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Research Article

Real-Time Monitoring Of Parking Lot Space Detection

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ABSTRACT

The project aimed to develop and implement a "Real Time Monitoring of Parking Lot Space Detection". It presents a pioneering approach by integrating computer vision and machine learning techniques to analyze the High-Quality
Camera to classify parking spaces as "occupied" or "vacant". The impact of this Parking Lot Space Detection system extends beyond the convenience of finding available parking spaces. It offers several advantages, such as reducing the time and frustration associated with parking, optimizing space utilization, improving traffic flow within parking lots, and ultimately contributing to reduced congestion and environmental benefits.

Keywords—Parking Lot Space Occupancy, Real-Time Monitoring, High-Quality Camera, Machine Learning, Image Processing.

I. INTRODUCTION

Background of the Study

Parking is an essential way to the modern transportation system, and it increasingly challenging day by day in urban areas. With the growing population and increasing private vehicles, parking has more becoming a serious problem, leading to traffic congestion and traffic issues. Therefore, looking for parking space always waste travelling time that will cause irritation to the drivers. (H Ibrahim & Hossam Eldin, 2017).

Public parking lots should be responsible for the information of the availability of the parking space. However, manually checking or maintenance of parking lot space needs a lot of human power or resources. Real-Time Monitoring of Parking Lot Space Detection has been good in a way that will monitor, maintenance and, give information to the drivers over the time. Additionally, it is essential to ensure that parking is optimally utilized. (Kieu-Ha P. et al., 2022).

The proposed system will use USB Web Camera vision techniques to detect and monitor the availability of parking spaces in real-time. It will also provide information to drivers about the availability of parking spaces, thereby reducing the time and effort required to search for a parking spot. Additionally, it will help parking lot managers to optimize the utilization of parking space, leading to better revenue generation.

The manual methods used by the current parking management systems lead to poor parking space allocation accuracy, protracted wait times, and the inability to track parking lot occupancy in real time. Inefficient use of parking facilities is a prevalent issue. Misaligned or oversized vehicles, improper parking, and the lack of real-time occupancy data lead to wasted parking space, which could otherwise accommodate additional vehicles. Also, the inability of conventional parking management systems to allocate parking spaces efficiently contributes to traffic jams, increased pollution, and aggravation for drivers.

To address this issue, the proposed real-time monitoring of parking lot space detection system aims to address these challenges by utilizing advanced cameras to provide an information about the availability of space its either vacant or occupied. Use the enter key to start a new paragraph. The appropriate spacing and indent are automatically applied.

A. Objectives of the Study

Generally, this study aims to create, design, and develop the study entitled "Real-Time Monitoring of Parking Lot Space Detection". This system would provide an information about the availability of parking lot space its either vacant or occupied.

Specifically, this study aims to:
- To develop a system that will monitor the parking lot space in real-time.
- To develop a system that will optimize the poor parking space allocation.
- To develop a system that reduce the queuing.

B. Significance of the Study
The significance of the real-time monitoring of parking lot space detection system lies in its potential to provide an efficient and effective parking management solution. Traditional parking management systems face various challenges, including inaccurate parking space allocation, long waiting times, and the inability to monitor parking lot occupancy in real-time. These challenges can lead to traffic congestion, pollution, and driver inconvenience.

In this project, the beneficiaries are including;
Drivers- The system will benefit the drivers by providing realtime information on available parking spaces.

KCC Mall of Marbel- The system will benefit the establishment by optimizing the space parking lot allocation.

To the researcher- The system will help the researcher to develop their skills, practical experience that surely usable for them in future.

To the future researcher- This study would probably help them to analyze another problem and to become foundation for their references.

C. Scope and Limitation
The scope of the study will aim to develop a real-time monitoring system for space detection that can provide an accurate information to drivers and parking lot operators. It includes the implementation of space detection using only USB web cameras, integration of the OpenCV that provides algorithm with a web-based system for real-time monitoring. The system will perform includes detection accuracy, realtime information and user-friendly interface design to be simple and accessible so anyone can use it.

The limitation of the project is the system capabilities which includes the dependency of the system into USB web camera in parking lot. Also, the accuracy of the parking space detection is dependent on the quality of the USB web camera and their positioning that can affect the system performance. Scalability issues, regulatory considerations, and the need for user compliance highlight the multifaceted challenges of realtime parking detection monitoring. Recognizing and addressing these limitations is essential for the nuanced and successful deployment of such systems in parking management scenarios. Also the range of the camera to monitor is based on the high-quality camera that is being used.

II. THEORETICAL FRAMEWORKS

A. Review of Related Literature
Parking Lot Occupancy Monitoring
According to Ding and Yang (2019), parking lots are becoming more prevalent along with the growth of automobiles. The condition of various spots is assessed in many parking lots using ground sensors. Ultrasonic, geomagnetic, and infrared ray are the three main technologies used in conventional parking space detection. Particularly in parking lots with a lot of accessible space, this necessitates the installation and upkeep of sensors in each parking place, which might be costly. Despite having a better degree of precision, this procedure is costly. In order to cut costs, this research suggests an object detection model based on YOLO v3 that can increase detection accuracy and accomplish realtime detection without sacrificing detection speed.The limitation of the project is the system capabilities which includes the dependency of the system into USB web camera in parking lot. Also, the accuracy of the parking space detection is dependent on the quality of the USB web camera and their positioning that can affect the system performance. Scalability issues, regulatory considerations, and the need for user compliance highlight the multifaceted challenges of realtime parking detection monitoring. Recognizing and addressing these limitations is essential for the nuanced and successful deployment of such systems in parking management scenarios. Also the range of the camera to monitor is based on the high-quality camera that is being used.
According to Espejel-GarciÁ (2021) parking automation has been developed for locating available parking spaces inside a parking lot with new technologies such as automatic collection, capacity or empty spaces` detection; to both reduce search and time and avoid crowd of vehicles waiting to park in it.
Saif (2021) cited that Detection of vacant parking space is becoming a challenging task gradually. Space utilization and management of vehicle space is now a demandable field of research. Searching for an empty parking space in congested traffic is a time-consuming process. The existing vacant parking space detection methods are not robust or generalized for images captured from different camera viewpoints. Finding a proper

parking space in a busy city is really a challenging issue and people are facing this problem on a daily basis. The main purpose of this research is to comprehensively discuss the previous researches of vacant parking space detection and compare them from different aspects. Methods used in previous researches are descriptively discussed along with their advantages and disadvantages. The frameworks of previous researches were compared on six generalized phases and the experimental results are compared in terms of dataset, accuracy, processing time and other performance measures. This research also focuses on the challenges of vision-based vacant parking space detection which will contribute to future researches and researchers can work to overcome these challenges.

