

# **ENHANCED ECONOMY BASED SMART PARKING SYSTEM USING MACHINE LEARNING**

*Thesis submitted in partial fulfillment of the requirements for the award of degree  
of*

**Master of Engineering**  
in  
**Software Engineering**

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## Certificate

I hereby certify that the work which is being presented in the thesis entitled, "*Economy Based Smart Parking System Using Machine Learning*", in partial fulfillment of the requirements for the award of degree of Master of Engineering in *Software Engineering* submitted in Computer Science and Engineering Department of Thapar Institute of Engineering and Technology, Patiala, is an authentic record of my own work carried out under the supervision of *Dr. Seema Bawa and Ms. Harkiran Kaur* and refers other researcher's work which are duly listed in the reference section.

The matter presented in the thesis has not been submitted for award of any other degree of this or any other University.

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This is to certify that the above statement made by the candidate is correct and true to the best of my knowledge.

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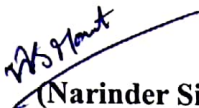
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## Abstract

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For the development of smart cities, various types of smart applications are requisite wise smart health care, smart electricity system, smart home, smart parking system, smart irrigation, and smart waste management system, etc. In these applications, the smart parking system is one of the most important aspects of a smart city. But finding the parking space in a very large parking area has been becoming a serious problem because of increase in the number of vehicles on the road and the number of fewer parking slots available for parking. The drivers are wasting so much time and fuel to find the proper parking slots.

The proposed work applies Linear Regression approach of Machine Learning for forecasting and predicting future parking price changes based upon the previous dataset. The user can change the parking price according to his needs. Also, it describes varied factors which directly or indirectly affects parking price.

Using the proposed system, users can view the available slots and book slots based upon their choices of place, pricing option, etc. This web system assists the customer to book parking spaces online. User can pay the parking charges online through PayPal account. Hence this application reduces the user's effort and time of searching the parking space and also avoids the congestion of traffic.

*Keywords:* Smart parking system, Parking prices, machine learning, Regression, Least-squares regression, Web-services, parking data set

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## List of Abbreviations

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AI	Artificial Intelligence
BST	Binary Search Tree
CO <sub>2</sub>	Carbon dioxide
CPU	Central Processing Unit
CSS	Cascading Style Sheets
EBSPS	Economy Based Smart Parking System
GB	GigaByte
ID	Identification
IDE	Integrated Development Environment
LED	Light Emitting Diode
ML	Machine Learning
PSP	Personal software process
PING	Packet Internet Groper
RAM	Random Access Memory
ROM	Read-Only Memory
RSSI	Received signal strength indication
SFpark	San Francisco Parking
TB	TeraByte
WSN	Wireless Sensor Network

# Chapter-1

## Introduction

---

In this chapter, a description of a smart parking system has been provided. The smart parking system helps the driver to find appropriate parking location without any hassle. Further, an introduction to machine learning, along with its applications has been described in this chapter. Also, the machine-learning algorithm which helps to predict the future results of the parking system has been elucidated in the present chapter.

### 1.1 Introduction to Smart Parking System

In recent years, a large number of newly registered vehicles were reported compared to the previous years, which makes it a rough estimate of a 54.5% increase in a span of 7 years. This has introduced the problem such as congestion in traffic and the unavailability of parking space. The situation is worse in Asia due to narrowness of roads in comparison to the West. With the growth of the population, the number of vehicles are increasing on-road day by day. In a big city, finding the parking space for vehicles has been becoming a big problem and it is also becoming very costly. Finding the car parking space during any special day like the festival, movie days as well as peak time is very challenging. The driver has been wasting much time and fuel to find the parking slots. It can be very annoying for car drivers to search the parking slot for vehicle parking. It may be going on because the parking spot is very tough to find as the spot may be taken already by another car. Statistical results help to understand that manual searching for vehicle parking space requires a huge amount of energy, time and fuel consumption, which leads to CO<sub>2</sub> emission in large quantities; as compared to online search parking slots.

The countries like, Europe, the United States, and Japan have implemented smart parking system incorporated with advanced technologies. By utilizing smart parking system in the car parking, the above-mentioned problems got reduced manifold. Online parking reduces search time for parking slots, fuel consumption, and CO<sub>2</sub> emission as compared to manual

slots booking for vehicle parking [11]. The online smart parking system allows user to acquire the parking slots online in advance, which is a help to reductions of parking slots searching time, reduction in environmental pollution and reduction in frustration of driver. This system also provides a feature for pre and post-trip booking [7].

The proposed system in this thesis work is a new parking system based on “Enhanced Economy Based Smart Parking System Using Machine Learning”. This system is not based on any sensors, which mean the proposed system has a low cost of installation and maintenance.

Enhanced Economy Based Smart Parking System Using Machine Learning is a web-based smart parking system. It provides an online platform for booking the parking slots. Users can view the available slots and book slots based upon their choices of place, pricing option, etc. Users can pay the parking charges online through PayPal account and book the slots in advance.

This system also provides a new feature like divided payment charges which are divided further into two categories including premium and economy parking slots. In premium parking slots the parking charges are high as compared to economy parking slots area charges which provide the user with very good security and parking location near the entrance of the parking area. On the other hand, in the economy parking area, charges are less, it provides less security and vehicle parking space is not closer to the entrance. Users can choose premium parking slots or economy parking slots according to their budget.

## **1.2 Machine Learning**

### **1.2.1 Introduction of Machine Learning**

In real words, humans can learn everything from their learning capability and their experience, similarly, the machine learning algorithm learns from past data or experiences like humans. Machine learning provides the capability to computers, enabling them to learn from past datasets without being explicitly programmed.

Machine learning is a subset of artificial intelligence (AI) that is concerned with the implementation of algorithms that help the computer to learn from past experiences and historical data.

## 1.2.2 Applications of Machine Learning

A multitude of applications of machine learning can be elucidated as below:

a) **Image Recognition:** Image recognition using machine learning is the common application of machine learning. Image processing mainly uses face detection and image recognition etc. It is also used to identify persons, places, objects, etc. For example, Facebook provides the user with an option of Automatic friend tagging suggestions. When a user uploads a picture with their facebook friend, then user gets a tagging suggestion with name. For this feature face recognition algorithms of machine learning has been used technology used.

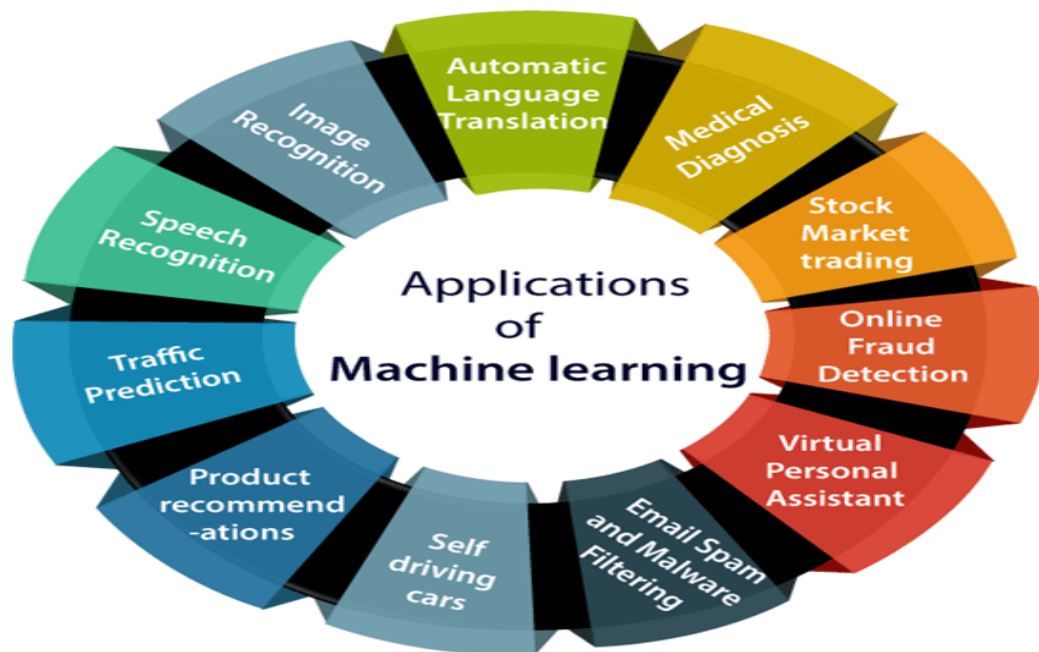


Figure 1: Applications of Machine Learning [27]

b) **Speech Recognition:** Google provides an option “Search by voice”. It is based on machine learning speech recognition and is very common or popular feature of machine

learning. Speech recognition is a process to convert speech or voice into text form, also called “Computer speech recognition” or “Speech to text”. Speech recognition machine learning is also used in Siri, Google Assistant, Alexa, and Cortana.

c) **Traffic Predictions:** Machine learning also helps in applying traffic prediction. If we visit a new place, we use “Google Maps”. This application show user every route and shortest route of destination also show the predict condition of traffic, like heavily congested, slow-moving, traffic is cleared or not, etc with the help of real-time location of the vehicle using sensors and Google Map app.

d) **Self Driving Cars:** Self-driving car is most exciting application of machine learning. While driving, car can automatically detect the objects and people. An unsupervised machine learning algorithm is used to derive the self-driving cars technique.

e) **Email Spam and Malware Filtering:** When we receive a new email, email gets filtered automatically as normal, social, important, junk or spam. and we receive a normal or important email in primary section of inbox, social sites emails in social file box, and junk and spam emails in spam box. Some of the spam filters used by Gmail include Content Filter, Header filter, General blacklists filter, Rules-based filters and, Permission filters. Machine-learning algorithms such as Naïve Bayes classifier, Decision tree, and Multi-Layer Perceptron, are used for email spam filtering and malware detection.

f) **Stock Market Trading:** Long short term memory neural network algorithm is used in stock market trading. In stock markets shares are always risk of up and down. A machine learning algorithm is used to detect stock market trading prediction.

g) **Medical Diagnosis:** In medical science, machine learning is used for disease diagnoses. It helps in finding brain diseases such as brain tumors etc.

h) **Automatic Language Translation:** One of the most advanced features of machine learning is “Automatic language translator”. For example, we are going to a new place and we are not aware of the language of that place. Machine learning helps to convert the text

into any language. Machine learning algorithm Neural machine learning use to translate the text into our familiar language. It is called an automatic translation.

