

**PAY AS YOU PARK SMART PARKING SOLUTION:  
VACANT PARKING SPACE DETECTION WITH  
IMAGE PROCESSING**

**2021-198**

**Project Proposal Report**

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Sri Lanka Institute of Information Technology

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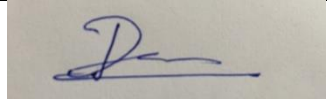
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## Declaration

We declare that this is our own work and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of our knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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The above candidates are carrying out research for the undergraduate Dissertation under my supervision.

Signature of the supervisor:

Date:

## **Abstract**

In the present days, people usually use private vehicles instead of public transport methods. Current Corona Virus Pandemic situation has become a huge reason behind this. Also ease of work, comfort and availability can be taken as few other reasons. A huge drawback while using private vehicle is finding an available parking space in a parking area. It leads to several personal and social-environmental problems such as consuming personal time, missing opportunities, getting late for occasion and ultimately burning fossil fuels for several minutes destroy personal money and releases huge number of toxic gases to the environment.

There are several methods to identify an available parking space currently in some parking areas. Currently there are solutions given by smart sensors, micro-controller units-based approaches and ultrasonic sensors. Those systems have accuracy related issues such as showing available when a vehicle is parked and vice -versa which makes the system unreliable and consume user's time and money.

In the present, most parking areas use surveillance camera for safety reasons. The proposed system gives the ability to use surveillance camera instead of IoT devices and smart sensors which saves cost and use existing resources.

This "Pay as You Park" smart parking system analyzes the parking areas using computer vision and send availability data of parking area to the next component to continue the process of making vehicle parking a hassle-free, efficient process while enhancing the user experience.

The user has the ability to find the nearest available parking space through mobile application and the owners of the parking slots have the ability to get currently available parking lot details through web portal. This system will save the time of the user and save opportunities and save the environment-pollution by reducing the fossil fuel burn.

Keywords: vacant car parking space, available car parking space, smart parking system

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## **LIST OF ABBREVIATIONS**

Abbreviation	Description
LDR	Light Detection Resistors



## **1 Introduction**

### **1.1 Background & Literature survey**

On the earlier days most of the car parking lots in Sri Lanka used their own car parking systems and above-mentioned systems provided services such as calculating the car parking fee, printing parking tickets and keep the parked vehicles' details such as parked time, vehicle number etc. But in the past 2 to 3 years there has been a rapid increase in using a smart parking solution instead of a ticketing system. With the launch of Shopping malls such as Colombo City Centre and One Galle Face, the Sri Lankan people could finally experience smart parking systems.

As PcMag explains on its website [4] a smart parking system is a system that supports vehicle drivers to find a free parking spot in a parking area by identifying a free parking spot using sensors.

Many researches have been conducted regarding smart parking solutions and integrating sensors [5][6] into parking slots and above-mentioned examples depicts how those sensors have been added to parking slots in Sri Lanka. These systems have proved that having a system makes the driver's experience better.

Even though it showed the number of available parking spaces inside the mall, some customers found out that those slots showed as available by the sensors were already in use.

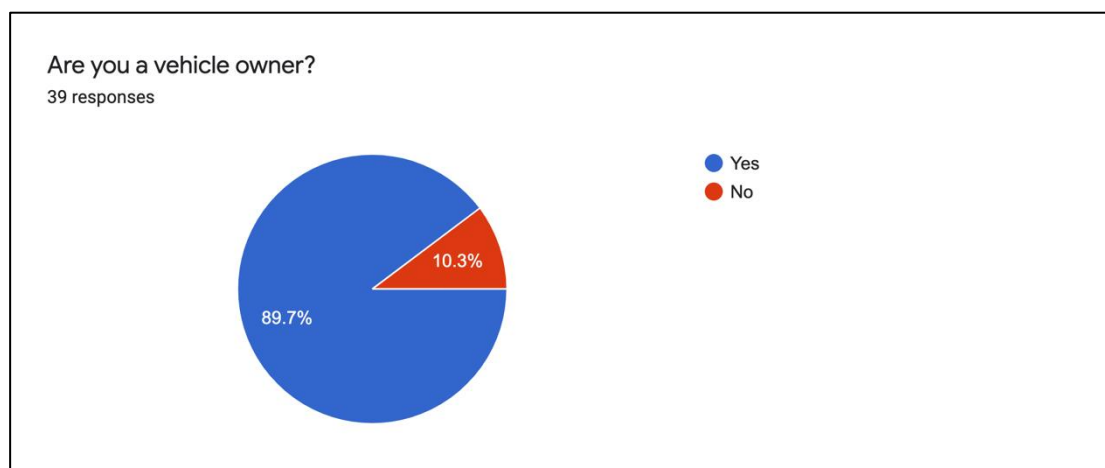
The currently used ultrasonic sensors, Arduino based systems, and Microcontroller based systems have the accuracy issues such as in bad weather conditions, animals or any other objects etc. [2][3]

