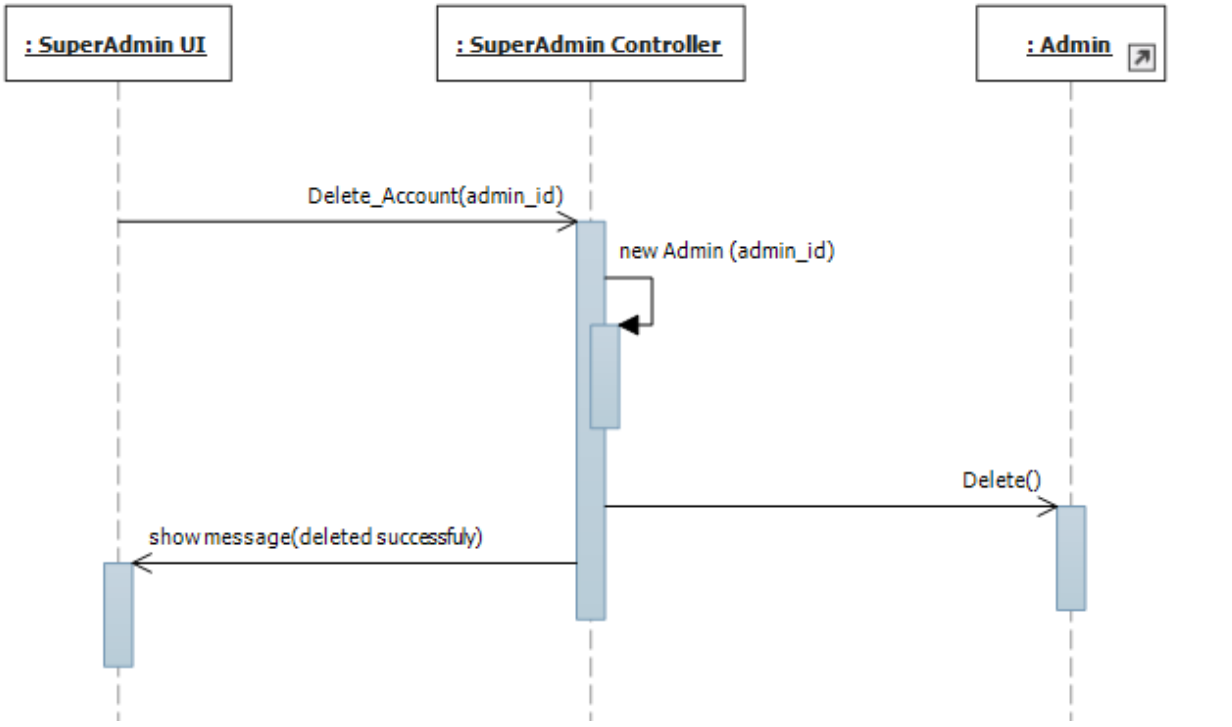

Figure 5.3: Sequence Diagram For Delete Admin

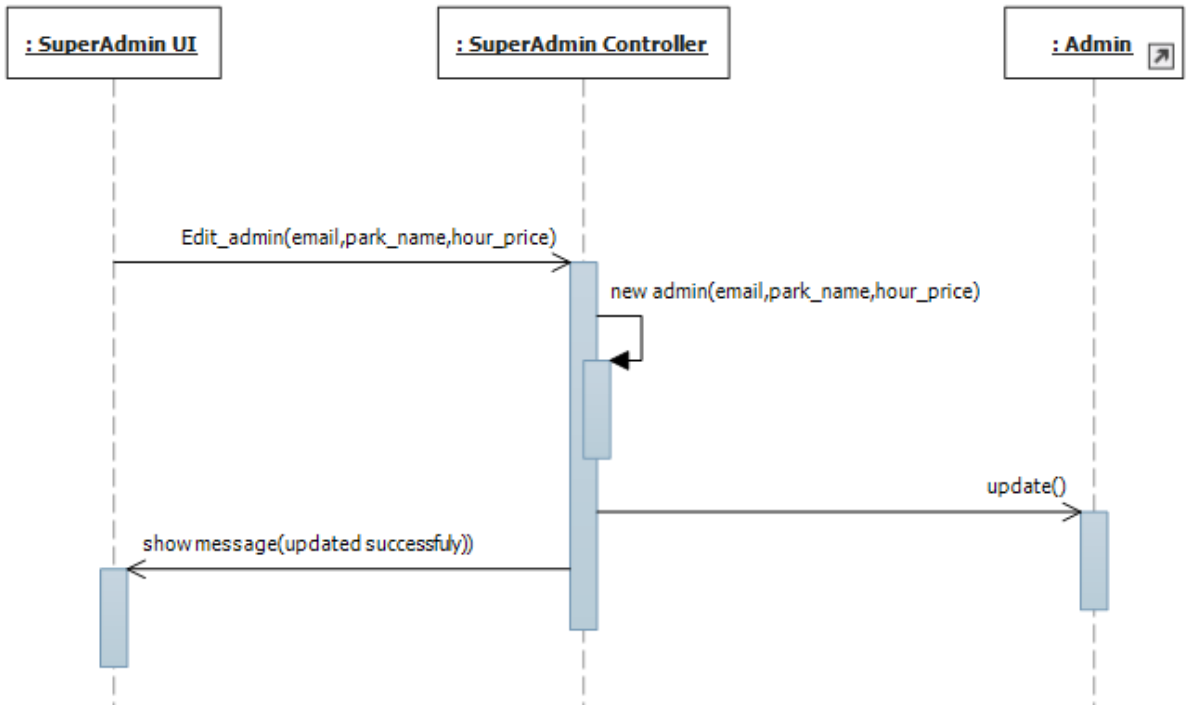