### 1.2.3 Categories of Machine Learning

Machine learning can be categorized into three types of algorithms:

- i. Supervised Learning
- ii. Unsupervised Learning, and
- iii. Reinforcement Learning

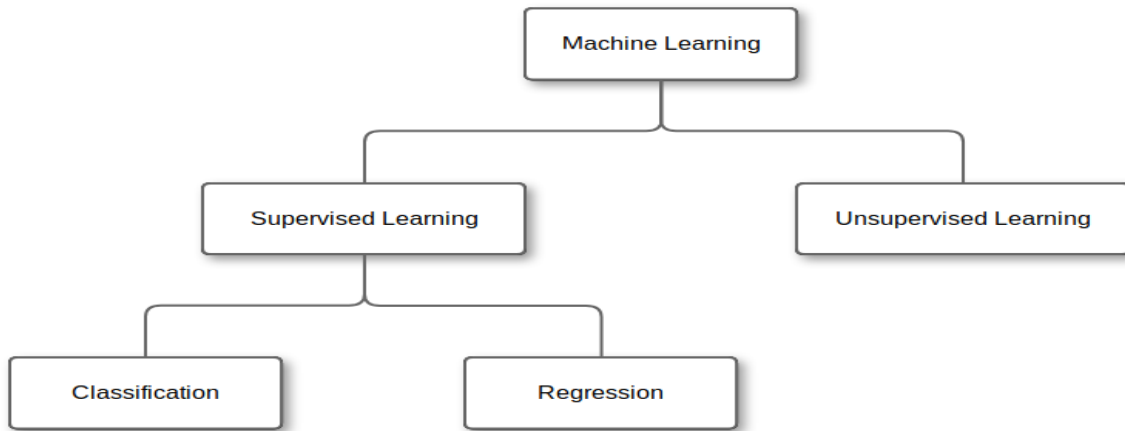


Figure 2: Categories of machine learning [27]

- i. **Supervised Learning Algorithm:** Supervised learning name indicates the supervisor or teacher. In supervised learning we train or teach the machine using labeled data. Labeled data means that each data item has been already marked with the correct answer. The supervised learning algorithm analyzes the training data and predicts the correct results from labeled data.

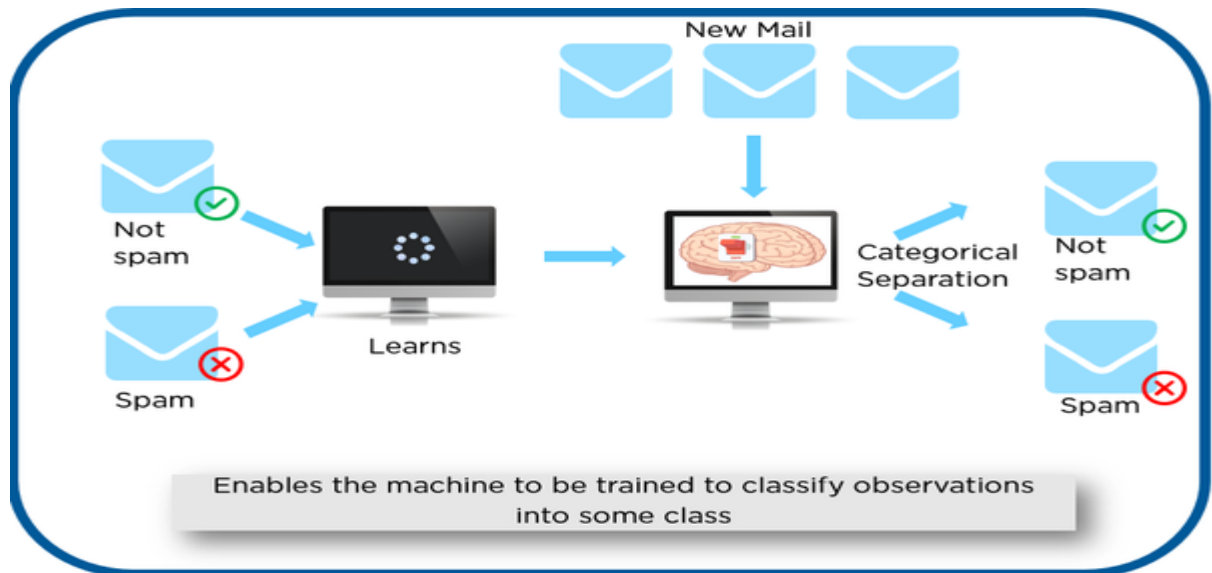


Figure 3: Example of Supervise learning [26]

Figure 3 shows that emails have been marked as “spam email” and not “spam email”. We receive a normal or important email in the primary inbox, and spam emails in spam box and not span emails in not spam box in labelled form. This labeled form of data is utilized as a training dataset to apply supervised learning.

### Types of Supervised learning

The supervised learning has been classified as:

a) **Classification:** In classification learning problem, the output generated is in the form of categories such as “0” and “1” or “Disease” and “Non-Disease” etc.

b) **Regression** In regression learning problem the output variable is a real value., for example, real cost, weight or dollars, etc.

ii. **Unsupervised Learning Algorithm:** Unsupervised learning provides the training to the machine using unclassified and unlabeled information and also allows system algorithms to act on the data without guidance. For example, grouping the unsorted information using pattern analysis. For this set of problems machine itself gives structure to the unlabelled dataset.

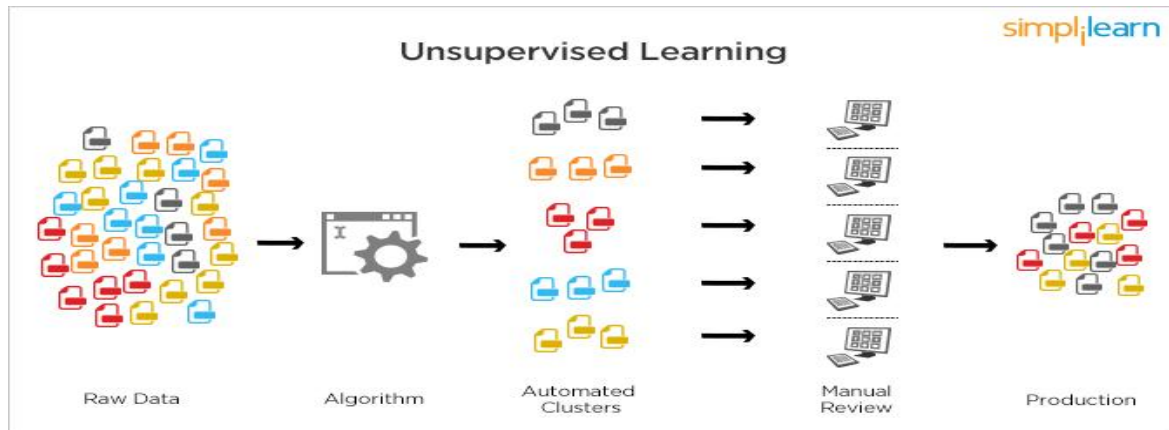


Figure 4: Example of Unsupervised Learning [26]

From Figure 4, we have some random raw data set and machine has no idea about the features of this raw dataset. So, any useful information is not retrieved from this dataset. The machine learning algorithms groups this dataset according to patterns, differences, and similarities; to retrieve useful information from it.

### Types of Unsupervised learning

Unsupervised learning has been classified as:

a) **Clustering:** The clustering ML problem is wherein we have to determine the intrinsic groupings in the datasets, including grouping of customers according to their purchase behavior.

Henceforth, the present study is an endeavor to appraise the current scenario of the parking system and design “Enhanced Economy Based Smart Parking System Using Machine Learning”.

In the proposed parking system, all the car information like car arrival time, number of slots booked, number of available slots, premium or economy slots, etc. are stored in the main server. Machine learning algorithms use this dataset to predict the parking crowd in current date and time. In this thesis, some useful attributes from parking system database have been used, and Linear Regression (LR) approach of machine learning has been applied to these

attributes and parking prices have been predicted according to available parking on specific date and time.

## Chapter-2

### Literature Survey

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#### 2.1 Review of Related Work

A brief picture of relatable studies has been presented in the proceeding paragraphs as:

Jih-Fu Tu,(2019), described a smart parking lot guiding system comprising a plurality of parking space sensing gadgets, a cell communicate tool, a processing device, and a signal transmission tool and records base. This utility helped people additionally for recognition of the parking time and parking expenses they have to pay [1].

Thomos B., Kovoov B (2018), proposed a system that described an android application for customers to book the parking lots in advance through internet banking, debits card or credit score card and so on. When the consumer successfully login with the system then the user was offered a unique client identity. This identity had been utilized by them for future car parking reservations. The autonomous trolley was used to take the vehicle from the entrance to the correct parking slot recognized by the device. After that, it sent a picture message to customer email, to verify user that car was efficiently parked [2].

Kizilkaya B., et. al (2018) presented a hierarchical technique based on Binary Search Tree (BST) for monitoring parking structures that facilitated users to attain a free parking spot without problems. On the first level, the algorithm only checked effective assessments nearest vehicle parks and on the second level of hierarchy selected car park was searched in line with the nearest place [3].

Qiong T., et. al (2018), proposed a new dynamic pricing model for parking reservation. This system was used to make most of the estimated profits of the parking supervisor. It reported that the parking charge varied with the arrival call and the number of vacant parking areas [4].

Alsaferi W., et. al (2018), highlighted the smart parking system which provided the solution to finding the parking space problem. In addition, it provided user with roadside congestion status, indoor parking area and on-street parking collection data using different sensors and processed them locally with the help of other devices. All the data had been evaluated by machine learning approaches [5].

Simhon E., et. al (2018), studied the San Francisco (SFpark) parking location. SFpark used occupancy charge facts from the previous month to modify the price within the present-day month. It used machine learning Least Squared Regression (LSR) approach that predicted the prices of next month's parking prices [6].

Hainalkar G. and Vanjale M. (2017), proposed pre and post-trip booking system while utilizing existing parking website data. The author proposed smart parking based on the internet. It included particular parking location with automatic cashless billing and the proposed system provided the update of each and every parking area to traffic police. It helped traffic police to manage the urban state traffic problems [7].

Anitha J., et. al (2017), introduced the Intelligent parking system using Android application and described the methodology to develop the system. The author also described all the modules of intelligent parking system such as the system offered to check parking status (available or booked) by the user and booking the specific slot in advance. The authors had described a different type of Admin and customer module features such as addition of parking location, viewing parking location, viewing all booking slots, user feedback and so on [8].

Grodi R., et. al (2016), presented a smart parking system prototype using networks and wireless sensor technology. Wireless sensor network (WSN) was used to detect the current parking status like the number of occupied space or number of availed slots and transmitted all information to the database server. User can access this real-time information through mobile application or website and receive all real-time updates. This system also detected the real-time location of user and provided them with nearby available parking slots based upon real-time information [9].

Vakula D. and Kolli Y. (2017), depicted an online parking system in Hyderabad city. This is an online parking booking system to define the parking problem in Hyderabad city. Users can book parking slots at any time and from any place using mobile Phone, computer or laptop. The authors described an algorithm based on a Smart parking system in which a user can book a particular slot online for vehicle parking and system provided the user with a barcode. After this barcode has been matched with the parking database, the parking gate automatically opens. An offline way to book a parking slot in which all tasks were performed manually and customer received a cash receipt to enter the parking gate has been elucidated [10].

Rehman M. and Shah M. (2017), differentiated the manual parking system and online parking system. This study described how much parking slots searching time was reduced, and further how it affected fuel consumption and CO<sub>2</sub> emission of the vehicle during parking in big cities, organizations and congested areas. The result was shown using graphs and it was evident that automated parking systems significantly reduced the time, cost and CO<sub>2</sub> emission efficiently [11].

Mutiara G., et al (2017), presented and implemented a low-cost design system for wireless parking module, which might be containing a parking sensor to discover every car area, and LED display. It was used to check the availability of the parking space, the condition of the parking area, which helped to reduced maintenance costs. This module used a NodeMCU as a microcontroller and PING Ultrasonic sensor. All modules wherein connected wirelessly to the main server through a router. The proposed module price turned into much less than common retail expenses as compared to other modules that were found in the marketplace [12].