These accuracy issues and not having a proper way to find a vacant space inside a parking space consumes valuable time of the drivers and burns a lot of money.

Figure 1.1 depicts that nowadays majority of the people own their private vehicles instead of using public transport methods such as Buses, Trains etc. The number of vehicles used in roads are increasing day by day and it is keep growing. [1]

Therefore this condition increas the needness of a proper car parking system which shows the vacant spaces to avoid the traffic and save the time of the consumer.

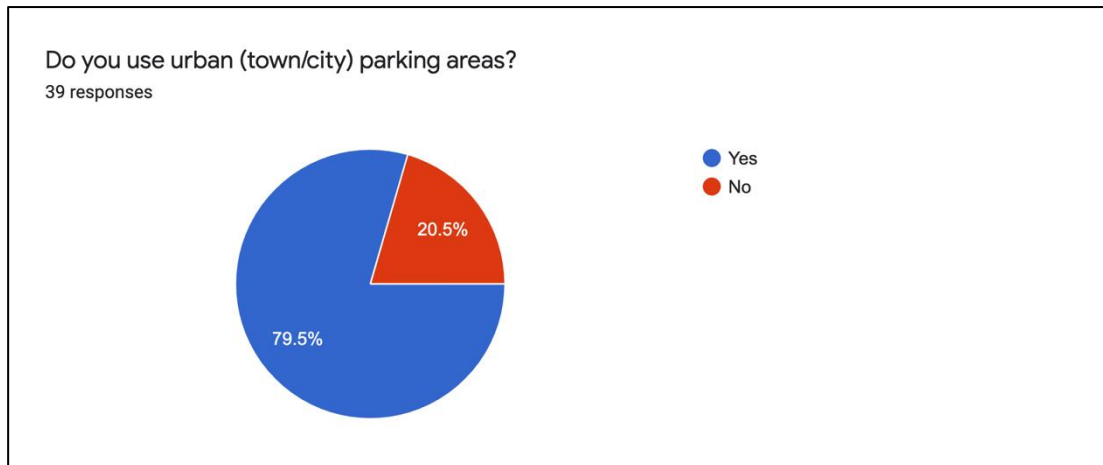
Researches done on this field have proved that number of vehicles in a public city has been hugely increased and due to this, drivers spend 30% of their driving time to park a vehicle.[2] Some researches done on this field have found that even drivers use an average time of 3.5 minutes to 14 minutes to find a free parking space.[3]



*Figure 1.1 Summary of Private vehicle survey*

*Figure 1.1 Summary of Private vehicle survey*

Figure 1.2 conveys that majority of the vehicle owners use urban parking spaces in their day to day lives. In order to satisfy their parking needs in time there should be a proper way to identify available (vacant) parking spaces at the real time because this data can be used to guide the drivers to use their time efficiently.



*Figure 1.2 Percentage of people who use urban parking spaces*

Considering the above-mentioned surveys and researches they prove that having a better solution than a sensor systems to identify the vacant car spaces in a car parking area and the “Pay as You Park” smart parking system using surveillance camera is the best option since surveillance cameras are already installed in parking areas therefore it manages upfront investments while giving the ideal data to the user. Even though there are sensors to identify the parking spaces due to inaccuracy it proves that it needs to be replaced by this solution. Also this gives the feature of getting exact slot’s details which are vacant and it helps to guide the customer to the particular available(vacant) slot through the mobile app.