Figure 5.4: Sequence Diagram For Edit Admin

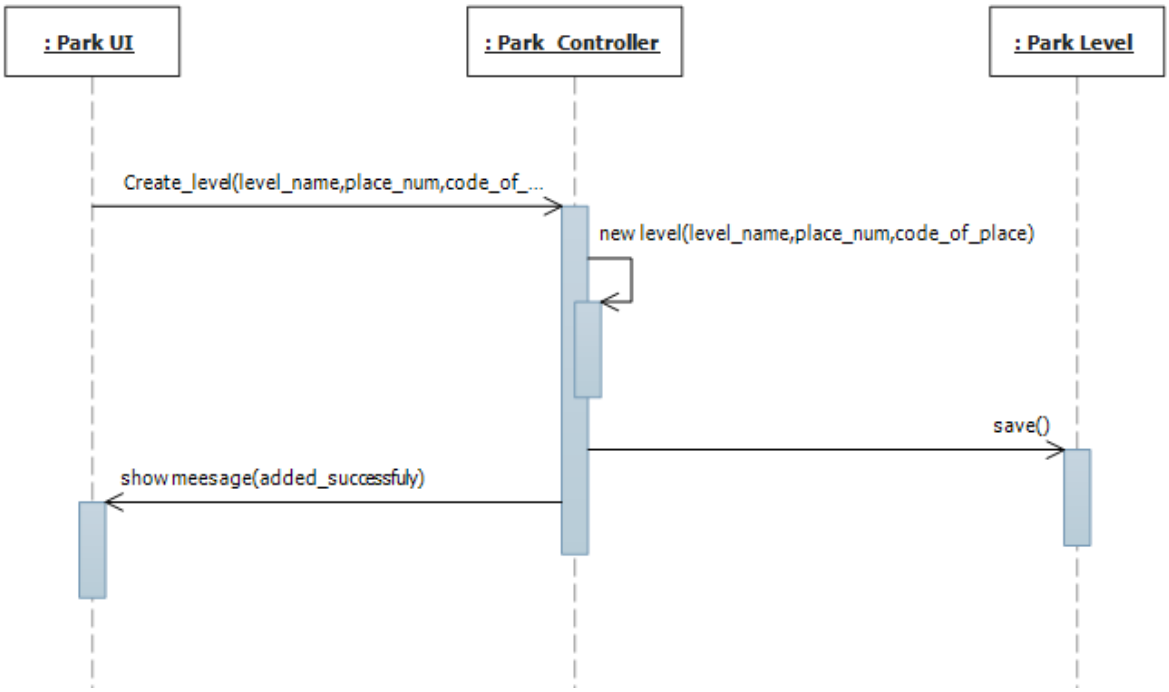

Figure 5.5: Sequence