Real-Time Parking Lot Space Detection

According to De Heaver (2020), as the number of vehicles continues to grow, parking spaces are a premium in city streets. In addition, due to the lack of knowledge about street parking spaces, heuristic circling in the streets not only costs drivers' time and fuel, but also increases city congestion. In the wake of the recent trend to build convenient, green and energy-efficient smart cities, common techniques adopted by high-profile smart parking systems are reviewed, and the performance of the various approaches are compared. A mobile sensing unit has been developed as an alternative to the fixed sensor approach. It is mounted on the passenger side of a car to measure the distance from the vehicle to the nearest roadside obstacle. By extracting parked vehicles' features from the collected trace, a supervised learning algorithm has been developed to estimate roadside parking occupancy. Multiple road tests were conducted around Wheatley (Oxford shire) and Guildford (Surrey) in the UK. In the case of accurate GPS readings, enhanced by a map matching technique, the accuracy of the system is above 90%. A
quantity estimation model is derived to calculate the required number of sensing units to cover urban streets. The estimation is quantitatively compared to a fixed sensor solution. The results show that the mobile sensing approach can perform at the same level as fixed sensor solutions under certain conditions and substantially fewer sensors are needed compared to the fixed sensor system.
The aim of OpenCV is to help the computer to manipulate the content of an image and do some specific tasks over it. OpenCV is a library of programming functions mainly used for image processing. We can solve many real time problems using image processing applications. The rise in the field of OpenCV makes way for many new inventions. In this paper, we can implement this concept to track whether the parking space is occupied or not using OpenCV to detect vehicles. Detection of those vehicles is mainly based on motion detection, Whereas the module is implemented in Raspberry Pi single board computer to achieve IoT automation. It regularly tracks the parking space and compares with the empty parking lot coordinate image. If any free space available it will be automatically sent to the remote database, which is then retrieved by the user while accessing the website or mobile app and finding the available spaces (Journal, 2021)

The commute to a school or office campus, a driver often must spend time circling a parking lot in the hopes of a free space. This increases the traffic in busy locations, such as densely populated neighborhoods or universities. In this paper we detail our attempts decrease the search times of drivers by allowing them to view where available parking spaces are located. Our system processes live images from a web connected camera and determines if a vehicle is currently stationed in each individual space of a parking lot. The results of this program are then relayed to the user in a multi- platform mobile application. Our goal is to produce a system that could constantly and accurately monitor a series of parking lots to determine the availability of parking spaces on a university campus. This research project was the result of various students at Midwestern State University. The genesis of our project began after students complained about the amount of time it took them to find a suitable parking location on campus. In the Fall of 2017, two students agreed to take on the challenge of identifying available parking using image processing. After a literature review, the group saw that using digital image processing was an established problem with various approaches (Enem, 2023) According to Kurkute, et al., (2019) every day thousands of drivers spends a lot of time to find where to park the vehicle. The result of this situation increasing traffic problems and traffic congestion. In order to solve this problem, the implementation of Smart Parking: Parking Occupancy Monitoring and visualization System in the city for managing parking places is mandatory. Smart parking is so important in every smart city. It will allow the drivers to Reserve a parking place on the Platform of Smart Park. The proposed Smart Parking system consists of an on-site deployment module that is used to monitor and signalize the state of availability of each single parking space. A web application is provided that allows an end user to check the availability of parking space and book a parking slot accordingly. It will also allow to rent our area for parking purpose. The paper also describes a high-level view of the system architecture. Towards the end, the paper discusses the working of the system. According to International Journal of Scientific Research in Science, Engineering and Technology IJSRSET, (2021), the planned system known as automobile parking space Detection victimization Image process. This method proposes a technique of detecting the existence of position vehicles by process the image of the car parking zone taken by a police work camera and then count the accessible auto mobile parking space that is show in front of entrance of car parking zone. The system employs pictures, since all space within the car parking zone will be discovered with relatively few cameras. Aside from that, the system is compact, and therefore the price isn't pricey. The image of a parking lot is taken by a policework camera set at some height within the car parking zone.

CCTV Camera

Closed Circuit Television i.e., CCTV are widely for security purposes getting the opportunity to be useful with time. Human face identification is one of major interests for this technology. In this paper, Human face is detection method is proposed with better accuracy and speed. This method can find wide use in this technological era as biometric identification is one of the best methods of verification. In the proposed method divulgence of different facial parts, such as, Nose, Eyes & Mouth could be done effectively and rapidly, without being concerned of the light or illumination in the background of the person. For this we have used Ada Boost Algorithm through which quick and precise results have obtained that are far better than that of previous methods. The results present critical improvement utilizing introduced technique over different past systems. It might be visible that proposed procedure is staggeringly able with basic spurring power in observation usage. This method finds its extensive Human face detection capabilities for security purposes in identifying the person among the group of living or non-living objects (Kushwaha, 2021).

According to Suganya, et al., (2018) CCTV (Closed Circuit Television) or video surveillance is a useful technology that is mainly used for security purposes. It can be found at many places from public to private locations. The video footage captured by the cameras are stored in secondary devices like pen drives, hard disk drives. The most challenging problem in CCTV camera is storage space occupied by the footage. Because each day, the camera captured a large amount of data and stored it. But some of these data may be useless when there is no activity is performed. Hence compression techniques are used to reduce the storage space. We are proposing an idea to optimize the storage space by reducing the redundant frames. By using MSE (mean squared error) the adjacent frames are compared and the redundant frames are deleted between the adjacent frames of the video.

CCTV or Closed-Circuit Television is a tool that can help improve the security system and minimize theft both in private homes and public places. But not all CCTVs are equipped with drive motors in all directions and can be used to monitor at an angle that is difficult to reach by CCTV. So that it can minimize the use of the number of CCTVs used to reach every difficult angle seen by CCTV. In this study a simulation tool was designed that combines CCTV with Arduino UNO circuits, Joysticks, Servo Motors, DC Motors, and Relays so that CCTV can move vertically and horizontally. With the development of this simulation system, it is hoped that it can more efficiently cost the cost of moving CCTV, with a webcam monitoring system and controlled movement through the joystick. And with this simulation can be an alternative to CCTV systems (Lestari, 2019).