## 1.2 Research Gap

Even though there are number of occasions sensors are being used in current system in Sri Lanka and researches have been conducted on sensors and micro controller-based solutions such as,

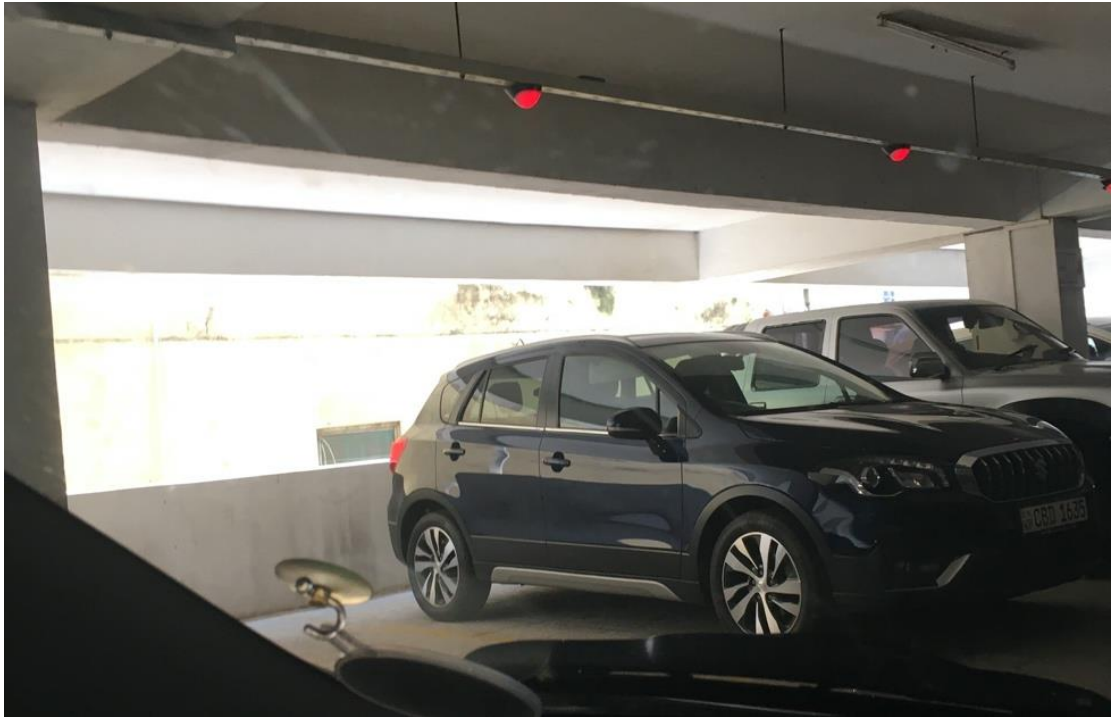
- Ultrasonic sensors
- Magnetometers
- Infrared Sensors
- LDR – Light Dependent Resistors.

Above-mentioned researches have been conducted on both locally and internationally [3][5][6][7][8] and current systems in Sri Lanka have drawbacks such as

- not suitability to open-outdoor parking slots
- object detection issues such as humans, animals and other objects are being identified as vehicles
- high power consumption of sensors

have been identified by the researches. [2][3]

In figure 1.3 displays an occasion where even though the parking space is vacant, the sensor detects it is in use at a situation where there is nothing visible in the space. This is a one example to the above-mentioned drawbacks of parking systems in Sri Lanka.