Diagram For Create Park

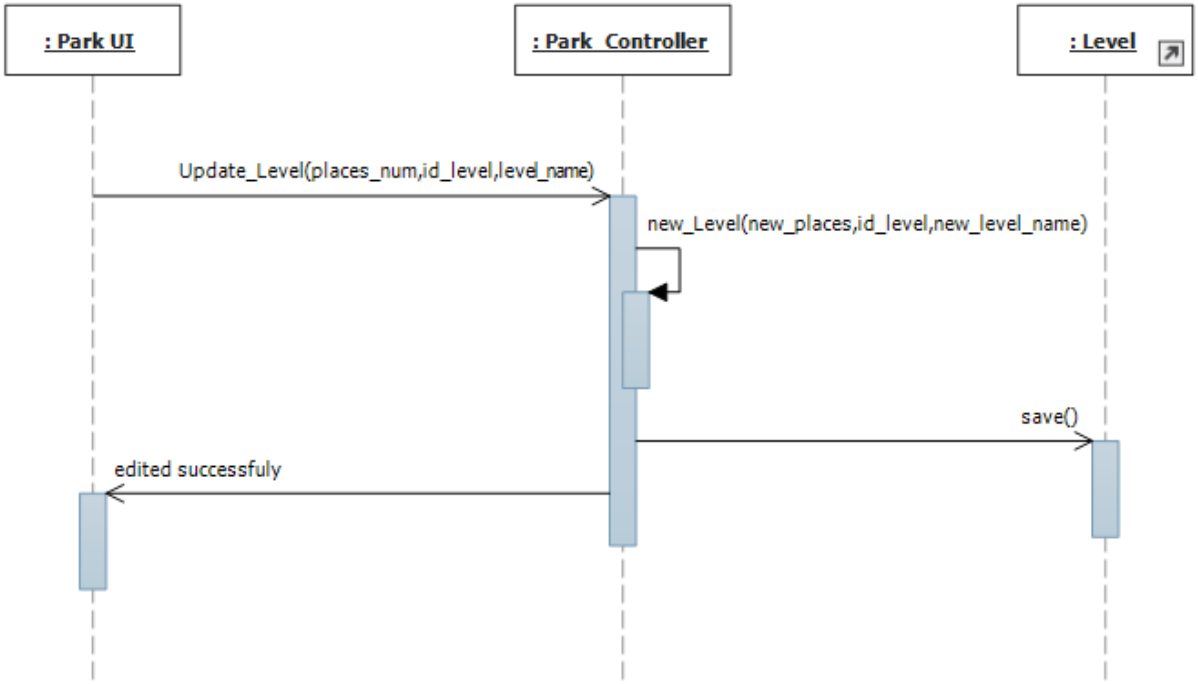

Figure 5.6: Sequence Diagram For Update Level

……..

