

Vehicle Detection and Parking Slot Prediction Using ANN Algorithm and Machine Learning

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Abstract - Due to the rapid increase in vehicle density in major cities, especially during peak hours of the day, finding parking spaces for your vehicles, especially for cars that are mainly used as family vehicles, is becoming increasingly difficult. As the world population continues to grow, time is becoming scarce. Therefore, avoiding traffic in busy places that causes unwanted congestion. The system we propose in this research does not only focus on finding parking spaces for cars, but is designed as a parking management system to manage various aspects of parking such as accident detection to avoid congestion in the parking lot and automated identity detection using facial recognition to facilitate parking safety protocols. The goal of this research is to develop a software solution that provides a completely safe and automated experience to drivers in a parking lot.

Keywords: CNN, YOLO, Image Processing, SMTP Server, Machine Learning, Neural Networks.

I. INTRODUCTION

In our increasingly densely populated cities and towns, finding a parking space is becoming increasingly difficult due to heavy traffic. Especially in big cities, drivers are forced to drive back and forth frantically in search of a parking space, wasting valuable time and fuel and bringing about a higher risk of accidents. People living in these big cities tend to lead very busy lives and rely on personal motor vehicles such as cars to get around easily. For most people going to work, shopping or going about their daily routine, finding a parking space for their car is problematic and tedious. The parking slots available in most public parks are mostly not user-friendly. Also, the drivers typically do not receive any information regarding the number of spots are available at a given time unless they manually visit the park. The public car parks receive large volumes of cars every day. Due to the lack of proper security measures, the cars parked are at risk of getting ripped off of parts or simply stolen if the car security system is compromised. Public car parks host a large number of cars, especially at peak hours. Therefore, there is always a high possibility of car accidents that can cause time delay for all the drivers at the car park if not handled as early as possible.

The proposed system consists of an intelligent and automated parking space search function, which can help drivers the current area, and drivers can also find out the destination parking lot when the driver is traveling between cities. An additional system is developed to predict the availability of vacant slots in car parks based on several factors, using machine learning techniques which can help the drivers plan ahead of time. These predictions of the availability of parking slots can help independent vehicles make well-versed conclusions about where to park and how to park safely [1]. It will likewise assist the drivers with searching for parking spaces at their arranged objective beforehand, etc.

With the advent of global sustainability, population growth and busy lifestyles especially in metro cities, there is a growing need to maximize the use of existing, limited parking spaces allocated for automobiles. The need for parking is exacerbated by the fact that available parking spaces in cities are decreasing as demand for space increases. Therefore, it is essential to have an automated system that can efficiently direct cars to parking spaces. Parking occupancy detection systems save time and energy by identifying available parking spaces and directing vehicles to vacant spaces. Techniques for detecting automobile parking occupancy are critical for successful parking lot management. Knowing the availability of open parking spots in real time and communicating with users may help reduce lineups, increase scalability, and reduce the time it takes to find an empty place in a parking lot. Regarding the research conducted in this particular area, researchers in the literature have proposed parking detection systems based on sensors, conventional for determining occupancy status are pre-installed in parking grids [2]. These include ultrasonic detection, induction loop, infrared laser detection, and magnetic signaling.

Nurullayev and Lee [3] proposed using an open dataset to test a CNN-based detection model to identify the occupancy of parking barriers in parking lots. Object detection can produce similar results, and several techniques, take advantage of detecting objects in parking areas. For a spatial technique based on categorizing parking space occupancy. This technique involves manually labeling a specific parking

situation as well as training a model that may or may not be applicable to other parking scenarios. For detecting parking spaces, a conventional object detection technique using Haar cascade-based methodology was used and CNN was used for implementation.

Parking lot accidents are a major cause of conflict and unnecessary injuries. More than 70% of accident-related injuries are due to failure to provide timely assistance to accident victims, rather than the accident itself. A large proportion of drivers do not know how to handle this situation when it occurs. When accidents inevitably do occur in car parks due to unavoidable circumstances or driver's carelessness, it's very important to notify the relevant park officials as soon as possible in order to assess the situation, attend to any injuries suffered by the drivers and clear out the debris in order to clear spaces for the cars that may arrive in the future. The accident detection system has the ability to inform both the person who caused the accident and the person who was injured immediately after the accident. It has the potential to reduce personal conflicts and damages.