Khanna A. and Annad R. (2016), elaborated a smart parking system in which customers booked parking slots in advance for a specific time period and also pay the parking charges in advance. Booking can be done through e-wallet or credit card. The user can successfully park the vehicles in favorable parking slot and can confirm occupancy using the mobile application. This system can provide useful real-time information about parking slots like

the number of availability of parking slots in a parking area and number of booked parking slots in a parking area [13].

Lee C., et. al (2016), stated a smart system of parking for detecting and finding the parked location of customer vehicles using the ultrasonic and magnetic sensor. These sensors communicate with each other by using the Bluetooth module and identify the entering and leaving vehicles in the parking slot and memorized the vehicle parking location [14].

Demegillo A., et. al (2016), described the Philippine city car parking problem due to huge increase in the number of vehicles. The customer checked real-time available parking slots. This parking system helped customer find the parking lots areas and provided some new features like providing a window of specific parking slots. The customer can also display the outside parking garage, check an online number of available and booked parking slots, etc [15].

Cai W., et al (2015), designed a smart parking guidance system based on parking lots of sensor networks. This system was based on combined wireless communication technology, positioning technology, and sensor technology. Positioning module detected the customer vehicle's location, sensor module detected each parking lot, and real-time information transmitted to the information center. This, in turn, sends real-time data to the customer [16].

Samadhi A., et al (2015), proposed Android application to find empty slots for vehicle parking. The author described Ration Unified Process Methodology for their system. They used ADOBO Dreamweaver, Photoshop CSS and unified modeling language tools to develop this Android application. This Android application helped driver to find the parking slots quickly. This application is useful for both car and motorcycles drivers for finding the parking slots online and could display the total number of empty slots are available for vehicle parking [29].

Ji Z., et al (2014), described a cloud-based intelligent vehicle parking system in smart cities. It also followed the Personal Software Process (PSP) methodology to develop an intelligent parking system. The authors described three layers of car parking system: application layer,

sensor layer, and communication layer, which described the implementation of the system and architectural part proposed by a simple smart car parking service for a university [17].

Lan K. and Shih W. (2014), considered a scenario in which user can get access to the floor plan of the constructing with the assist of smartphones. The system utilized the sensors on the smart cellphone to compute the person’s course. The moving distance and walking trajectory with the map permitted the machine to estimate the driver’s present location within the building [18].

Bonde D., et al (2014), explained Autonomous Car parking system controlled by an Android application. It described deployment of the system which offered free parking slot allotment to the car and a suitable path-tracing to the lot. If none of the parking space is available, then car could not enter the parking space until any of the parking slots, gets free [19].

Polycarpou E., et al (2013), presented the survey results about the needs of drivers from the infrastructure perspective. The trends in parking availability monitoring system, parking reservation and dynamic pricing schemes had been discussed in detail. The author also examined the technological capability of the said schemes to integrate them with advanced parking infrastructures; so as to assist both the drivers and the parking operators [20].

Table 2.1: Comparative study about various smart parking systems

Author(s) Name and Year	Approaches used	Objective	References
Kizilkaya B., et. al (2018)	BST(Binary Search Tree) monitoring model	Used BST monitoring model to find the nearest available parking slots	[3]
Alsafery W., et. al (2018)	Linear regression	Provided the solution of finding the parking space problem	[5]
Simhon E., el. al (2018)	Least Square Regression Model	Predicted future prices on the bases of past month dataset	[6]

Grodi R., et. al (2016)	Wireless sensor network (WSN)	WSN used to detect the current parking status and number of occupied space or number of availed slots and transmitted all information to the database server	[9]
Rehman M., Shah M (2017),	Time, Cost and CO <sub>2</sub> emission Effect on manually or automated parking	Defined a comparative analysis between manually and online parking, Also effect in Cost, time, CO <sub>2</sub> emission to finding the parking slots	[11]
Mutiara G., et al (2017)	with wireless parking module, number of parking sensor	All module wherein connected wirelessly to the main server through a router and provided real-time information to the user.	[12]
Lee C., et. al (2016)	using ultrasonic and magnetic sensor and Bluetooth device for communication between this sensor	Bluetooth module and identified the entering and leaving vehicles in a parking slot and memorized the vehicle parking location.	[14]
Fechete F, Nedelcu A (2014),	Multiple Regression Model	The objective of the organization was to measure the effectiveness and efficiency and economic performance.	[20]

From the review of related literature, it can be summed up that an array of works regarding automatic car parking has been elaborated including the varied aspects of the machine learning-based architecture design in the car parking system.

#### 3.1 Research Gaps

From the literature survey undertaken, the following research gaps have been identified:

The pre and post parking trip booking and traffic police update of each parking area need to be addressed which might aid in management of urban traffic problems. Its implementation in rural areas is needed [8].

A more easy and secure system is required with additional features and facilities. The hardware device like a camera and sensors etc. for tracking the current location of vehicles and cameras to check the condition of vehicles is also a requisite [9].

The existing parking system encompasses sensors within parking spot optimization and saves the false parking spot detection. An optimized device that might connect with all booked and available parking spots and provide actual-time update records to end-consumer so a person can tell approximately booked and to be booked parking spots around their preferred location needs to be prepared [10].

The billing system and security system also needs to be added in the system, which further required more complexity for implementation on a large scale in the real world [12].

The more accurate RSSI (Received Signal Strength Indication) measurement method is required to be implemented with additional application of smart parking system space for reservation for parking slots, such as accident alarm so on. Also, Wi-Fi module has to be addressed for sensors for communicating with each other and for increase in the processing speed [15].

The studies can also be more desirable to consist of more functions and reduce the difficulties that are seen due to the absence of an effective, dependable and better parking device [16].

The increase in quantity of sensor nodes, and locating some fairly small parking is also required because the work system is much complex and it is very difficult to test [21].

### **3.2 Problem Statement**

From the research gaps recognized in the previous section, the problem can be stated as:

The new parking system based on Enhanced Economy Based Smart Parking System Using Machine Learning (ML) has been proposed. This system is not based on any sensors which mean the proposed system has a low cost of installation and maintenance.

It provides the user with real-time information so that the user can view the available slots and book slots in the parking lot.

The proposed system also provides a new feature like payment classification includes premium and economy parking slots.

Machine learning approach used for forecasting the parking price and predict the future parking charges based upon the previous dataset. It also describes some factor which directly or indirectly affects parking price, based on factor and dataset.

### **3.3 Objectives**

The following are the objectives of the proposed work:

- a. To study and analyze the existing smart parking system.
- b. To propose enhanced economy based smart parking using machine learning, and
- c. To design, implement and test the proposed economy based smart parking system.

## Chapter-4

### Tools and Methodology

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#### 4.1 Techniques and Tools Used

The following techniques and tools have been used in the present study:

Table 4.1: Software Configuration

Software Tools	Specification
Operating System	Microsoft Windows 7, Professional
IDE	NetBeans 8.0.1, Python 3.7.1
Programming Languages	Java, HTML, CSS, JavaScript, Python
Web Server	Wamp Server 2.5
Designing Tools	ProjectLibra 2, StarUML, Creatly.com
Dataset	MySQL

Table 4.2: Hardware Configuration

Hardware	Configurations
CPU	Intel(R) Core(TM) i3-5005U CPU @ 2.00 GHz
RAM	4.00 GB (Gigabyte)
ROM	1 TB (Terabyte)

#### 4.2 Methodology

Machine learning approach is used for price forecasting and predicting future parking changes based upon the previous dataset. It describes factors which directly or indirectly affect on parking price, based on these factors and parking dataset.

All the data will be saved in the admin database like user registration information, booking information, slot information, parking charges, payment details, etc. This data admin will be

used to predict the parking charges. Parking charges, in turn, dynamically change during holidays, festivals, cinema, movie days, etc charges.

Parking price prediction is a regression problem may be formulated as a regression task. Regression analysis is a statistical approach used to approximate the relationship between a dependent and target variable. Regression evaluation could also decide how lot of those predictors impact a goal variable. In regression, a goal variable is always numeric. In general, price forecasting is performed by using the manner of descriptive and predictive analytics.

Linear regression is a statistical approach to model the relationship between one dependent variable and a set of independent variables.

The formula of linear regression:  $Y=a+bX$  ----- (1)  
the linear function that predicts the response value Y as accurately as possible as a function of the feature or independent variable X.

The equation of the regression line is represented as:

$$h(x_i)=\beta_0+\beta_1(x_1) \text{ ----- (2)}$$

Here,

$h(x_i)$  represents the predicted response value for  $i$ th observation.

$\beta_0+\beta_1$  are regression coefficients and represent y-intercept and slope of regression line respectively [28].

In Figure 5, it can be elaborated that the proposed work comprises design of features following by dependency check and dataset creation. Furthermore, data analysis was undertaken followed by creation of algorithm. The last phase involved prediction and end results.

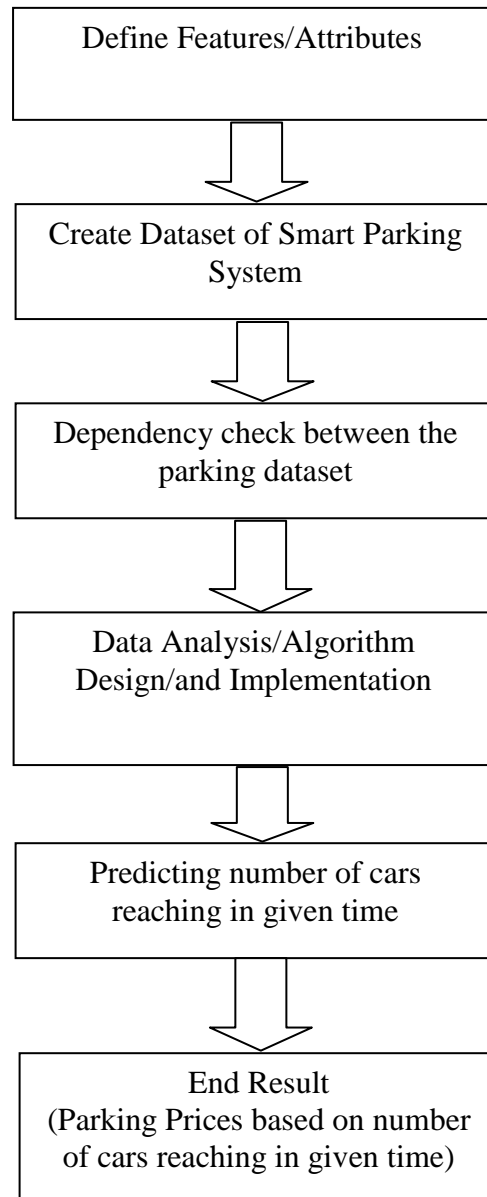


Figure 5: Block Diagram of proposed work

## Chapter-5

### Implementation and Results

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#### 5.1 EBSPS Implementation

Economy Based Smart Parking System (EBSPS) is a Web-based advanced parking system. It provides an online platform for booking the parking slots. Users can view the available slots and book slots based upon their choices of place, pricing option, etc.

##### 5.1.1 Modules For EBSPS

The main modules implemented in EBSPS include:

- i. Registration Module
- ii. Login Module
- iii. Manage Car Module
- iv. Check Area Module
- v. View Booking Module
- vi. Premium Slots Module
- vii. Economy Slots Module
- viii. Slots Booking Module

i. **Registration Module:** To use EBSPS, users are required to register with an authenticated Email ID and unique username, as shown in Figure 6. The fields marked with asterisk sign are mandatory to fill. If the user would register successfully, the user can successfully login with their account.