Finding a parking space that is open is a challenge for many automobile owners. Particularly during rush hours, it may quickly cause parking lot congestion as drivers get stranded and unsure of where to leave their vehicles. The majority of the time, vacant parking spaces are present, but the drivers are unaware of them. The free parking spot can be far away from them or hidden by other vehicles or things. Sometimes those in charge of managing parking lots may not have a clear view of the next parking place. Another motorist may arrive while the driver is circling the parking lot looking for an open spot, resulting in several losses including gasoline, time, and temper. (Nyambal, 2018)

According to Farley et al. (2021), the rising demand for parking space is causing problems in cities all around the world. Everyone who had a vehicle had to deal with this issue at some point. In adsdition to this problem, obtaining parking spaces in Indonesia's major cities was extremely tough. Office buildings and retail complexes with department stores are two common places where the problem can be bothersome.

In recent years, parking has become a serious problem due to the increasing number of private vehicles. Unsupervised parking lots detection has been employed in many systems for counting the number of parking space, identifying the location, and monitoring the changes of space status over the time. Recent researches have been done on improving parking lots detection systems, but these methods require high computation and large storage. This paper presents a novel method via using only a few frames captured by a single camera for unsupervised parking lots space detection. To obtain high detection accuracy under these critical conditions, we train and recognized from the video frame by machine learning methods, instead of segmenting them directly to find out the available space. Our goal is to build a highly accurate automatic detection system which is stable and economic for industry application (Qi Wu and Yi Zhang 2019)

The parking problem, which is caused by a low parking space utilization ratio, has always plagued drivers. The study of Wang et. al.(2022), proposed an intelligent detection method based on deep learning technology. First, they constructed a TensorFlow deep learning platform for detecting vehicles. Second, the optimal time interval for extracting video stream images was determined in accordance with the judgment time for finding a parking space and the length of time taken by a vehicle from arrival to departure. Finally, the parking space order and number were obtained in accordance with the data layering method and the TimSort algorithm, and parking space vacancy was judged via the indirect Monte Carlo method. To improve the detection accuracy between vehicles and parking spaces, the distance between the vehicles in the training dataset was greater than that of the vehicles observed during detection. A case study verified the reliability of the parking space order and number and the judgment of parking space vacancies.

Saini (2021) asserts that a significant challenge in major cities is obtaining a parking spot for a car. An imbalance between supply and demand for parking has been brought about by the growth in automobile ownership. The current state of affairs makes it necessary for all big cities to have a parking management system that can track parking spaces. Scalable, effective, dependable, and reasonably priced are all

requirements for the system. Deep learning-powered computer vision algorithms have made significant strides in recent years, and their performance in a number of applications has been highly encouraging. To solve the issue of parking spot detection, similar methods can be utilized.
Xu and Hu (2020) study the detection of parking slot based on vehicle sensors. At present, the commonly used automatic parking slot detection methods are mainly based on ultrasonic radar sensors and vision sensors. The ultrasonic radar method uses the ultrasonic radar installed around the vehicle to identify the parking slot using the principle of ultrasonic reflection. The vision-based parking slot recognition method uses the camera installed around the car body, and uses image processing method to identify parking slot. Among the methods of parking slot detection based on vision, the commonly used methods are based on pattern recognition machine learning and traditional neural network. However, due to its single structure, the limited extracted feature information led to sensitive to environmental changes, so the recognition rate is generally low and the generalization ability is weak in complex environment.

A study of Acharya, et..al (2020) stated that people spend on average 7.8 minutes in cruising for a parking spot, which accounts for 30% of the traffic flows in cities. To alleviate this issue and save time and effort, PGI systems (Chen and Chang, 2011) have been developed. PGI systems require accurate and up-to-date information on the occupancy of parking spaces to provide reliable guidance to vacant spots. Advantages of using camera-based PGI systems are threefold: no requirement for additional infrastructure, exact location of vacant parking spaces, and highly applicable to on-street and residential parking spaces. Image-based parking occupancy detection involves the detection of vehicle objects in parking spaces, but the drawback of using hand-crafted features is the limited ability of such features to adapt to variations of the object.

Deep CNNs have been shown to yield remarkable performance in a variety of image recognition and object detection tasks. This research proposes a transfer learning approach to parking occupancy detection using visual features extracted by a deep CNN directly. A detailed accuracy analysis is performed to identify the parameters that affect the accuracy of the framework, and results indicate the potential of the method in terms of accurate transfer learning and robustness. The developed framework is suitable for realtime applications with a simple desktop computer and can operate out-of-the-box, providing a reliable solution to the PGI systems for outdoor and on-street parking occupancy determination at no additional cost.

A research study of Grodi R., et.al (2016) presented a prototype of a smart parking system using wireless sensor technology and networks. Using a Wireless Sensor Network (WSN), parking spot statuses (occupied or idle) are detected and transmitted to a database, which can be accessed by users through a website or mobile app. The system should provide users with near instantaneous updates of available parking spots while the WSN allows for flexibility of sensor placement. With the successful implementation of smart parking, the economical and time costs associated with traffic jams, cost associated with wasted gas fuel, and time looking for an empty parking space will be significantly reduced.
The increasing number of automobiles on the road every day is making parking a severe issue. Finding a parking spot can be difficult, especially in densely populated areas or locations where sporting or cultural activities are scheduled. Some parking lots have installed sensors to measure capacity and notify drivers when spaces are full in order to tackle this issue. These sensors detect when a car enters or exits a parking lot. This is a partial solution that enables vehicles to find out if a parking lot has available parking places, but not where those spots are located specifically (Grodi R., et.al, 2016).