*Figure 1.3 A malfunctioning parking sensor at Liberty Plaza - Colombo 03*

Infrared Sensors – There are two types of Infrared sensors are being currently used in the systems. Active Infrared Sensors which identify the availability of a parking space detecting changes and Passive Infrared Sensors which identifies the vacant space by emitting an infrared energy and detects any object in front of it. These sensors are highly responsive to environmental changes such as rain and snow. These sensors are unreliable since they tend to responsive to objects such as a person or an animal too. Investment wise and maintenance wise cost is high since they need to be installed in a particular format in the parking slots on the ground or ceiling. Since these sensors are responsive to rain these are not suitable to outdoor parking slots in Sri Lanka where rains frequently.[2][3]

Ultrasonic Sensors – Ultra sonic sensors have the same principle of Infrared sensors, but the difference is ultrasonic sensors produces a sound wave between 25 and 50kHz instead of infrared energy. This type of sensors are low cost, but it takes a huge cost for the installation and maintenance. This type of sensors are also sensitive to environmental changes such as rain and snow. Therefore, mostly suitable for indoor parking systems in Sri Lanka.[2][3]

Light Dependent Resistor Sensors (LDR) – Light dependent resistors basically work on the shadow detection theory. When a vehicle is parked over a LDR sensor, it blocks the light source towards the sensor and identifies it as a shadow. When the parking slot is vacant the sensor is exposed to light source and identifies it as a vacant slot. LDRs detect availability of an object using luminosity directed towards the sensor. Natural light conditions differ from morning time to evening, in natural events like rain etc. Also, in the nighttime some parking slots lack good lighting conditions to work these sensors. Therefore, these sensors are not suitable for outdoor usages and indoor usages where lighting condition are insufficient.[8] Economical wise these sensors are simple to use and integrate.

Magnetometers - This kind of sensors identifies the availability of a parking space using change in electromagnetic field. These sensors need to be placed near to the vehicle therefor they are installed under the earth for best results. They are not affected by environmental conditions, therefor suitable for both indoor and outdoor usages. The major drawback of a managing this system is the cost related to install and maintain these sensors on a large scale.

Pay as You Park : Image Processing – Image processing is a technique used for analyzing, enhance, compress and reconstruct images.[9] This technology takes an image as the input and processes it with computational algorithms and outputs

desired data. In the proposed “Pay as You Park” system it uses surveillance cameras currently being used in parking lots to identify vacant spaces inside it. Due to the use of existing CCTV (surveillance) cameras instead of using a brand-new system it saves upfront investment of the car park owner and even if it needs to install CCTV cameras in case of not having a CCTV camera system, it increases the car owner’s safety and experience of the car park. Nowadays most of the Car parking lots use surveillance cameras for the safety purposes.

Table 1.1 compares currently available sensor-based systems with the proposed Image processing-based system in Sri Lanka.

Sensor Type	Accuracy	Suitable for bad weather conditions	Investment and maintenance cost	Suitable for indoor parking	Suitable for outdoor parking
<b>Passive Infrared</b>	Poor	No	High	Yes	No
<b>Active Infrared</b>	Poor	No	High	Yes	No
<b>Ultrasonic</b>	Moderate	No	High	Yes	No
<b>LDR</b>	Poor	No	Low	Yes	No
<b>Magnetometer</b>	Moderate	Yes	High	Yes	Yes
<b>Pay as You Go: Image Processing</b>	High	Yes	Low	Yes	Yes