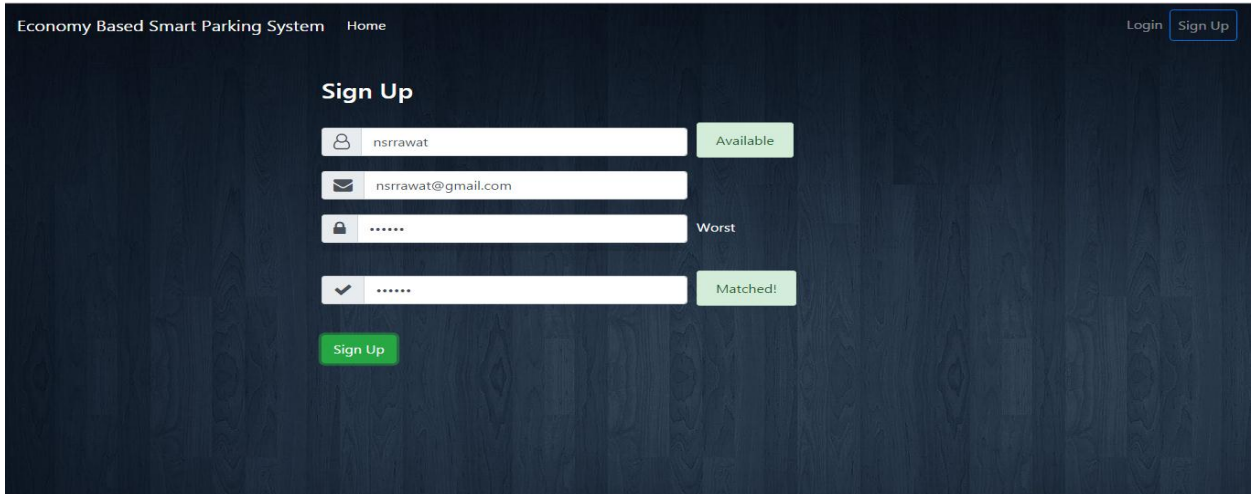


Figure 6: Sign Up Module

ii. **Login Module:** Figure 7 shows that, after successfully registering with parking website, users are required to login the website with their username and password. After successful login user can book the favorable slots and check the availability and also book slots as per their requirement.

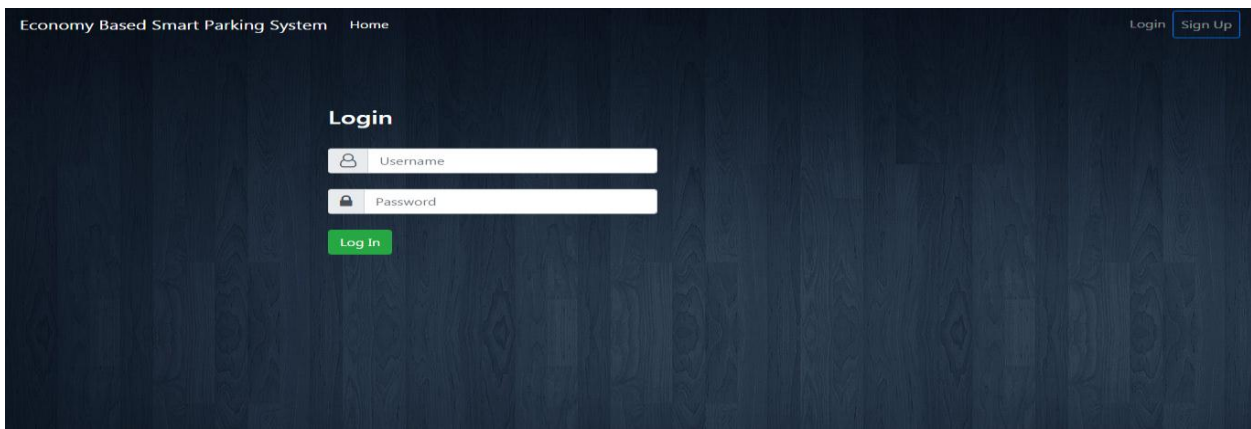


Figure 7: Login Module

iii. **Manage Car:** User can add car details in their profile like User car plate number, car model, etc. The user uses these details into future car parking. In addition, information about multiple cars can be saved for booking parking slots.,as shown in Figure 8.

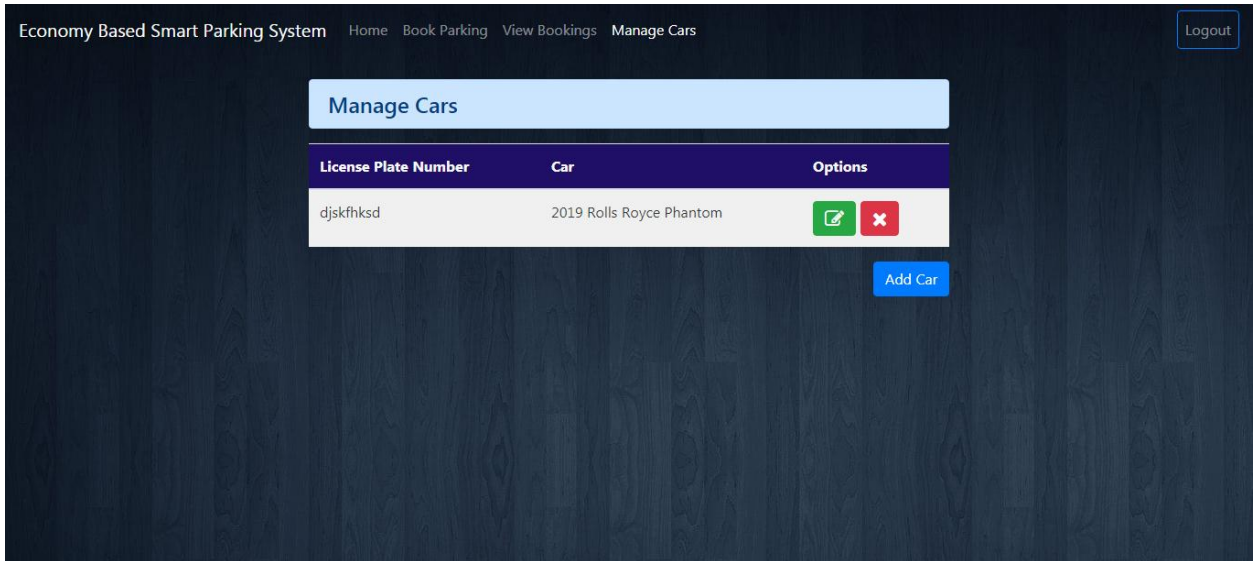


Figure 8: Manage Car

iv. **Check Area Module:** Figure 9 demonstrates, after successfully login, users can check the number of areas present for vehicle parking and choosing the favorable area for car parking. User can also check the number of booking slots and available slots and book the parking slots as per requirement,

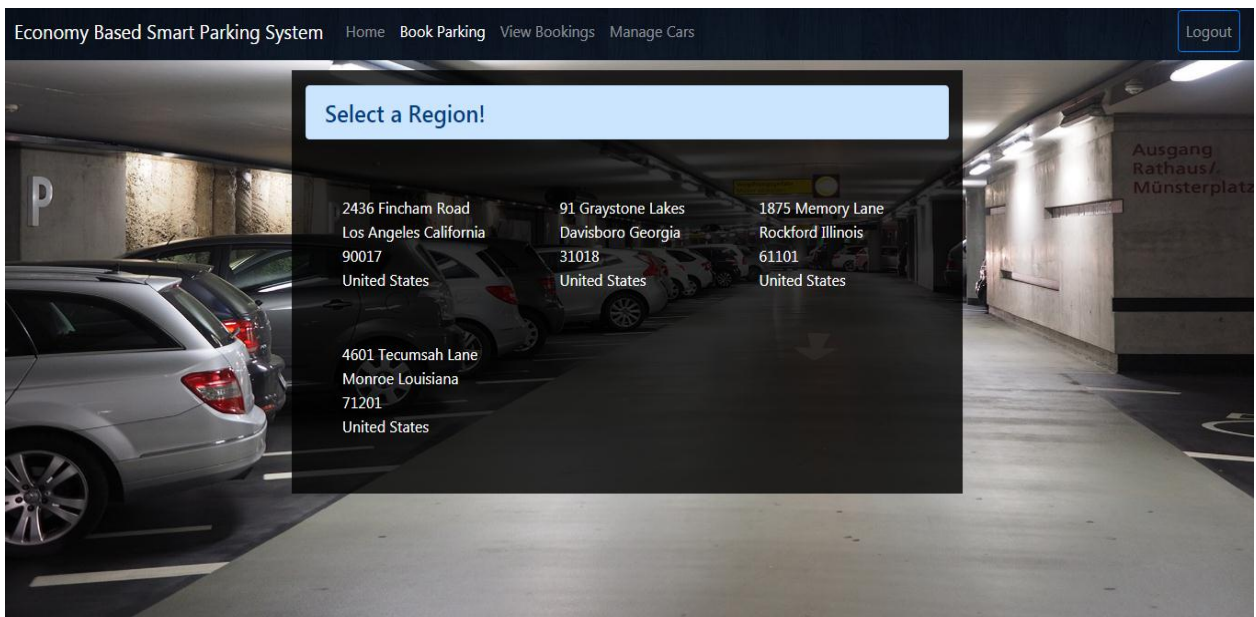


Figure 9: Check Area Module

v. **Check Status Module:** Figure 10,11,12 shows that users can view the number of available slots, present booked slots and can further book slots based upon their choices of place, pricing option, etc.