Both the public and private sectors have difficulties when planning and maintaining parking spots. Many of these problems are brought on by the inability to build additional parking lots as quickly as the populace adopts new automobiles. Technology advancements in the sensing and machine vision sectors enable us to develop systems that provide features that are hard to carry out with little human assistance in big parking operations. Real-time parking spot occupancy monitoring is a prime example of this kind of capability. The creation of a system to track parking spot occupancy is the goal of this effort. An IoT platform will be utilized in conjunction with computer vision-related technologies to accomplish this purpose. Varied scenarios with varied illumination intensities were used to validate the technology. Even in situations where there was little ambient light, the results are highly encouraging (Giampoli L & Hessel F., 2021)

With increasing the number of vehicles over the years, parking has become an important issue particularly in commercial environments such as shopping malls, schools, government offices, and airports. Finding a vacant parking space in town areas is time-consuming and therefore not satisfying for potential visitors or customers. In this article, a low-cost video-based system is proposed for parking space detection. A CCTV feed is used in combination with a desktop computer for computation. Different feature extractors and computer vision algorithms were evaluated in order to retrieve accurate state information for each of the observed parking space. Combination of feature extractors and classifiers were found which properly solved the given task. The output is offered for the parking lot users through an android app with real-time feedings. (Jmsmg & Wickramaarachchi, 2019)

According to Sorri (2021) first impressions are important for businesses, schools, shopping centres, airports, and hospitals. Parking areas represent a secure space for visitors' vehicles, an opportunity for revenue, and a key component of the flow of traffic around a city. Management of parking areas involves ensuring the safety and security of visitors, contributing to customer satisfaction, and allowing parking lots to operate efficiently. Technology plays a key role in supporting this management, with network video cameras being used to monitor the activity and capacity in parking areas effectively. This allows businesses and city officials to support the flow of visitors and residents.
This paper reports a vision-based parking spot monitoring system implemented on Google Coral Edge TensorFlow Processing Unit. The system utilizes videos from available surveillance cameras to automatically learn the parking spot locations after a few parking events in each spot. Then it can detect vacant and occupied parking spots in the parking lot in real time. This is achieved using the combination of temporal difference images and machine learning models. The temporal difference image detects moving objects while the machine learning models identify potential vehicles. By combining the two methods with size and speed filters, the system is able to successfully detect the parking and leaving events for each parking spot near the camera with an accuracy of 92.31%. Without additional information, the system also learns newly available parking spots and unavailable prior parking spots by calculating the confidence level based on recent records of parking events. The system is also able to reconstruct the 3D environment of the parking lot. This method greatly reduces the efforts of manual assignments of parking spots in prior reported systems (Drake D. et al., 2023).
The study of (Paidi, Fleyeh 2018) cited that parking management is an integral component for city planning administrators and is one of the research themes in a smart city development. It can take up to 14 minutes to find a parking space according to previous studies. Parking has been an important research area as it enables accessibility to commuters and is capable of enhancing business opportunities. Lack of parking spaces at a retail store can lead to loss of business opportunities, so stores spend higher expenditure to acquire sufficient number of parking spaces. To address the parking problem, parking guidance systems were developed to reduce congestion, fuel costs and air pollution.

Amato, et al., (2016), techniques for detecting parking occupancy are crucial for managing parking lots effectively. The time it takes to discover an empty spot in a parking lot may be greatly decreased by knowing in real-time whether there are any available free parking spots and informing the users. Ground sensors are often used in parking lots to assess the condition of the individual spots. This calls for the installation and upkeep of sensors in each parking place, which might be costly, particularly in parking lots with a large number of available spaces.

The rapid industrial growth has caused a rise in the number of vehicles on the streets, leading to parking-related problems. Currently, most existing car parks do not have a systematic approach and most are manually managed. This problem usually occurs in urban areas, where the number of vehicles exceeds the availability of parking spaces. Various systems have been developed to ensure the smoothness of traffic congestion in some car parking areas, from manual implementations used in older systems to modern implementations used in current computerized systems.
Recent advancements in parking space management include the implementation of the Internet of Things, optical character recognition, and image processing on aerial images. Intelligent Transportation System (ITS) is a concept of multitechnology that integrates Cyber Technology, electronic technology, information technology, systems engineering, and systems engineering, and is practiced by many developed countries to deal with traffic and parking problems (Tagolanao et.al,, 2021).

The study of Nurullayev and Lee (2019) stated that, the importance of vacant parking space detection systems is increasing dramatically due to the avoidance of traffic congestion and the time-consuming process of searching an empty parking space. To overcome these obstacles, their study proposed an approach based on Dilated Convolutional Neural Network specifically designed for detecting parking space occupancy in a parking lot, given only an image of a single parking spot as input. To evaluate the method and allow its comparison with previous strategies, they trained and tested it on well-known publicly available datasets, PKLot and CNRPark + EXT. The proposed method showed more reliability than prior works especially when tested on a completely different subset of images. Investigations showed that, in comparison with previous approaches, for the task of classifying given parking spaces as vacant or occupied, the proposed approach is more robust, stable, and wellgeneralized for unseen images captured from completely different camera viewpoints, which has strong indications that it would generalize effectively to other parking lots.

According to a blog from (Asura Technologies Ltd., 2022) parking managers may obtain real-time information on the availability of each parking place on their property using the video analytics technique known as parking space occupancy detection. As long as there are cameras with a good view of the monitored parking places, the solution may be employed on or off the street. A video analytics solution that processes the live video from the surveillance cameras delivers parking spot occupancy data around-the-clock. The program could continually watch cca depending on how the cameras are set up. 3 parking spots in a garage, however it might include a

bigger size in open-air situations. Parking space availability data is constantly and immediately available with parking space occupancy monitoring.

According to the study of Guo, Shi (2021) the rapid development of the national economy has caused a huge gap in the demand for parking space, leading to problems such as imperfect parking systems and irregular parking. To solve these problems, the design and promotion of intelligent parking systems has become an urgent demand. Existing parking management service products are not perfect due to inaccurate positioning, limited scope of use, inaccurate vehicle information identification and feedback, and some problems in promotion and cost. This research aims at the technical level and carries out a series of design and improvement. Positioning technologies include ultrasonic, infrared, RFID, Wireless Fidelity (WiFi), ZigBee, and Bluetooth. WiFi coverage is used to identify and locate the free parking spaces. Vehicle navigation systems are divided into three parts: parking lot end, cloud end, and user end. This study uses improved neural network algorithm for path navigation. Auxiliary parking systems have been developed, and image recognition technology has been developed. This study studies image recognition technology and positioning technology, exploring its existing application results, and optimizing its application mechanism.
A mobile sensing unit has been developed as an alternative to the fixed sensing approach. It is mounted on the passenger side of a car to measure the distance from the vehicle to the nearest roadside obstacle. A supervised learning algorithm has been developed to estimate roadside parking occupancy. Multiple road tests were conducted around Wheatley and Guildford in the UK, and the accuracy of the system was above 90%. A quantity estimation model was derived to calculate the density of sensing units required to cover urban streets. The results showed that the mobile sensing approach can perform at the same level as fixed sensing solutions when accurate location information is available, but substantially fewer sensors are needed
(Roman,et, al. 2018)

B. Conceptual Framework

The framework includes the mechanisms for processing and analyzing the real-time data obtained from parking space detection. This involves algorithms, data storage, and processing systems that convert raw data into actionable information.