*Table 1.1 Comparing current system with Pay as You Go System*

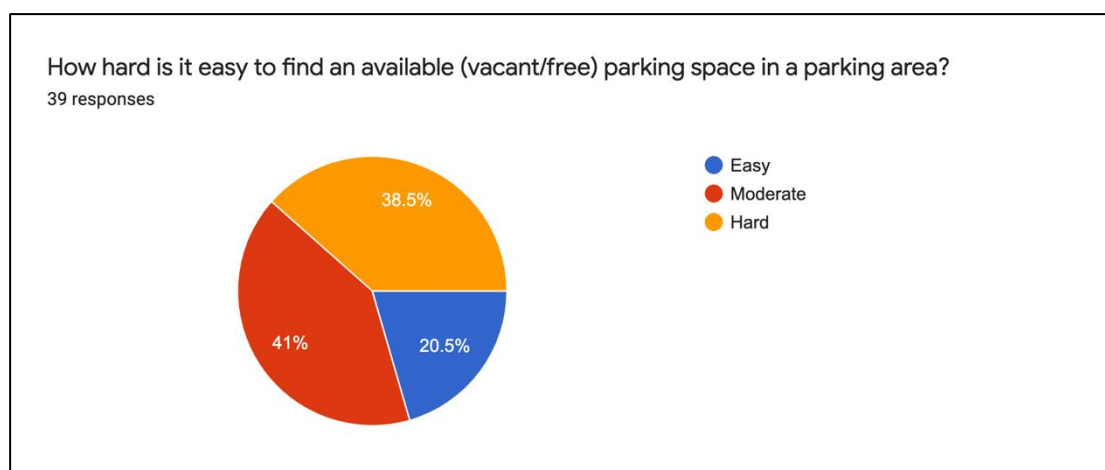
This proposed “Pay as You Park” smart parking system overcomes all of the above-mentioned drawbacks and gives a better experience for the user by saving time and money. Also since a single CCTV camera can cover a wide area it saves the cost of having single sensor per single parking space and this increases the maintainability of the system. The vacant spaces and used spaces data will be sent to the next component to guide the user to the particular parking spot.

### 1.3 Research Problem

In the present days, an urban area has a huge number of vehicles incoming and outgoing per day. The number of vehicles in a city has been increased hugely over fast few decades, which leads to increase of traffic in urban areas. The number of vehicles has been increased by over 50%. Nowadays sub-urban and rural areas also have huge traffic rates. [1][2][3]

One of the most important things a private vehicle owner need is to find a parking space to park his/her car in order to satisfy his/her needs. According to researches an average time around of 3.5 to 14 minutes to find a free parking space which make stressful events to drivers such as accident and even sometime missing the opportunity to attend to an occasion and even business opportunities. [3]

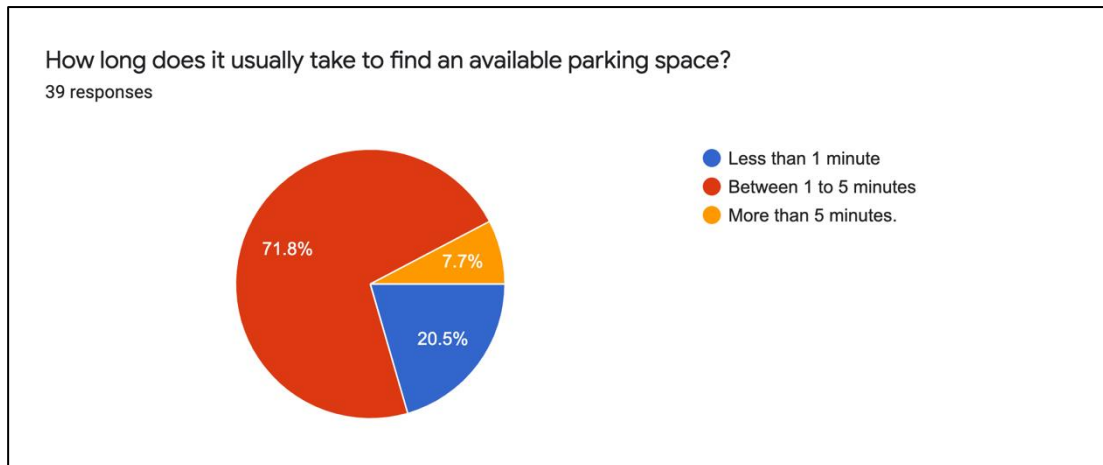
Currently in Sri Lanka any parking system does not provide the feature to find exact parking slots which are vacant and though some systems display available slots on the ceiling due to their inaccuracy sometimes the drivers have to go cycles of rounds to park the vehicle. Even some car parks do not allow drivers to drive back their vehicle in the reverse.