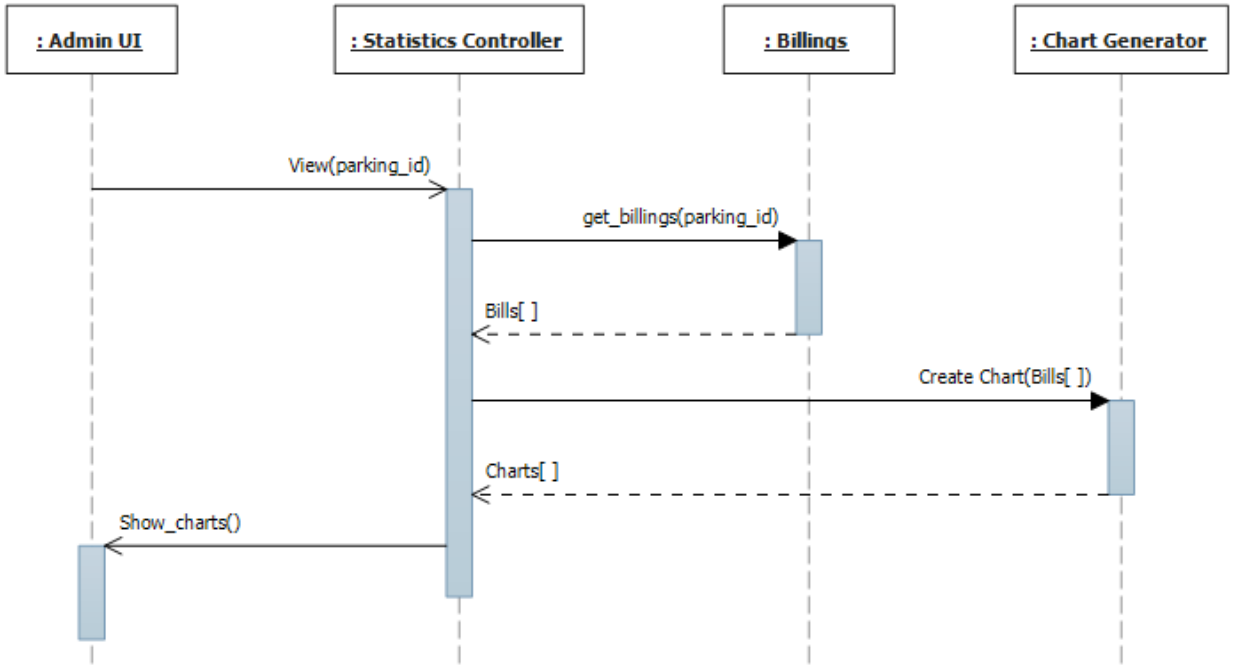

Figure 5.7: Sequence Diagram For Show Statistics

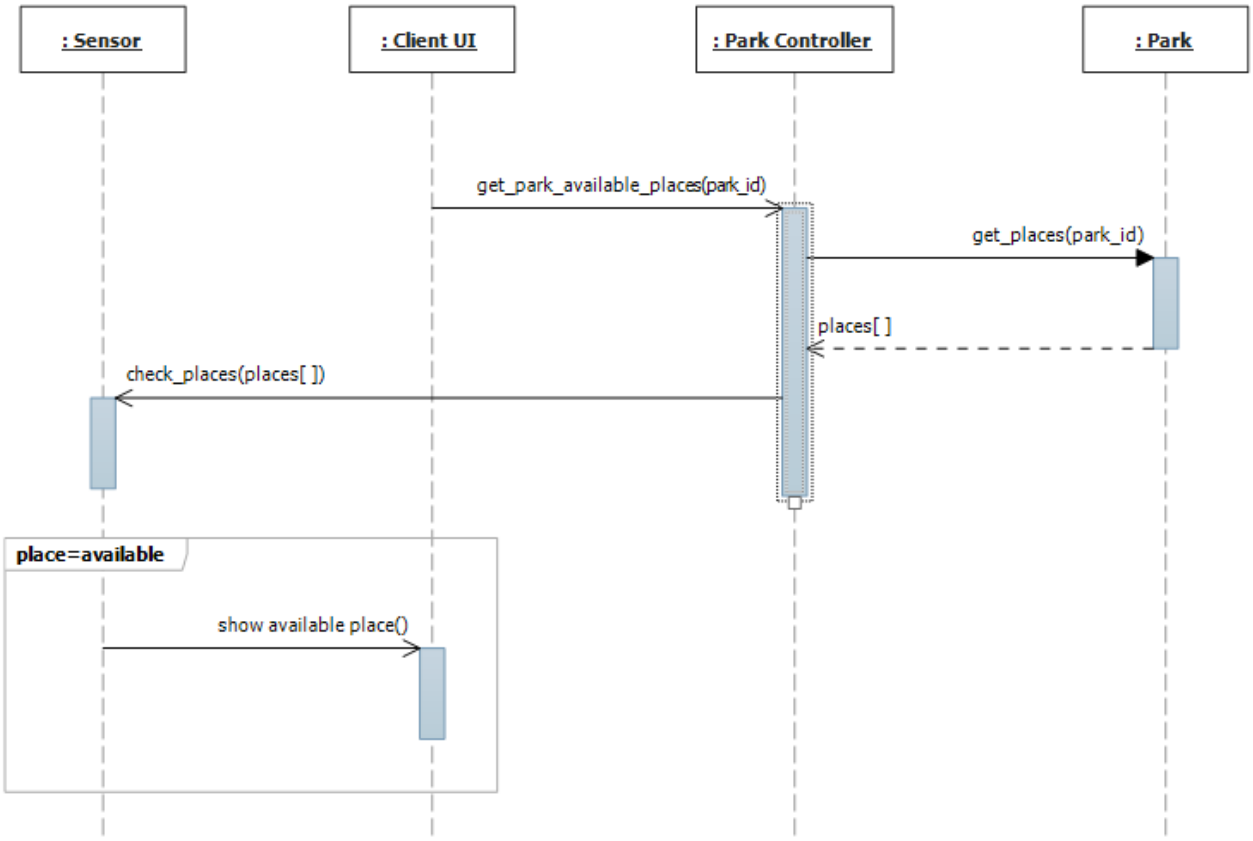

Figure 5.8: Sequence Diagram For View Available Places

Figure 5.9: Sequence Diagram For Get Place Status

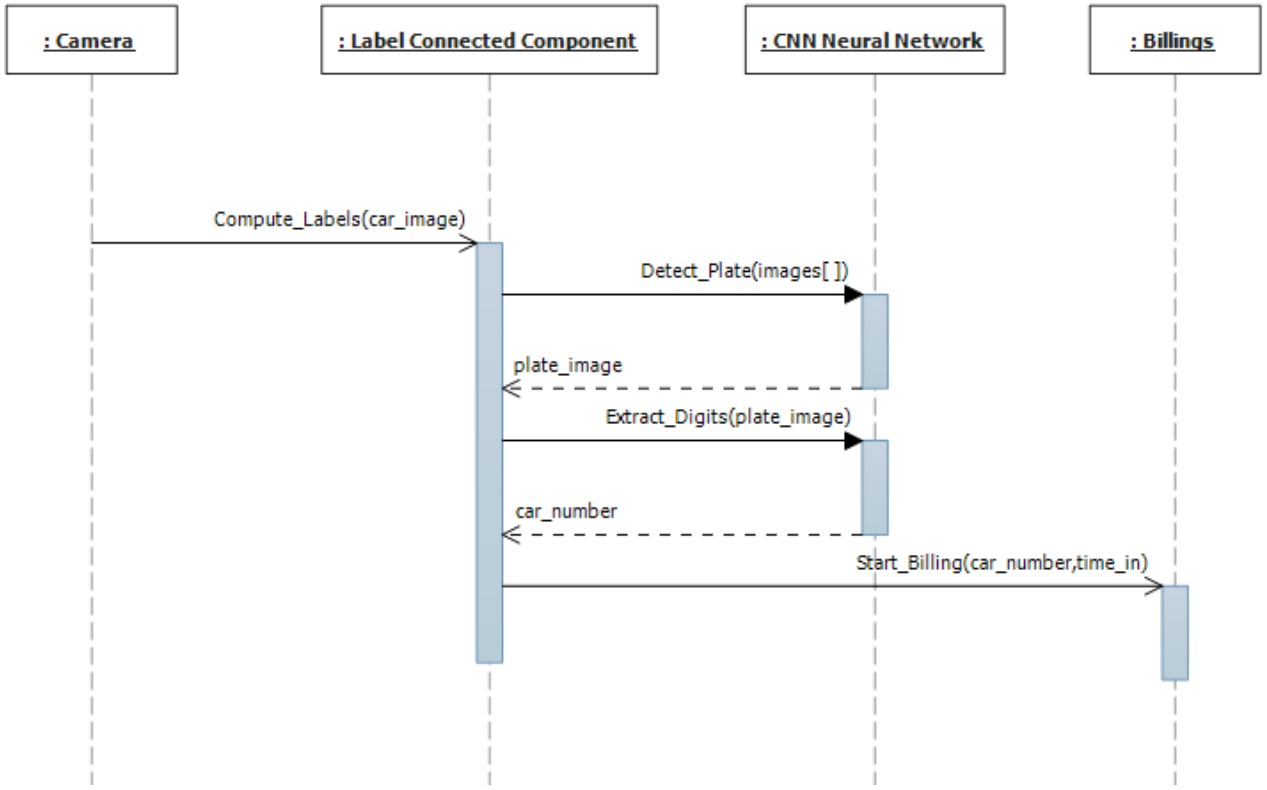

Figure 5.10: Sequence Diagram For Start Billing

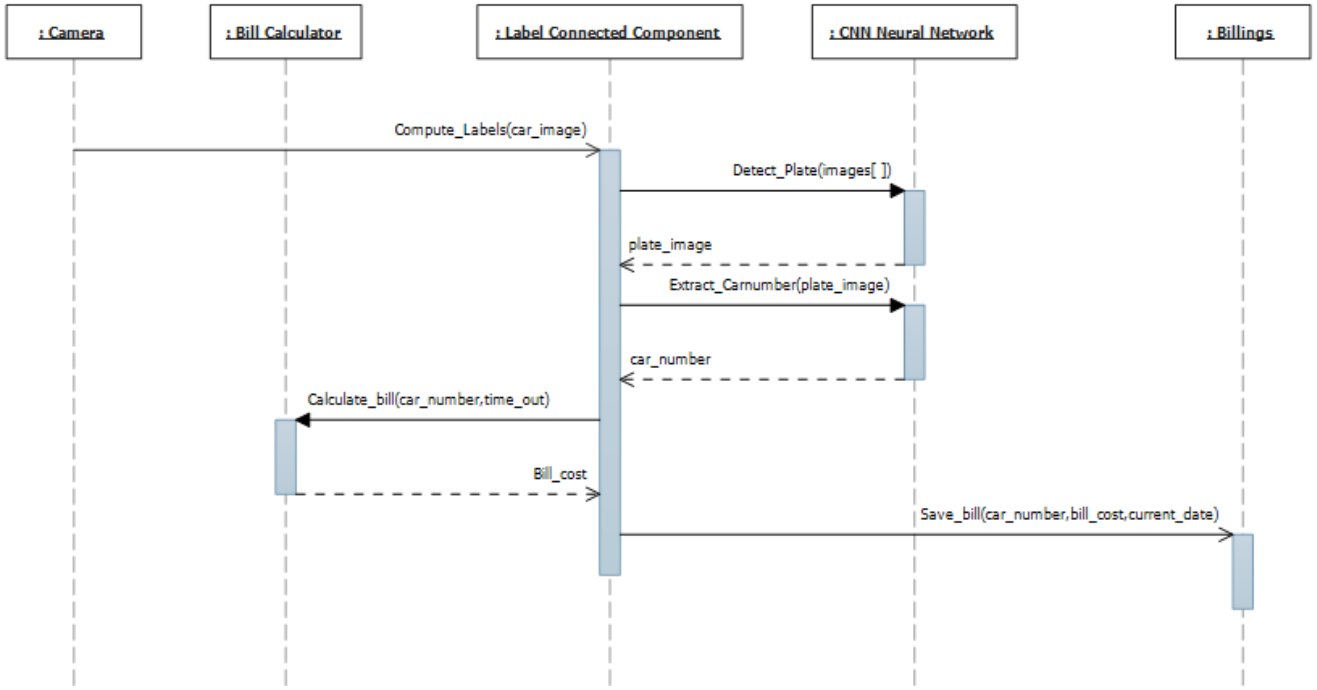

Figure 5.11: Sequence Diagram For Calculate Bill

5.3. ERD Diagram:

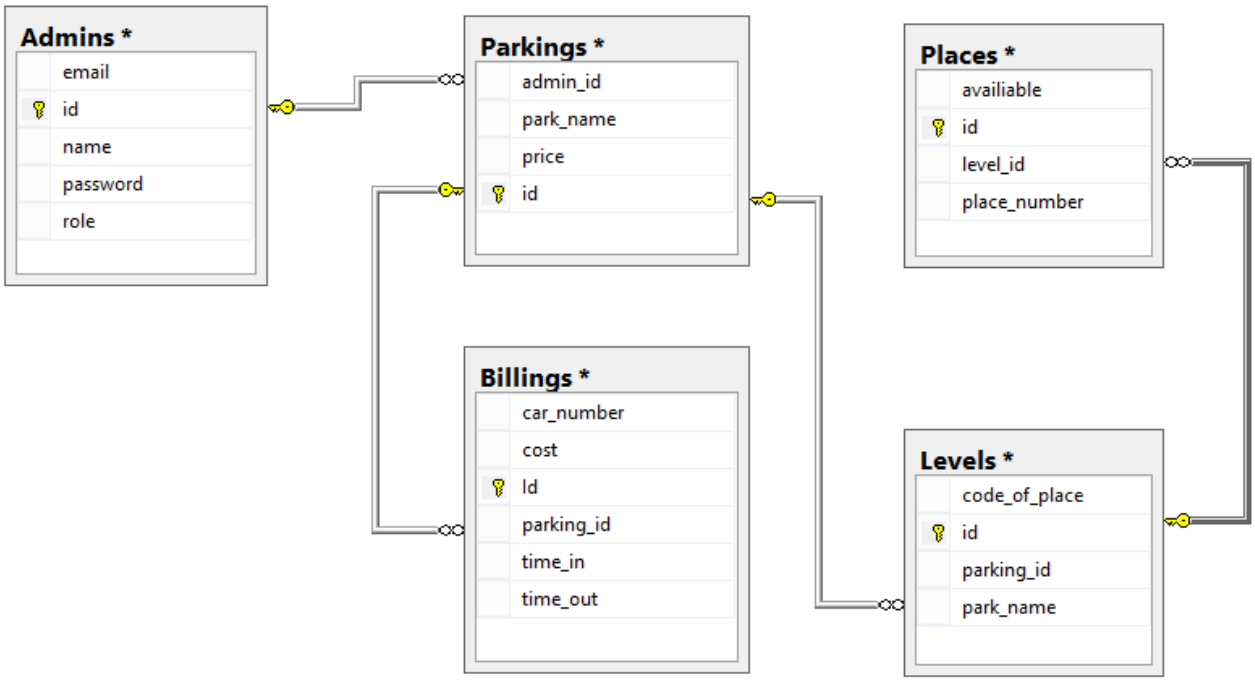

Figure 5.12: ERD Diagram

5.4. Software Libraries:

We used the following frameworks in SPS project :

- Tensorflow :Tensorflow is a deep learning python framework written in low level language C/C++ and encapsulated by python interfaces, tensorflow is a high level framework and is easy to use,easy to understand and is very efficient in complex mathmatical operations .

Figure 5.13: Tensorflow Logo

- Opencv:Opencv is image processing python framework written in C/C++ and encapsulated by python interfaces.