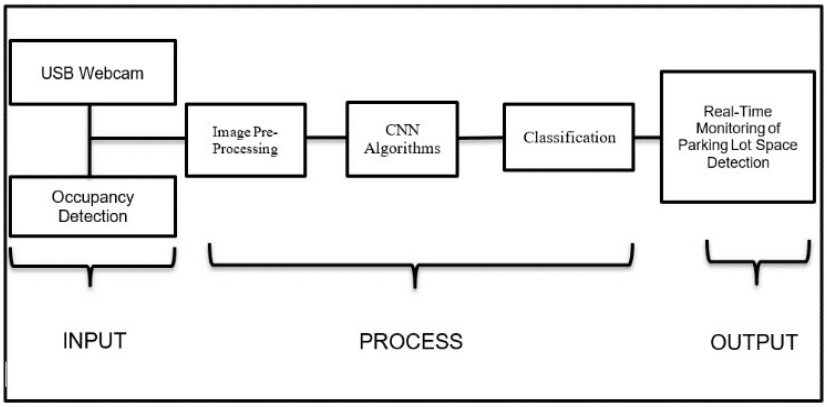

Figure 1. Conceptual Framework

The conceptual framework shows a summary of the functions of the system. The input indicates where the data is obtained from, such as from a USB camera or presence detection. The process looks like this: image preprocessing, machine learning algorithms, and maintenance. Finally, the result shows "real-time monitoring of parking lot detection.".

C. Definition of Terms

USB Webcam - is a camera use to the prototype as a video surveillance, is it use transmit the signal to a specific place

Occupancy Detection- The process of detecting the parking lot space if occupied or unoccupied.

Image Pre-Processing -The process of analyzing an image to extract useful information.

Computer Vision- The field of study that focuses on how computers can be made to interpret and understand images and videos.

Machine Learning- The process of training a computer to recognize patterns in data and make predictions or decisions based on that data

II. OPERATIONAL FRAMEWORK

A. Materials

Real-Time Monitoring of Parking Lot Space Detection to make the computerized system that integrates hardware and software components, the researcher stated the following requirements:

Software Requirements

The requirements below show the software specification used to create this system.

Components Specifications

Operating System: Windows 10 64-128 bit

Programming Language: PHP and Python

Database Software: MySQL

Server: Xampp

Table 1. Software Requirements

The Table 1 shows the software requirements for components and specifications used to create this system. The components used are Operating System (OS), Programming Language, Database Software, and Server. The specifications are Windows 10 64-128 bit, PHP and Python, MySQL and Xampp.

Hardware Requirements

The requirements below show the software specification used to create this system.

Components Specifications

High-Resolution Cameras USB Web Camera Processor Intel Core i5-7th Gen Memory 8gb RAM Hard-Disk 120GB SSD, 500GB HDD

Table 2. Hardware Requirements

The Table 2 shows the components and specifications used to create this system. The components used are highresolution camera, processor, memory, and hard disk. The specifications are a USB Web camera, an Intel Core i5-7th Gen, 8 GB of RAM, a 120GB SSD, and a 500GB HDD.

B. Methods

Software Development Methodology

The researcher used Waterfall model for its very easy to understand and use, and it is the earliest SDLC approach that was used for software development. The whole process of software development life cycle is divided into each phase. Typically, the outcome of one phase acts as the input for the next phase sequentially.

Waterfall Method

Figure 2. Waterfall Software Development Methodology

Requirement Analysis

The researcher gathers and analyze the process in terms of the manual operation used by the establishment. The researcher planned the process of the system using the information gathered. Thus, to improve the operation the researcher used Real-Time Monitoring of Parking Lot Space Detection.

System Design

The researcher made the design of the system simple to use by some users, which was unaffected by the system and also wouldn't cause them confusion. Thus, the system has its own database to ensure the data input and will monitor the system.

Development
The researcher transforms the design documentation into actual working code. To emphasis is to translate the system specifications into executable software components.

Testing
The researcher tested the system to find the error and repair it along the way to avoid technical problems during deployment.

Deployment
Once the system has been tested and validated, it is deployed or installed in the production environment. The establishment can start using the system for their intended purposes.

Maintenance
After the implementation of the system, the developer will maintain the hardware and software, and the system will be up-to-date and ensure that all parts are functioning and working properly. The system will be observed by the programmer, and when the system encounters an error while in use, it will be immediately repaired.

C. System Flowchart of Existing System

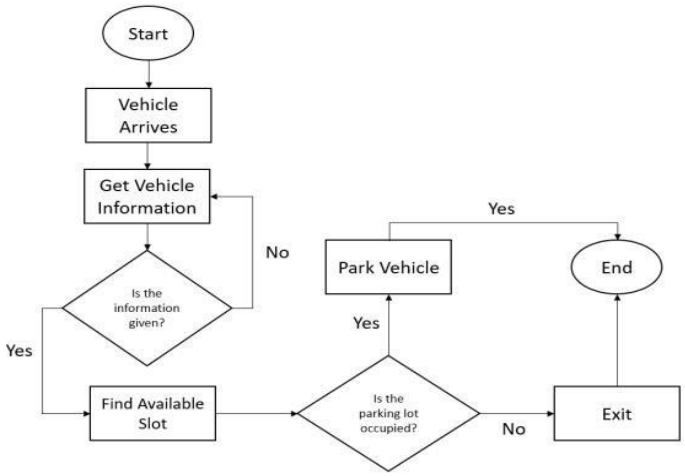

Figure 3. System Flowchart of Existing System

Existing Flowchart Diagram
The diagram shows the systematic process of existing system. Whereas, the first operation is the vehicle arrives. After the vehicle arrives; the vehicle needs to get the information. After the vehicle get the information; the driver is able to continue in finding the available parking lot space. If the driver finds a slot, the drivers can park the car.