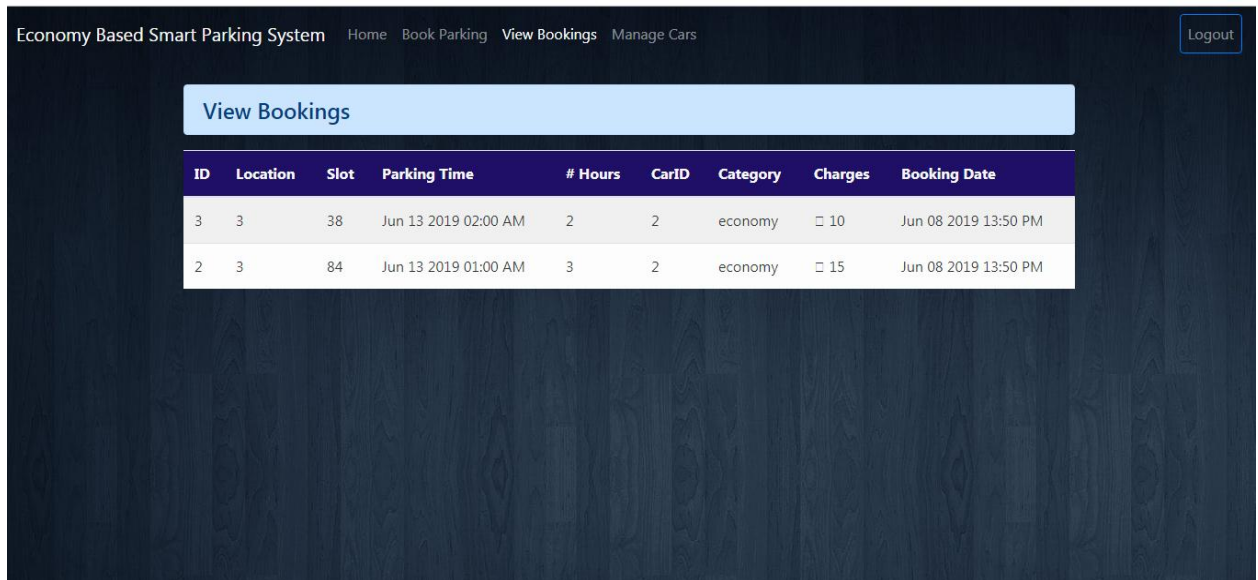


Figure 10: View Booking

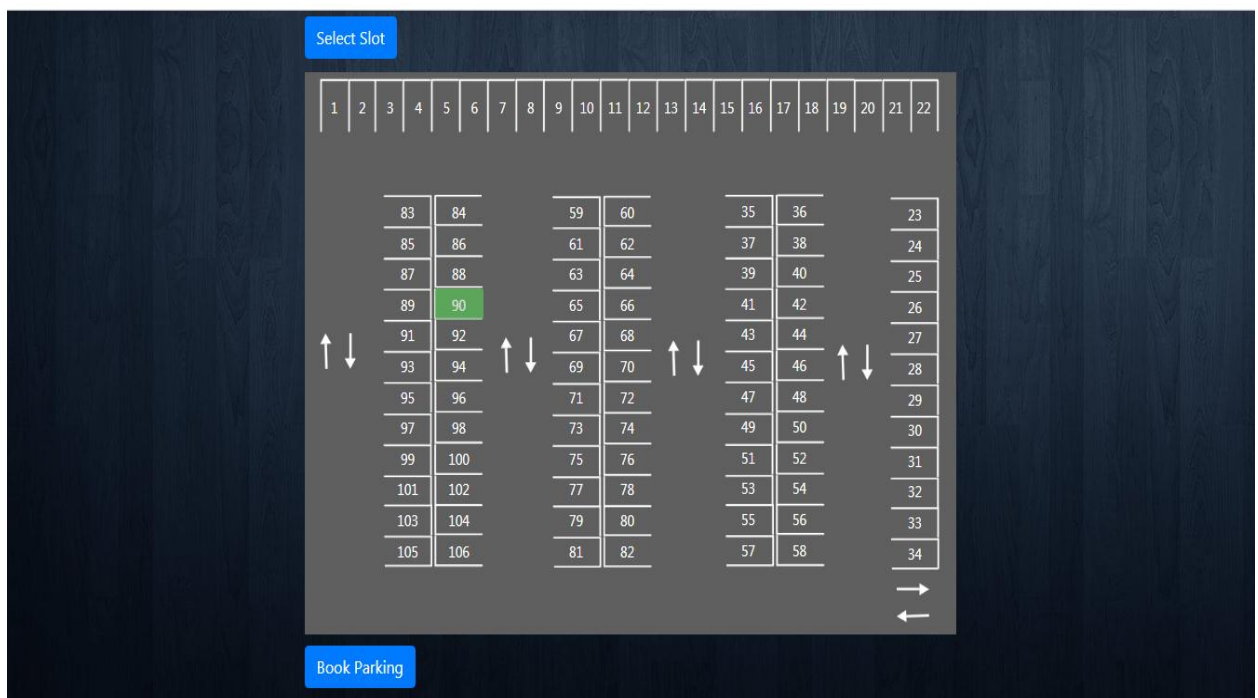


Figure 11: Check Available Slots

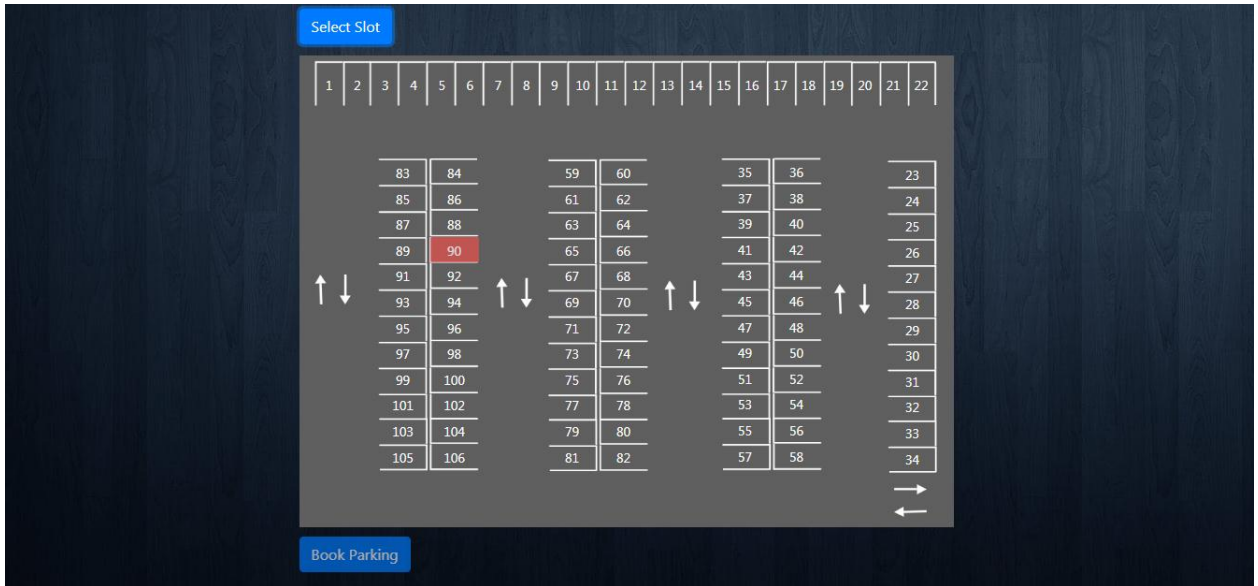


Figure 12: Check Booked Slots

vi. **Premium Slots Module:** Users can choose premium and economy slots based upon their choice. The premium slots have been provided with a fixed charge for parking. It also has good security and priorities to park near the entrance, as shown in Figure 12.

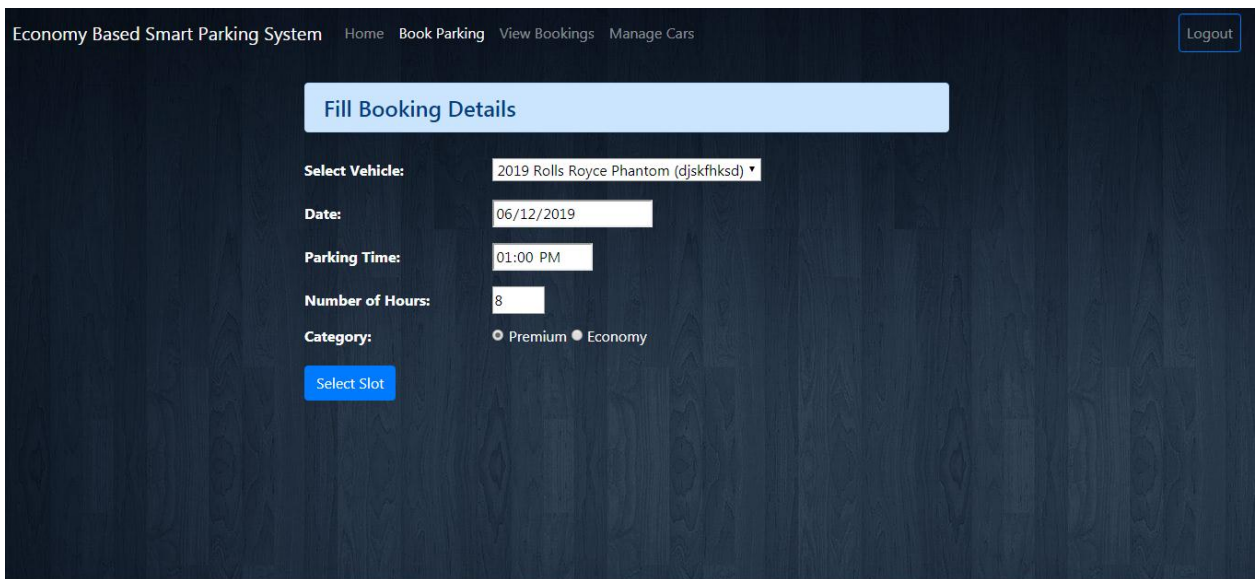


Figure 13: Premium Slots Module

vii. **Economy Slots Module:** In economy slots, less price for parking, less security, and parking spaces are not closer to entrance. Figure 14 depicts the working of economy slots module.

Economy Based Smart Parking System Home Book Parking View Bookings Manage Cars Logout

### Fill Booking Details

Select Vehicle: 2019 Rolls Royce Phantom (djskfhksd)

Date: 06/12/2019

Parking Time: 01:00 PM

Number of Hours: 8

Category:  Premium  Economy

Select Slot

Figure 14: Economy Slots Module

viii. **Slot Booking Details Module:** Figure 15 demonstrates, after choosing the premium and economy slots, users can book slots based upon their choices of place for car parking. After successfully booking the parking slots, user can view the parking details using this module.

Economy Based Smart Parking System Home Book Parking View Bookings Manage Cars Logout

### Booking Details

Username: test2

Vehicle: 2019 Rolls Royce Phantom (djskfhksd)

Location ID: 1

Slot ID: 90

Date: 06/12/2019

Parking Time: 01:00 PM

Number of Hours: 8

Category: premium

Charges:  80

Pay

Figure 15: Slots Booking Details Module

## 5.1.2 Database Tables

As depicted in Figure 16, a database table of user details contains all the user information like username, password, email, etc.

#	Name	Type	Collation	Attributes	Null	Default	Comments	Extra	Action
1	<b>UserID</b>	int(11)			No	None		AUTO_INCREMENT	Change Drop More
2	<b>Username</b>	varchar(16)	latin1_swedish_ci		No	None			Change Drop More
3	<b>Password</b>	varchar(64)	latin1_swedish_ci		No	None			Change Drop More
4	<b>Email</b>	varchar(50)	latin1_swedish_ci		No	None			Change Drop More

Action	Keyname	Type	Unique	Packed	Column	Cardinality	Collation	Null	Comment
Edit Drop	<b>PRIMARY</b>	BTREE	Yes	No	UserID	0	A	No	
Edit Drop	<b>Username</b>	BTREE	Yes	No	Username	0	A	No	
Edit Drop	<b>Email</b>	BTREE	Yes	No	Email	0	A	No	

Figure 16: User Data

Figure 17 shows the database table for available car parking slots.

#	Name	Type	Collation	Attributes	Null	Default	Comments	Extra	Action
1	<b>ID</b>	int(11)			No	None		AUTO_INCREMENT	Change Drop More
2	<b>StreetAddress</b>	varchar(100)	latin1_swedish_ci		No	None			Change Drop More
3	<b>City</b>	varchar(100)	latin1_swedish_ci		No	None			Change Drop More
4	<b>PostalCode</b>	int(11)			No	None			Change Drop More
5	<b>State</b>	varchar(100)	latin1_swedish_ci		No	None			Change Drop More
6	<b>Country</b>	varchar(100)	latin1_swedish_ci		No	None			Change Drop More

Action	Keyname	Type	Unique	Packed	Column	Cardinality	Collation	Null	Comment
Edit Drop	<b>PRIMARY</b>	BTREE	Yes	No	ID	4	A	No	

Figure 17: Parking Locations

Figure 18 shows the database table describing the parking charges on hourly basis. Parking charges change automatically i.e. increase on an hourly basis. Both premium slots and economy slots parking have different charges.