Figure 5.14: OpenCV Logo

- Numpy : Numpy is a framework that is used in matrices operations such as matrices multiplication.

6TH CHAPTER

Discussion & Future Work.

6.1. Plate Recognition System Discussion:

Our CNN model achieved a very good results in term of accuracy.As we saw the digit segmentation is a critical task, because it must always get true results.

Label Connected Component may fail to segment the digits in a plate, because there are external factors such as lighting changes, orientation changes…etc.

Digit segmentation is a challenging task, it came with various solutions as we saw earlier.Today new techniques are proposed that solve the digit segmentation in a smart way.

Some of the techniques are as follow :

- You Only Look Once (YOLO) : YOLO is an advanced CNN, it is a new approach for object detection task. YOLO is the state of the art in computer vision tasks. YOLO looks at an image in a smart way .
- Regional Convolutional Neural Network (RCNN) : RCNN same as YOLO in term of accuracy, but YOLO is faster than RCNN in terms of training time, execution time.

6.2. Database Management System Discussion:

We built our SPS based on SQL DBMS.DBMS based on SQL cannot handle a huge number of requests from the users ,as a result,the system will not response in the future. Nowadays Big Data techniques are demonstrated their power.Big Data can handle a very huge number of requests .Some of the Big Data Frameworks are:

- Apache Hadoop.
- Apache Storm.
- Apache Samza.

In the future, we will attempt to implement the following:

- YOLO Algorithm to enhance the accuracy of the plate recognition system.
- Compare between RCNN and YOLO in terms of accuracy, execution speed.
- Design and implement our database on a Big Data framework such as Apache Hadoop framework.
- Design and implement an android application to expand our SPS services.
- Design and implement an iOS application to expand our SPS services.
- Add new interactive services in our website such providing the available places in a park based on the weather conditions, for example showing the places in a park that are not susceptible to the sun light, because sun light can hurt the driver's vehicle.

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Smart Parking System	SPS
Database Management System	DBMS
License Plate Recognition	LPR
Convolutional Neural Network	CNN
Hierarchical Extreme Learning Machine	H_ELM
Label Connected Component	LCC
Histogram Of Oriented Gradient	HOG
Extreme Learning Machine	ELM
Support Vector Machine	SVM
Vehicle Number Plate Recognition	VNPR
Radial Basis Function	RBF
True Positive	TP
True Negative	TN
False Positive	FP
False Negative	FN
Area Under Curve	AUC
Structured Query Language	SQL

Model-View-Controller	MVC
User Interface	UI
Personal Home Page	PHP
Hypertext Markup Language	HTML
Cascading Style Sheets	CSS
Plate Recognition System	PRS
Computer Vision	CV

Table 6.1: Abbreviations