D. System Flowchart of Proposed System

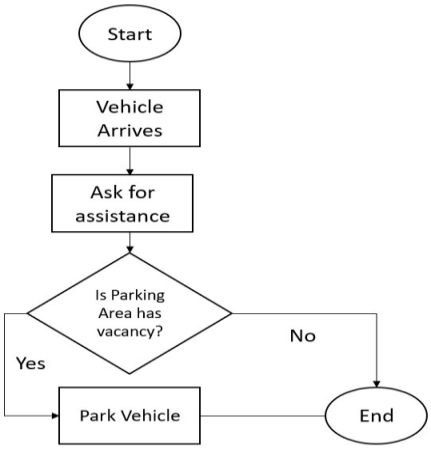

Figure 4. System Flowchart of Proposed System

Proposed Flowchart Diagram

The diagram shows the systematic process of proposed system. Whereas, the first operation is the vehicle arrives. After the vehicle arrives; the driver will ask assistance to the guard. In Parking Lot Occupancy; the driver is able to continue to park the vehicle.

E. Context Diagram

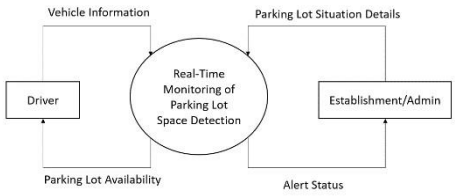

Figure 5. Context Diagram

Context Diagram

The diagram shows the data gathering and systematic operation of the system. Whereas, the driver will input the vehicle information to system and will notify the parking lot availability. The establishment or admin can rely the situation of the parking lot, and the system can alert the establishment.

F. Use Case Diagram

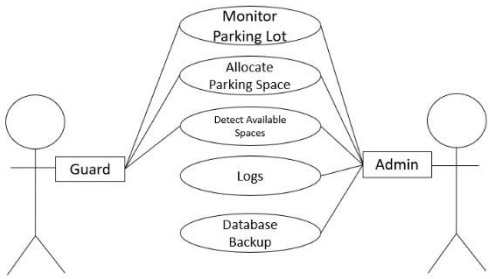

Figure 6. Use Case Diagram

Use Case Diagram

The diagram shows the task that admin and guard can perform. Some of the modules in the program are accessible by the guard while the admin is managing it. The use case diagram shows the whole system and five (5) use case which are Monitor of Parking Lot, Allocate Parking Space, Detect Available Spaces, Logs, and, Database Backup.

G. Data Flow Diagram

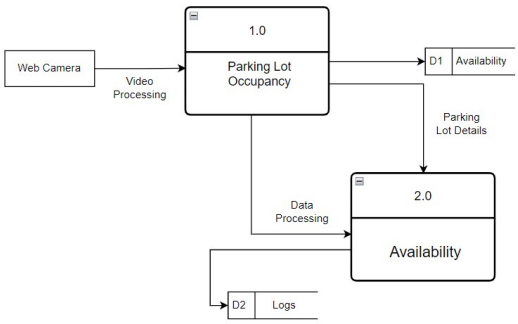

Figure 7. Data Flow Diagram

Data Flow Diagram

The diagram shows the data flow process, where the external entity is the web camera and the video processing data flow. The process includes the parking lot occupancy, and the data flow includes parking lot details and

data processing, which are stored in the availability database. The next process is availability and data storage in the log database.

H. Entity Relationship Diagram

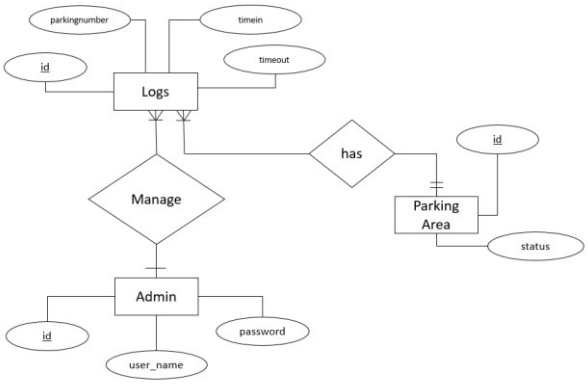

Figure 8. Entity Relationship Diagram

Entity Relationship Diagram

One to one admin has attributes ID primary key, user_name, and password manage many logs and logs has attributes ID primary key, parking number, timein, and timeout. Many logs has many Availability and availability attributes ID primary key, and availability.

I. System Environment

Desktop Application Output and User Interface Design

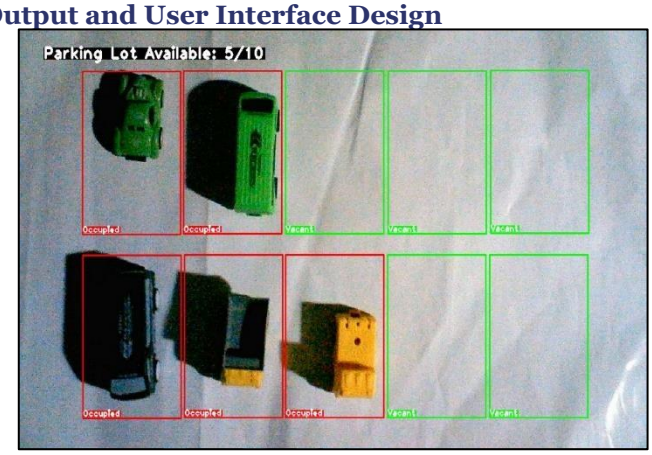

Figure 9. Monitoring for Desktop

Figure 9 shows the application for the user side, where the user can monitor the availability of parking lot space to see if it's either vacant or occupied.

Web Application Output and User Interface Design

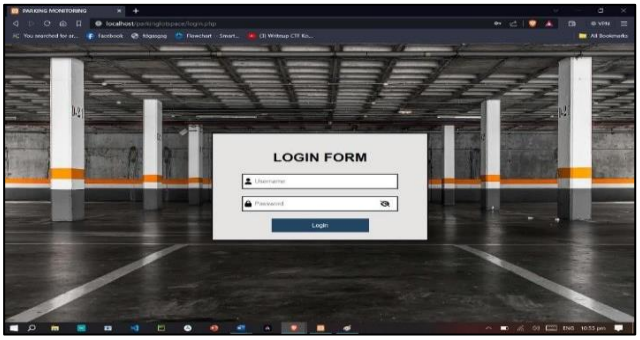

Figure 10. Login Interface

Figure 10 shows the login interface form for the admin where the admin can access the Real-Time Monitoring of Parking Lot Space Detection.