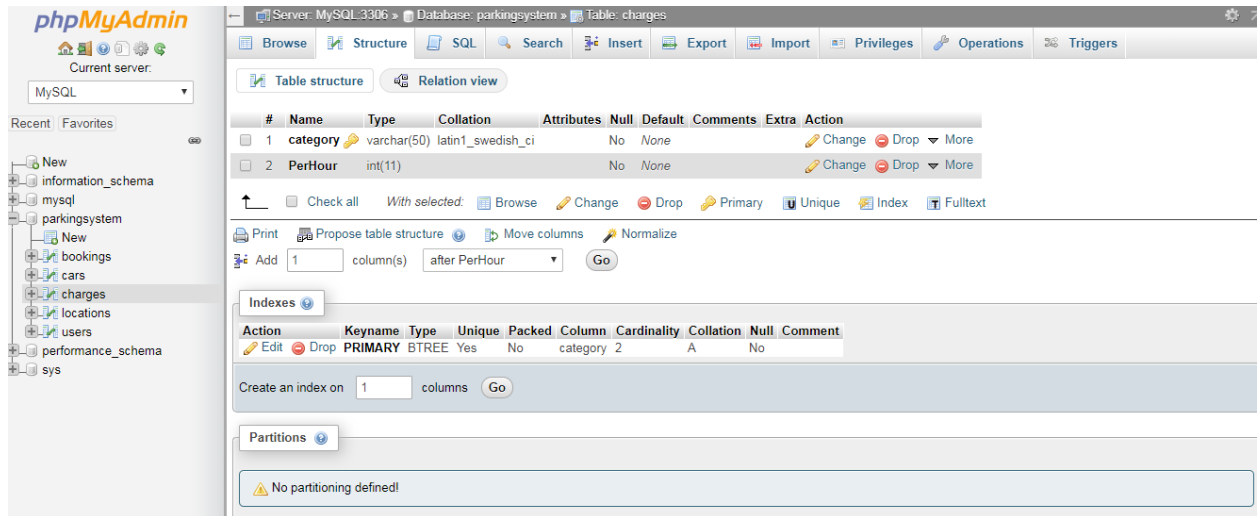


Figure 18: Parking Charges

The table shown in Figure 19 presents the database table for customer car details like car model, year, company, plate number, or customer username all stored in a database.

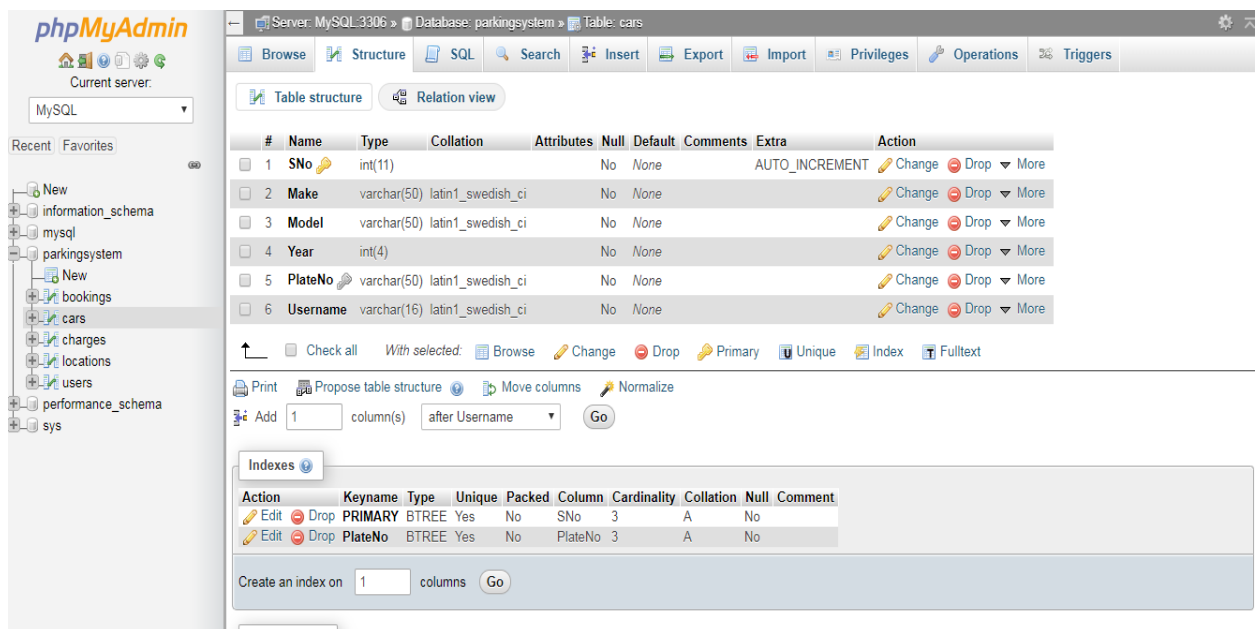


Figure 19: Car Details

Figure 20 shows the database table for customer parking details like customer username, parking location, slot number, category (premium or economy), parking date and time, hours, booking time, etc.

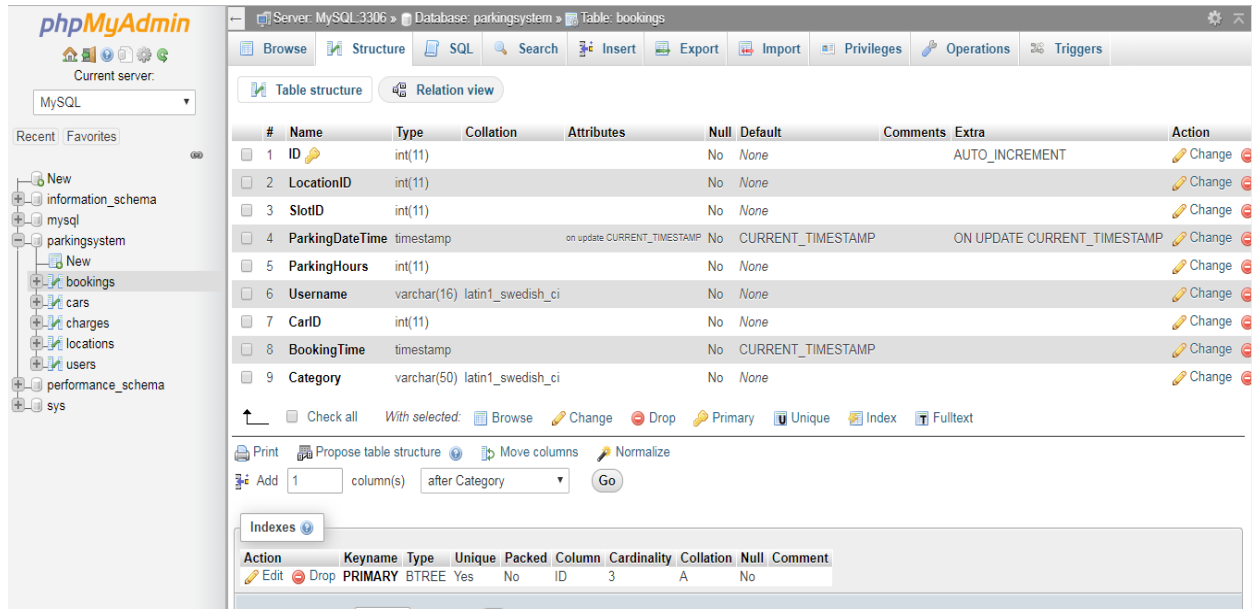


Figure 20: Booking Details

## 5.2 Use of Machine Learning For Price Prediction

### 5.2.1 Dataset Description

For the proposed work, the past 4 years (2015, 2016, 2017, 2018) parking lots dataset has been considered. This work predicts the future number of average cars coming in parking lots and the future crowd in parking lots. The proposed system predicts parking prices based average number of cars coming in parking lots.

Data Attributes: Date of Booking, Time and Occasion, etc

Dependent Variables: Numbers of cars

Independent variables: Date and time

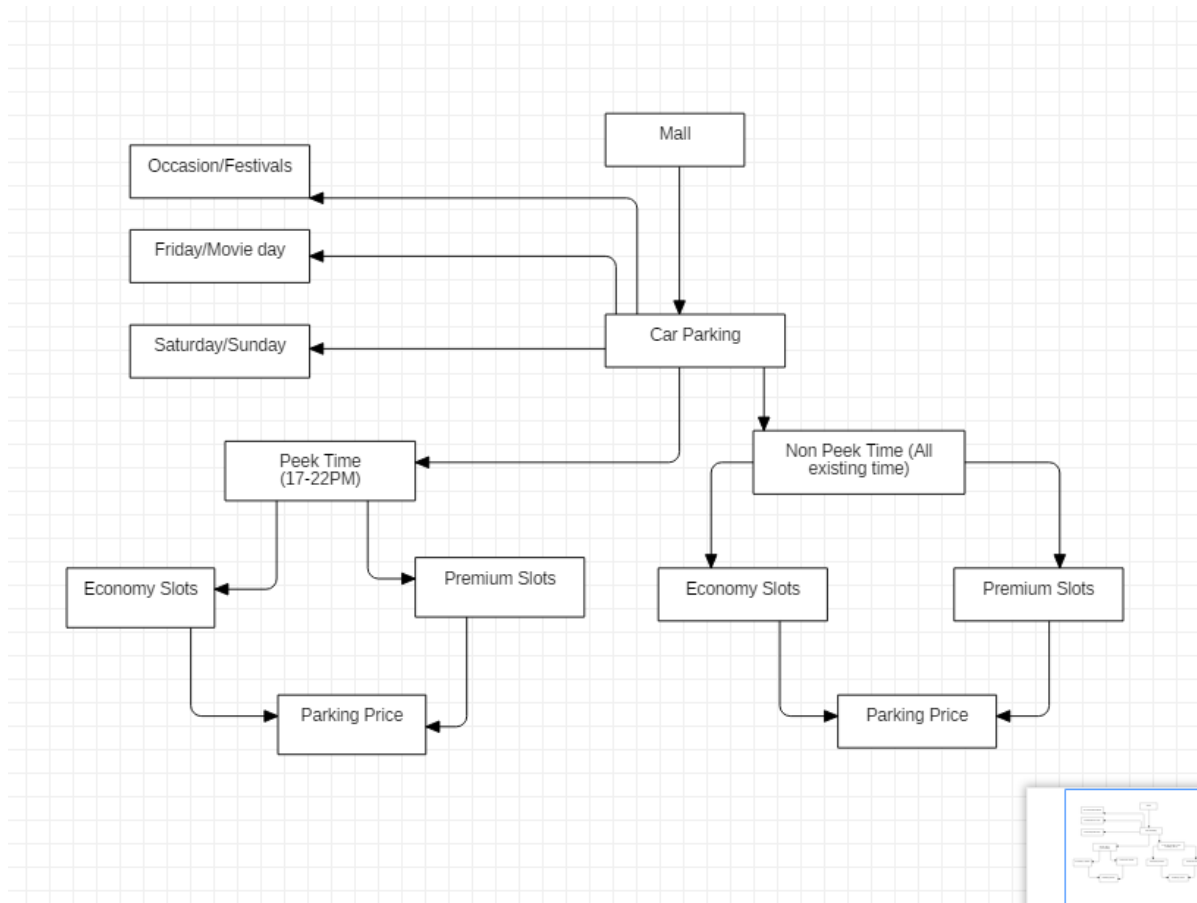


Figure 21: Dataset Details

### 5.2.2 Price Variation

Table 5.2.1 and Table 5.2.2 describes user-defined car parking changes. Users can dynamically change parking charges according to parking based upon user requirements.