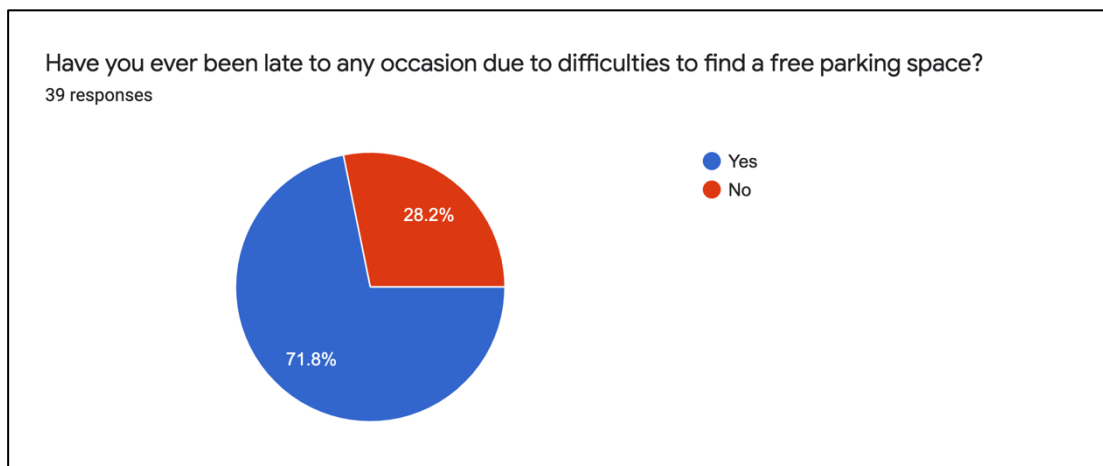
*Figure 1.4 Summary response of hardness to find a free parking spot*



Due to above-mentioned problems the drivers have to drive an average time 1 to 5 minutes to find a parking spot. This behavior sometimes makes the users of car park (drivers) late to some special occasions. And also, this process burns a lot of fossil fuels which lead to economic and environmental issues.



*Figure 1.5 summary response of average time take to park a vehicle*



*Figure 1.6 summary response of getting late to occasion due to parking difficulties*

Pay as You Park smart parking system will solve problems of finding a parking spot and give the user of the car park, the best user experience through the mobile application and will save the time while enhancing user experience.

## 2 Objectives

The main objective of the Pay as You Park mobile app is to give user a subscription model instead of traditional hourly based parking ticket systems. There will be several time subscriptions packages available to customers to choose. For an example there will be 100-minute subscription package as the basic subscription. If the user subscribed to 100-minute package the user will be able to use that 100 minutes of parking time at any parking lot registered to Pay as you park system. The current system has a problem of calculating the fee for an hour even though if the users parked their car for few minutes little as 5 minutes. In such situation Pay as You Park customer will get a deduct from their subscription for that exact time period. In here if the customer was subscribed to 100-minute and if the same customer parked his/her vehicle for 5 minutes, on his/her account 95 minutes will be remained after 5 minutes been deducted.

Apart from time-based parking fee calculation, Pay as You Park gives the ability to find the vacant parking slot in desired place conveniently. The app contains number of features in order to fulfill customer's needs. Services such as finding the available parking slots of a parking lot, finding the nearest parking lot, navigate to the nearest vacant parking slot, and if the needed lot is full app suggests the nearest lot and etc.

### 2.1 Specific Objective

- Find vacant space of parking slots

To identify the vacant spaces inside a car parking slot this system uses footages of CCTV (surveillance) cameras and process the footages using an image processing algorithm. The availability data of the parking lots of a parking slot will be sent as a REST API in order to continue the process of guiding the driver to the dedicated parking lot.