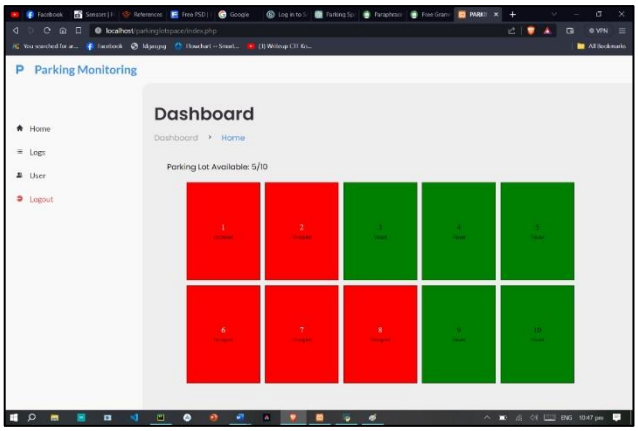

Figure 11. Dashboard Monitoring

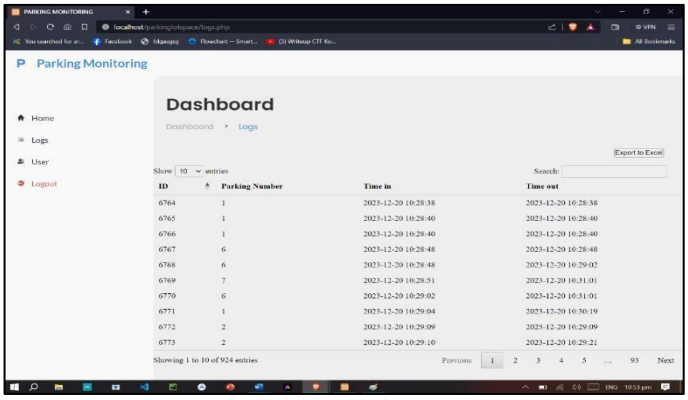

Figure 11. Logs Monitoring

Figure 11 shows the dashboard for the admin, where the admin shows the reflection on the desktop for the user.
Figure 11 shows the logs transaction, where it shows the parking number, time in, and time out of a transaction.

J. Questionnaire

FUNCTIONALITY	Statement/s	SA 5	A 4	F 3	D 2	SD 1	Weighted Mean
Accuracy and Precision	The system delivers a high and accuracy. The system aiming for consistent across multiple measurement.						
Sensitivity	The system demonstrates unparalleled sensitivity, promptly detecting changes in occupancy status and providing instantaneous updates.						
RELIABILITY	**Statement/s**						
Real-Time Performance	The system ensuring rapid and responsive functionality across diverse scenarios.						
Maturity	The system reaches its full functionality upon first implementation and test by the establishment.						
USABILITY	**Statement/s**						
Learnability	The system can be easily learned by the establishment due to its user-friendly interface.						

Attractiveness	The system has a very minimalist and user-friendly design that is pleasing to the eyes.						
Robustness to Lighting and Weather Conditions	The system ensuring consistent performance even in challenging lighting and weather conditions.						
EFFICIENCY	**Statement/s**						
Time-Behavior	The system responds easily right after every transaction you make.						
Resource Utilization	The system uses database to collect data and information.						
MAINTAINABILITY	**Statement/s**						
Stability	The system remains stable for a long period of time.						
Testability	The system has undergone various examinations and test runs before implementing to ensure the quality and efficient functionality.						
PORTABILITY	**Statement/s**						
Adaptability	The system can adapt its GUI at any screen resolution.						
Conformance	The system can perform its capabilities on what the establishment wants to do without hassle.						

IV. RESULT AND DISCUSSION

A. Testing and Evaluation

Twenty (20) security guards of KCC Mall of Marbel Parking Lot are responsible for analyzing the system's functionality, reliability, usability, efficiency, maintainability and portability because they are able to spot mistakes when one feature is malfunctioning.

The system features are broken down into a checklist form for system correctness, and each feature is listed separately so that each can be tested one (1) at a time.

B. Statistical Treatment

The formula for calculating the weighted mean is as follows:

$$\text{Weighted Mean} = \frac{\sum (x_i\, w_i)}{\sum w_i}$$

xi is the value of the variable (in my study the system evaluation results). wi is the weight corresponding to each value.

∑ Represents the sum over all values.

C. Interpretative Scale used to Interpret the Mean

Interpretation	Range of Mean
Strongly Agree	5
Agree	4
Neither Agree nor Disagree	3
Disagree	2
Strongly Disagree	1

a questionnaire constructed as a five-point Likert rating scale with the following equivalents: 1 – strongly disagree; 2 – strongly disagree; 3 - neither agree nor disagree; 4 - agree; 5 - strongly agree.

D. Questionnare Evaluation Result

FUNCTIONALITY	Statement/s	SA 5	A 4	F 3	D 2	SD 1	Weighted Mean
Accuracy and Precision	The system delivers a high and accuracy. The system aiming for consistent across multiple measurement.	18	2	0	0	0	4.9
Sensitivity	The system demonstrates unparalleled sensitivity, promptly detecting changes in occupancy status and providing instantaneous updates.	16	4	0	0	0	4.8
							Total WM: 4.85
RELIABILITY	**Statement/s**	**SA 5**	**A 4**	**F 3**	**D 2**	**SD 1**	**Weighted Mean**
Real-Time Performance	The system ensuring rapid and responsive functionality across diverse scenarios.	18	2	0	0	0	4.9
Maturity	The system reaches its full functionality upon first implementation and test by the establishment.	14	6	0	0	0	4.7
							Total WM: 4.8
USABILITY	**Statement/s**	**SA 5**	**A 4**	**F 3**	**D 2**	**SD 1**	**Weighted Mean**
Learnability	The system can be easily learned by the establishment due to its user-friendly interface.	19	1	0	0	0	4.95
Attractiveness	The system has a very minimalist and user-friendly design that is pleasing to the eyes.	18	2	0	0	0	4.9
Robustness to Lighting and Weather Conditions	The system ensuring consistent performance even in challenging lighting and weather conditions.	17	3	0	0	0	4.85
							Total WM: 4.9
EFFICIENCY	**Statement/s**	**SA 5**	**A 4**	**F 3**	**D 2**	**SD 1**	**Weighted Mean**
Time-Behavior	The system responds easily right after every transaction you make.	18	2	0	0	0	4.9
Resource Utilization	The system uses database to collect data and information.	17	3	0	0	0	4.85
							Total WM: 4.875
MAINTAINABILITY	**Statement/s**	**SA 5**	**A 4**	**F 3**	**D 2**	**SD 1**	**4.85**
Stability	The system remains stable for a long period of time.	17	2	1	0	0	4.8
Testability	The system has undergone various examinations and test runs before implementing to ensure the quality and efficient functionality.	16	4	0	0	0	4.8
							Total WM: 4.82
PORTABILITY	**Statement/s**	**SA 5**	**A 4**	**F 3**	**D 2**	**SD 1**	**Weighted Mean**
Adaptability	The system can adapt its GUI at any screen resolution.	14	3	3	0	0	4.55
Conformance	The system can perform its capabilities on what the establishment wants to do without hassle.	18	1	1	0	0	4.9
							Total WM: 4.725