Table 5.2.1: Parking prices for normal days

Car Range	Occasion	For Economy Slots	For Premium Slots
30-50	NO + Normal Days	5 rupees	10 rupees
50-100	NO + Normal Days	10 rupees	15 rupees
100-150	NO + Normal Days	20 rupees	30 rupees
150-200	NO + Normal Days	30 rupees	40 rupees

Table 5.2.2: Parking prices for occasions

Car Range	Occasion	For Economy Slots	For Premium Slots
30-50	Yes + Friday / Saturday / Sunday	10 rupees	15 rupees
50-100	Yes + Friday / Saturday / Sunday	15 rupees	20 rupees
100-150	Yes + Friday / Saturday / Sunday	25 rupees	30 rupees
150-200	Yes + Friday / Saturday / Sunday	40 rupees	50 rupees

### 5.2.3 Steps to Predict the Price

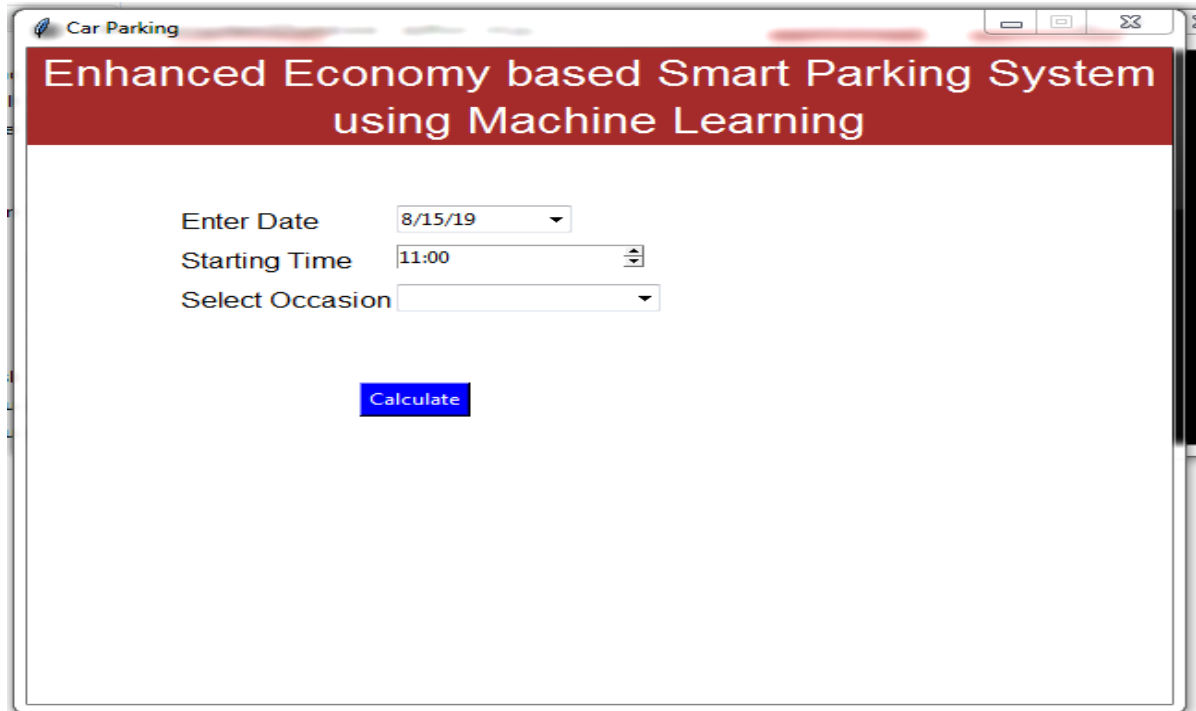
- i. Get input from user [Date, Time, Occasion]
- ii. Fetch previous year data based on the input values:
  - a) Input of all the previous year data from excel sheet
  - b) Find average in given (Date+Time+Occasion)
  - c) Output Array of previous average Cars
- iii. Predict future values:
  - a) Input future date (for which number of vehicles is to be predicted)
- iv. Output:
  - a) Predicted value (Car Range)
  - b) Create (fit.contains) polynomial function-Linear regression to compute  $y=a+bx$
  - c) Calculate the predicted values (Parking Prices)

### 5.3 Results and Discussions

Machine learning linear regression model has been used for price forecasting and predicting the future parking changes based upon the previous dataset.

The prediction results are based on the number of parking slots booked or the numbers of the car coming on a specific date or time in parking. In the present work, numbers of cars coming in parking lots prediction is based on the previous four-year dataset (2015, 2016, 2017, 2018), therein we can calculate the current and future parking crowd on specific time

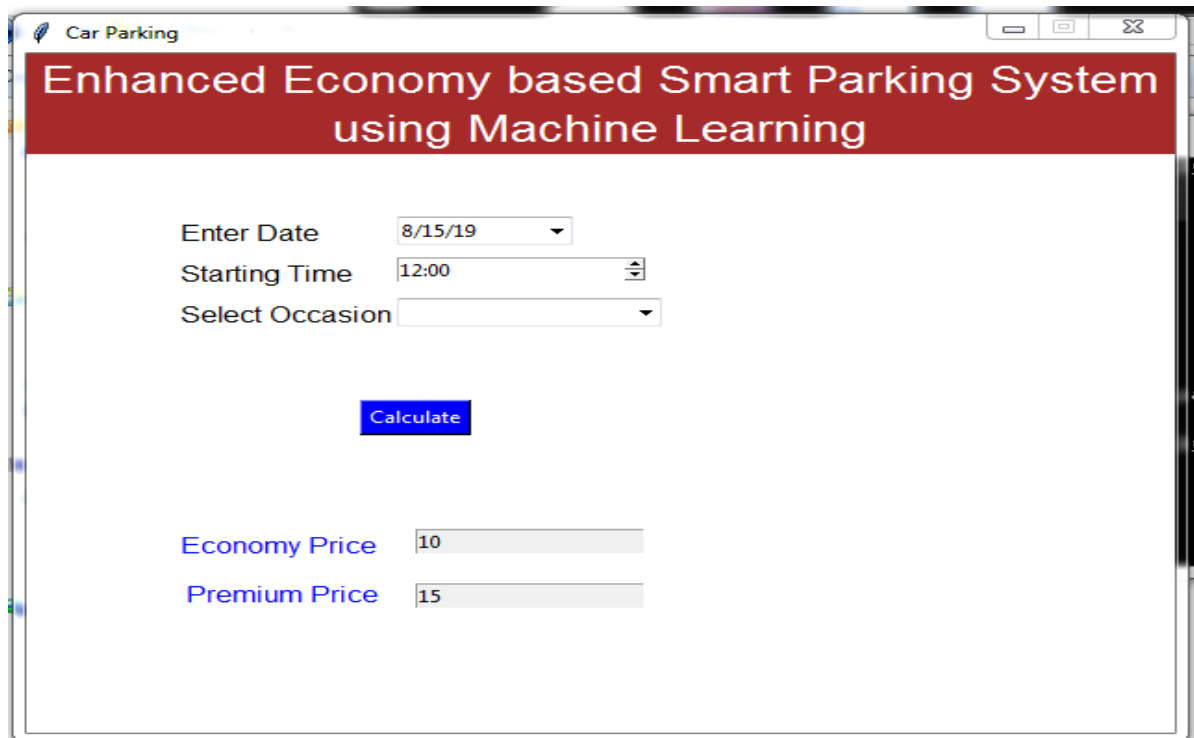
and date. It also described the effects of varied occasions like festivals or weekends and movie days on parking crowds. Based on this, the user can change the car parking charges dynamically according to their needs.



The screenshot shows a web browser window titled "Car Parking". The main heading is "Enhanced Economy based Smart Parking System using Machine Learning" in white text on a red background. Below the heading, there are three input fields: "Enter Date" with a dropdown menu showing "8/15/19", "Starting Time" with a dropdown menu showing "11:00", and "Select Occasion" with an empty dropdown menu. A blue button labeled "Calculate" is positioned below these fields.

Figure 22: Input Data

In Figure 22, the user can input the data like entry date, starting time and occasion and press the calculate button. It also predicts the prices of economy slots and premium slots date on specific date and time.



**Enhanced Economy based Smart Parking System using Machine Learning**

Enter Date: 8/15/19  
 Starting Time: 12:00  
 Select Occasion: [Dropdown]  
 Calculate  
 Economy Price: 10  
 Premium Price: 15

Figure 23: Normal day and time

In Figure 23, an example has been illustrated i.e. suppose the user chooses a specific day and time for car parking but doesn't choose any occasion on that day. The software will predict both the Economy slots price and premium slots price.