### **3 Methodology**

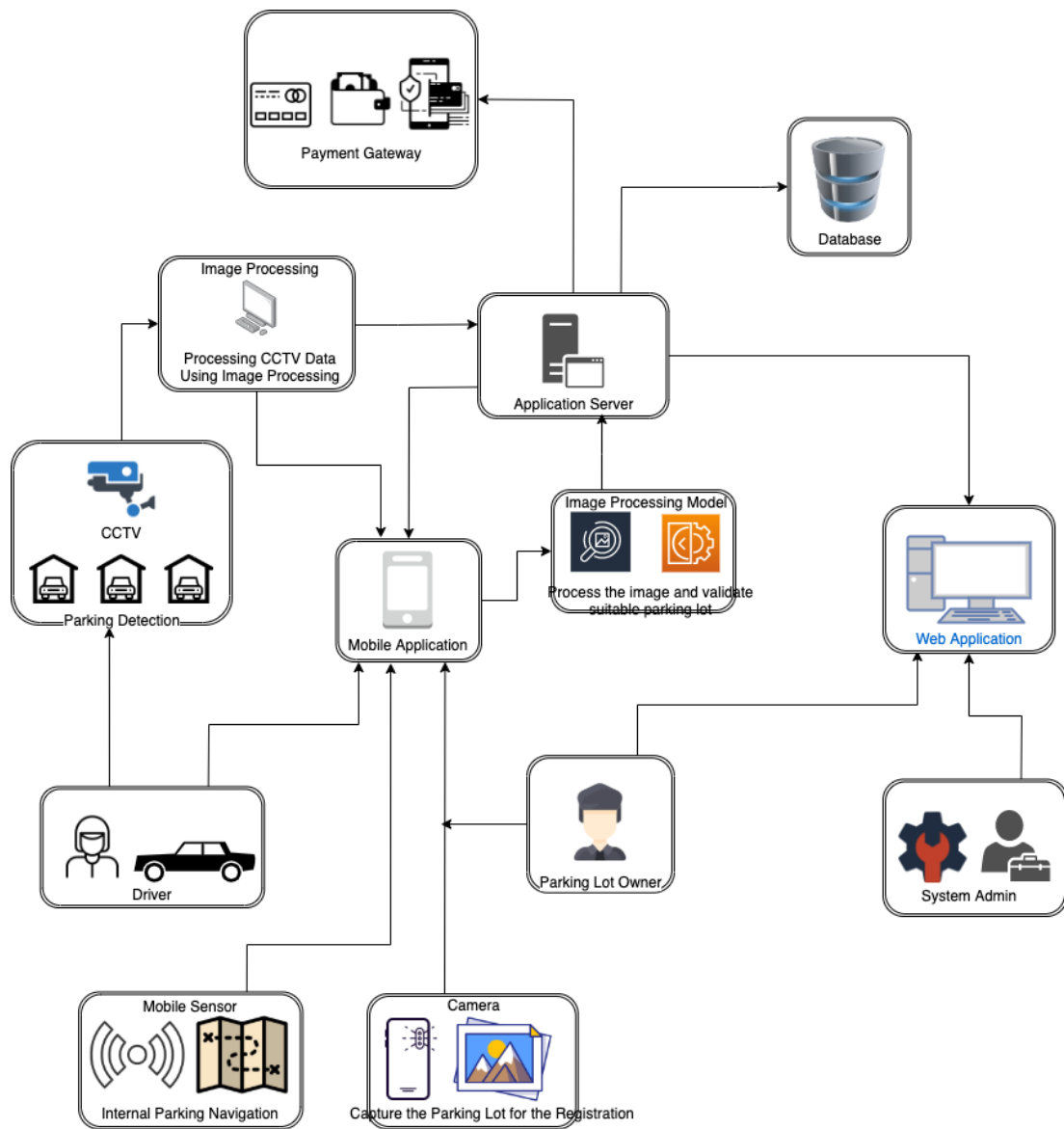
The proposed Pay as You Park system's vacant parking space detection will do the following tasks to perform the system's basic objective.

- Identify the vacant parking slots using Image Processing Algorithm
- Smoothening the shadow/ Noise Filtering using Gaussian Blurring, Median Filtering
- Number of vehicles detection
- Identify used parking slots
- Update the database of parking lots' current status in real time.

In this proposed system, an image processing algorithm will be used to identify whether a vehicle is being parked in a parking slot or not. [10][11] This will update cloud-based data base in order to display to the users about availability of the parking slots in a parking lot.

A survey has been done to confirm the coverage of car parking slots by CCTV cameras. Car parks cover all the parking slots in order to give safety to vehicles.

### 3.1 System Architecture



*Figure 3.1 High Level System Architectural Diagram*

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