Orosco, M. (n.d.). Web-Based Thesis/ Capstone Project Defense Evaluation System of the CCS Biñan. https://www.uphsl.edu.ph/.
https://www.uphsl.edu.ph/research/COMPUTER%20STUDIES/OROZCO,%20Michael%20M/Web-Based%20Thesis%20Capstone%20Project%20Defense%20Evaluation%20System%20of%20the%20CCS%20Bi%C3%B1an.pdf
Based on the evaluation matrix, the system demonstrates outstanding performance across key dimensions. The Functionality, with a rating of 4.85, the high Reliability score of 4.8 underscores the system's consistent and dependable operation, instilling confidence in users. A notable rating of 4.82 for Maintainability highlights the system's ease of maintenance and adaptability for future enhancements.
Usability, with a rating of 4.9, signifies an intuitive and user-friendly design, enhancing accessibility for a diverse user base. The Efficiency score of 4.875 reflects the system's optimal use of resources, ensuring swift and responsive performance. The Portability score of 4.725 emphasizes the system's versatility across different environments.

E. Overall Evaluation Result of the Capstone Project Defense Evaluation System

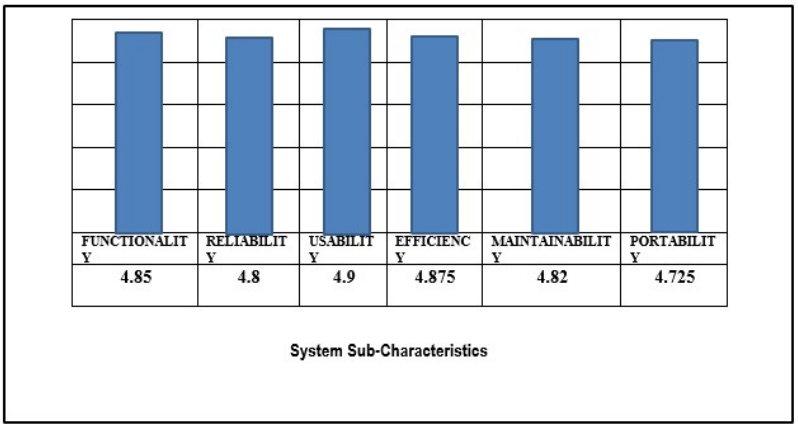

Figure 12. Overall Evaluation Result of the Capstone Project Defense Evaluation System

Figure 12. presents the overall evaluation results of the system were strongly agreed by the respondents with the highest weighted mean 4.9. However, the usability of the system was only agreed by the respondents with the lowest weighted mean 4.725. The final evaluation survey reflects of the system on how it is to be conducted. The results show that the security guards of KCC Mall of Marbel is in favor for the said system based on the result that the developer had for survey.

V. SUMMARY, CONCLUSION AND RECOMMENDATION

1.) Summary

Real-Time Monitoring of Parking Lot Space Detection identification represents a significant advancement in parking management systems. It seamlessly integrates advanced hardware components and powerful software elements to accurately and promptly detect parking space availability. This enhances overall parking facility efficiency, reduces traffic congestion, and improves user experience. The system showed robust performance in varying lighting conditions and weather conditions, ensuring reliable operation throughout the day. Integration of machine learning algorithms enabled efficient classification of parking spaces, allowing for quick identification of vacant and occupied spots. The real-time monitoring dashboard provided users with comprehensive insights into parking space availability, facilitating informed decision-making and enhancing overall parking management efficiency. Furthermore, the system's scalability and flexibility allowed for seamless integration with existing parking infrastructure, making it suitable for deployment in diverse urban environments.

2.) Conclusion

The Implementation of real-time tracking to identify parking spaces is a significant step forward in parking management systems. The integration of advanced hardware components, cameras, and processing units, works seamlessly with powerful software elements. Identification algorithms and data processing software analyze real-time information, which allows accurate and timely detection of the availability of parking spaces. User interfaces, communication protocols, and security measures ensure the efficient and secure operation of the system, while reporting tools facilitate data-driven decision-making. The benefits of real-time monitoring go beyond mere status detection. The system increases the overall efficiency of parking facilities, reduces traffic

congestion, and improves the user experience by providing timely information about available parking spaces. System administrators can obtain valuable information with the help of analytical tools that help them optimally allocate resources and plan for the future. However, it is important to recognize challenges, including technical limitations, environmental factors, and privacy concerns, which require continuous improvement and adaptation. As we navigate the evolving landscape of smart cities and smart infrastructure, real-time parking spot detection is a testament to the combination of hardware innovation and advanced software solutions. If the identified limitations are addressed and the system is continuously improved, the future offers promising opportunities to improve urban traffic, reduce environmental impacts, and improve the overall quality of life for residents and visitors alike. This remarkable precision not only expedites the process of finding parking but also contributes to optimized space utilization and reduced traffic congestion within parking facilities. By promptly disseminating accurate information to drivers, we not only reduce the frustration associated with parking but also contribute to a more seamless and environmentally friendly urban transportation ecosystem.

3.) Recommendation

To widen the scope of this system, the research suggests future research to improve the dependency of using highquality cameras to improve the features and accuracy of the system. Also, add features such as sensors to the hardware components, have them regularly checked for issues, and calibrate them as needed. Integrate the system with payment and reservation systems to offer users the ability to reserve parking spaces or pay for parking through the same platform. This creates a seamless parking experience. Improve the precision and reliability of sensor technologies, such as ultrasonic or camera-based sensors, to enhance their ability to detect various types of vehicles. The researcher also recommends implementing License Plate Recognition (LPR) to add other features, such as recognizing plate numbers, to monitor if the vehicle has a penalty or violation.

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