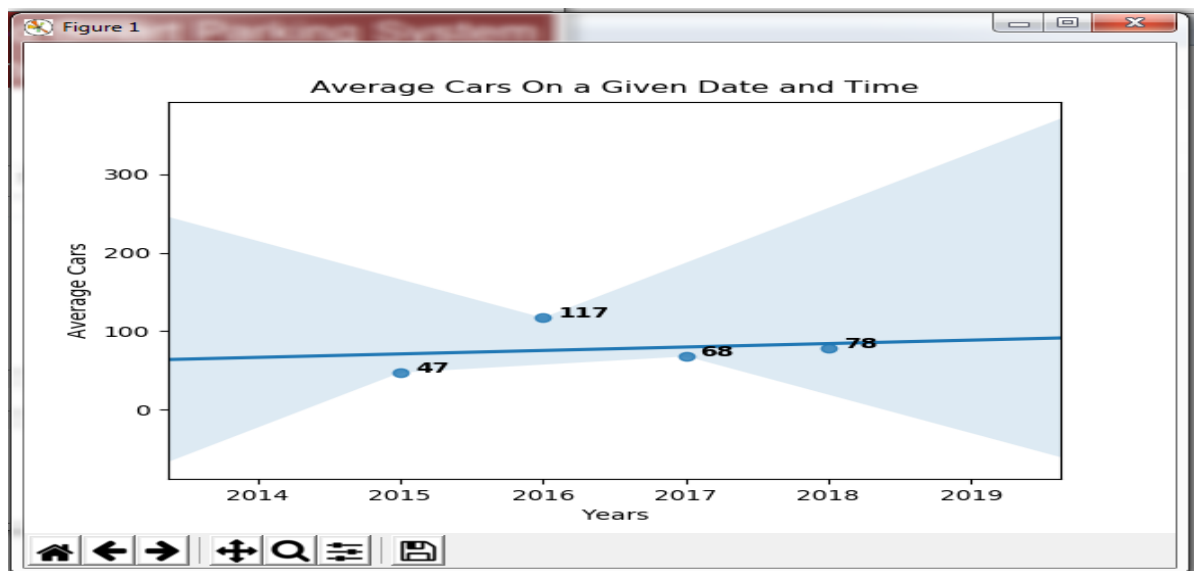
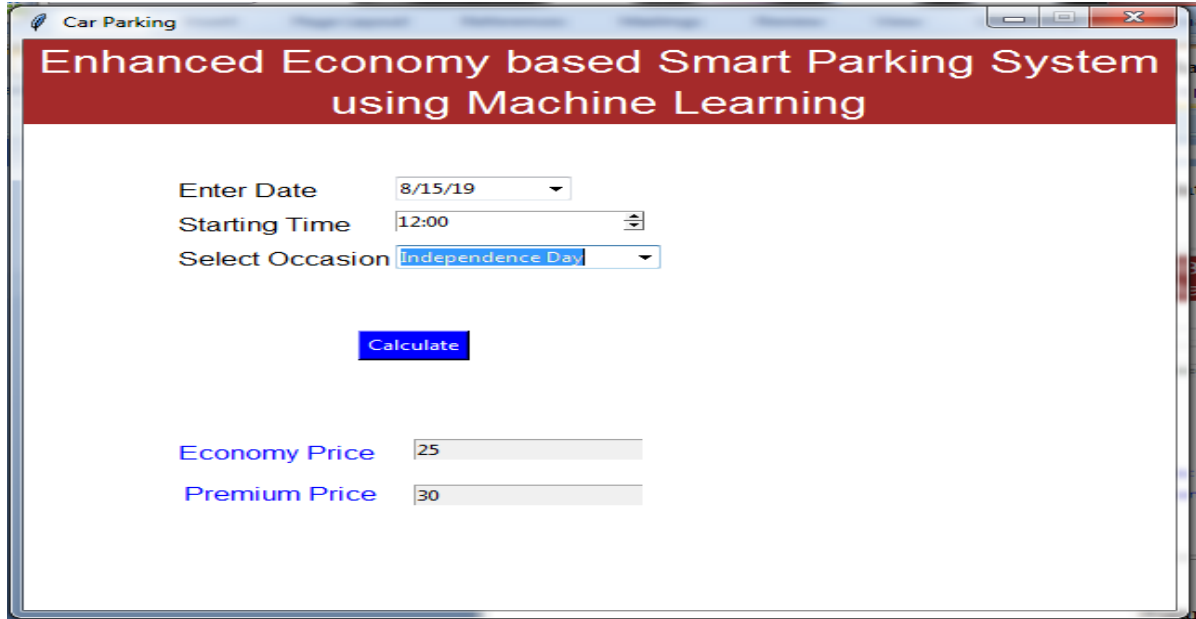


Figure 24: Linear Graph of Normal day and time

In Figure 24, the liner graph representation highlights the predicted average number of cars for a given date and time on normal day car parking.



Car Parking

## Enhanced Economy based Smart Parking System using Machine Learning

Enter Date: 8/15/19

Starting Time: 12:00

Select Occasion: Independence Day

**Calculate**

Economy Price: 25

Premium Price: 30

Figure 25: Occasions and non-peak time

In Figure 25, suppose the user chooses a specific day and non-peak time like 12:00 PM for car parking and also select occasion on that day. The prediction regarding the economy slots price and premium slots price are computed.

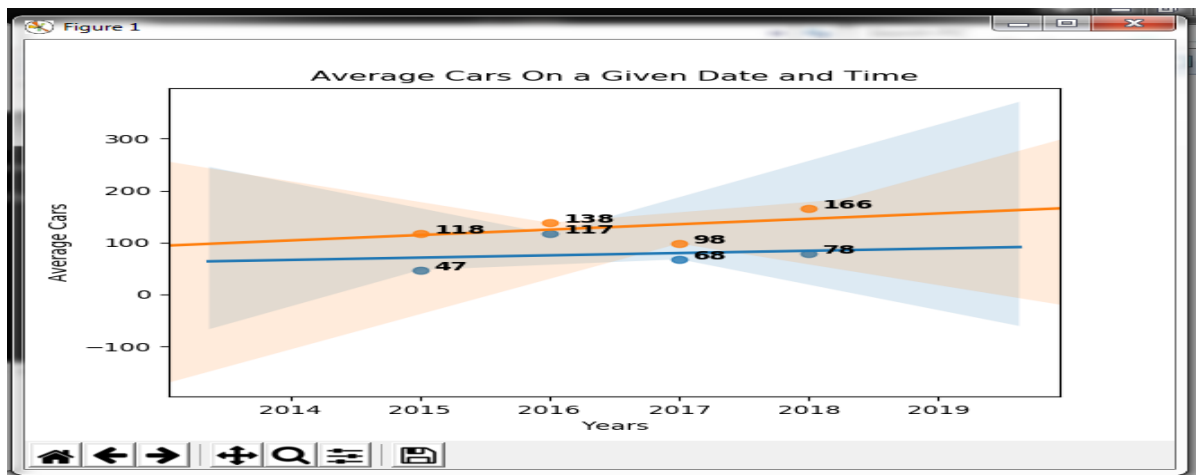


Figure 26: Linear Graph of Occasion and non-peak time

In Figure 26, the liner graph representations show the effect of occasions and non-peak-time on the parking crowds.

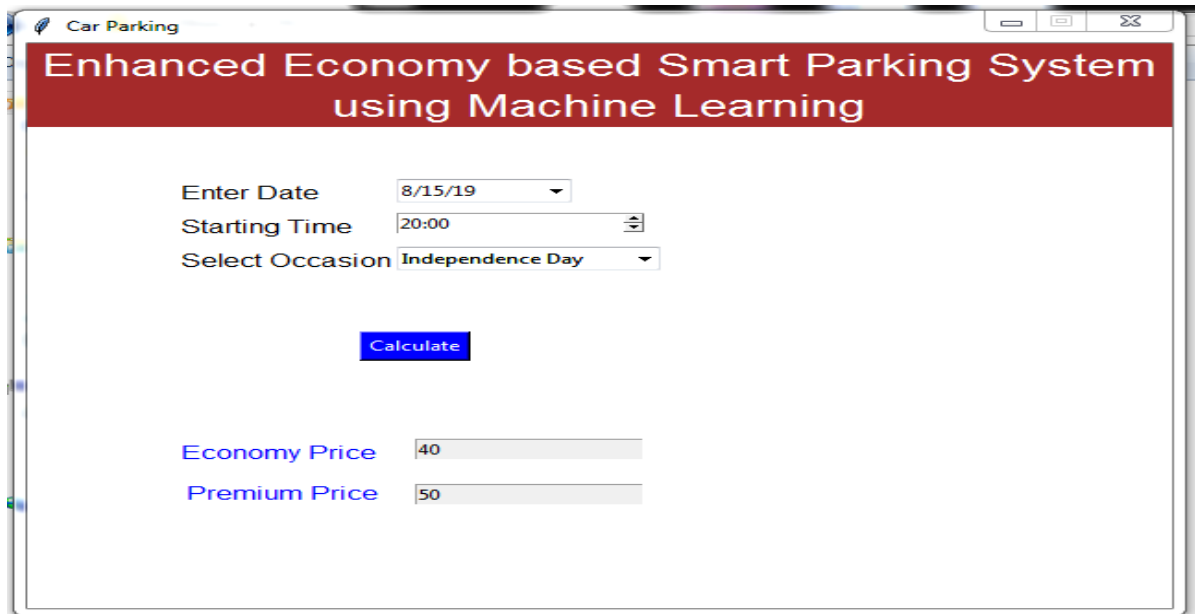


Figure 27: Occasion and peak time

Suppose the user chooses a specific day and peak time like 20:00 PM for car parking and also select occasion on that day. The prediction regarding the economy slots price and premium slots price has been demonstrated in Figure 27.

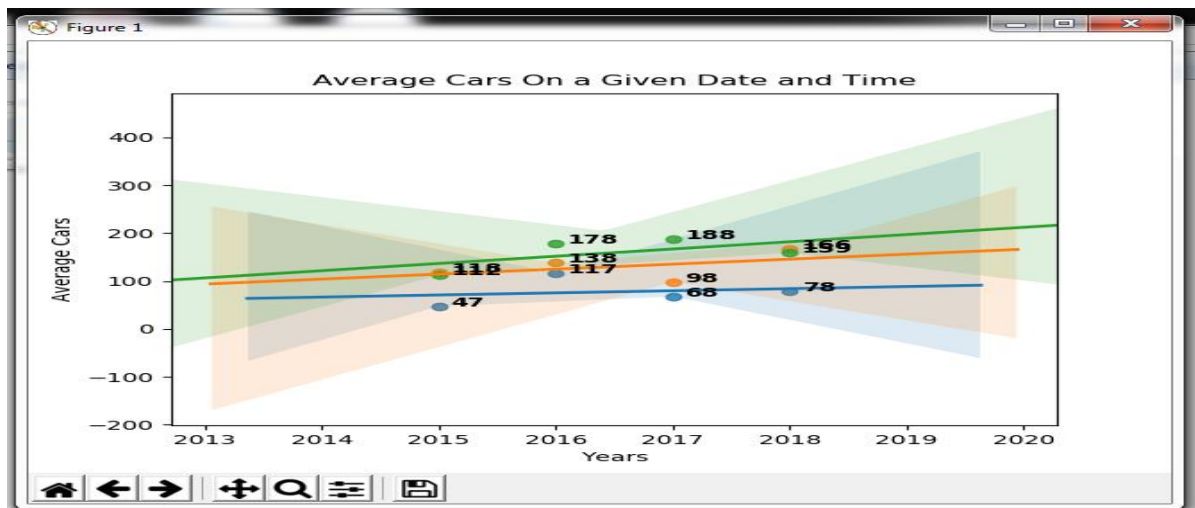


Figure 28: Linear Graph of Occasion and Peak time

In Figure 28, the liner graph representations show the effect of occasions and peak-time on the parking crowds.

## Chapter-6

### Conclusions and Future Scope

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#### 6.1 Conclusion

According to the literature survey, the existing smart parking system provides the features to the user to check the availability and booked parking slots through websites or android application. All the parking data was stored in the main server so that the user could easily get the updated status of car parking. Also the user could pay the parking charges online through debit card and credit card etc. Some of the researches in this area have used sensors to predict the current location of the car and parking area, and a picture message was sent to the customer to check if his vehicle was properly parked. One of the researchers has provided additional features of car parking, that is, theft management. If any theft vehicles entered in the parking gate the sensor checked the car plates and matched with the theft vehicle list from the database and if matched, then an alert message was sent to the police instantly.

This study has projected a smart parking system that enhances performance by saving users time much of the user's time was wasted for searching the parking space. The proposed study has easyfied the task of searching parking slots and predicts the pricing information about the selected parking lots, based on previous four years' data. In addition, the proposed system and its relevant methods have introduced dynamicity in the parking rates in accordance with festivals, rush hours and occasions throughout the year.

A multitude of advantages of the Economy based Smart Car Parking System has been elucidated in the present work. The major benefit of this work is to assist users to proceed on the right path leading to free parking space. As the end outcome users are made available with the closest parking location in the traffic situation, along with dynamic prices.

## **6.2 Future Scope**

The presented approach can be extended by adding following feature in the Smart Parking System

- i. More data from previous years can be collected, so as to predict more accurate results
- ii. Data attributes can be enhanced for its application to advance Machine Learning algorithms like multiple regression etc.
- iii. IoT application can be created by using advanced hardware and the same can be applied to large parking lots.

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