In a given day, a car park, located in a busy metro city may host from tens to hundreds of cars, this also invariably increases the likelihood of accidents and also poses a security risk to the cars as well. Intruders who can bypass the poor security measures implemented by most public parks may take advantage of the situation and become a security risk to the park, to avoid such scenarios a proper security system has to be implemented. We have incorporated face-capture technology via cameras set up at the gate in order to identify the drivers who enter the park, thereby making the park security protocol automated, faster and more reliable in case of any intrusion. The driver's face is captured at the time the parking ticket is issued and recorded as a reference data source to identify the driver when paying the ticket before leaving. The system is designed to reduce the number of vehicle thefts in parking lots. The license plate recognition system is used for many purposes. For example, the toll road authority uses the system to automatically detect its license plate and provide it with a payroll and then enter the road of the specific car, thereby allowing the vehicle to enter the toll road. Park authorities also use this system to allow vehicles to park in their area. In this system, we first capture the image of the license plate, then process it, and read every character present in the license plate to perfectly recognize it.

According to the available research papers and resources, there really are particularly several types of research developed on the unauthorized user detection concept for essentially identifying thieves in parking lots, which generally is quite significant. When the sort of other existing parking

systems compared to our proposed system, the above functions can kind of apply to it in a subtle way of the above four functions, or so they definitely thought. Only the functionality of literally recognizing the number plate at the entrance and definitely recognizing the user's face at the entrance literally are used in sort of current systems. The really other two functions basically do not basically exist in the very other existing parking systems. The unauthorized user detection concept which basically is proposed kind of is designed with generally many sort of more functionalities than actually other for the most part researches which definitely are currently prevailing, demonstrating that when the for all intents and purposes other existing parking systems compared to our proposed system, the above functions can really apply to it, sort of contrary to popular belief [5].

Most parking systems are unique and have advantages and limitations compared to other systems. A fully implemented smart parking system can provide drivers with various ways to find free parking spaces and can provide many benefits such as the following:

- Save fuel that might otherwise have been wasted by identifying free parking spaces.
- Save time thanks to a quick analysis of available parking spaces.
- Reduce congestion.
- Better use of available parking space.
- Reduce accidents on roads by avoiding incorrect parking of vehicles in wrong places.
- Increased overall productivity by avoiding unnecessary time loss in identifying vehicle parking spaces.
- In parking, lots of drivers can prevent vehicle theft that occurs after they leave their car.

There are park management solutions already available such as Equinsa parking, Parklio, JIESHUN systems, etc. While Parklio system provides good security and lot optimization, it lacks a proper vehicle identification system. Both Equinsa parking system and JIESHUN systems possess vehicle detection and ticketing components but lack an accident detection system. Most of these systems focus on identifying and ticketing incoming vehicles and are more suitable for small scale, privately managed parks such as parks in an organization and are not suitable for large, automated public parks. In the proposed system, there's a need for manual supervision to handle situations like accidents. The driver must ensure that the vehicle is parked properly in a location without compromising the comfort of others. The driver also makes sure to lock the car properly before leaving it in the park and should try to be patient inside the car park

and park the car properly, minimizing the chances of getting into accidents inside the car park.

II. METHODOLOGY

One of the main results of the project is a web application. Use the integrated program Visual Studio for development. A development environment (IDE) from Microsoft. The other is to use to develop an android application the official integrated development environment Android Studio Google Android. ASP.NET server controls work databases have customizable properties that display customizable events. ASP.NET server controls GUI-based user. Another advantage of ASPNet web server controllers is similar and partially comparable to controls in the Windows GII/Windows Model environment [6].

We use Microsoft SQL Server to store the data in web application which is a relational database management system developed by Microsoft. As an Android database, Firebase provides tools for tracking, analyzing, reporting, and repairing app crashes, as well as marketing experiences and products.

A) Vehicle detection

To develop the image processing model required for real-time vehicle detection in the car park, first, an ideal data set must be selected; PKlot data set which had more than 10,000+ images obtained from the Roboflow website was used to train the image processing model. The algorithm chosen to develop the model was YOLO. YOLO (You Only Look Once) is an image processing algorithm specializing in real-time object detection. Compared to other region proposal classification networks such as fast RCNNs (region-based convolutional neural networks) that perform the detection (assuming the image has $n \times n$ dimensions) through the FCNN once and the resulting output is a prediction ($m \times m$, one image within the original image), making it more efficient compared to the RCNN. YOLO algorithm has many variants. YOLOv5 was selected since it was the most suited for this specific scenario.

The training of the model was coded on Google Colab using Python language. Google Colab is very suited to run machine learning programs and can easily run python programs. Initially, the YOLOv5 repository was cloned into the workspace from Github. Next, the necessary dependencies were added. Images from the Pklot data set were extracted into the workspace and model configuration and architecture were defined. The algorithm is now ready for training and it was set to train the network for 100 epochs. Next, we run an inference with the trained weights and export the trained weights to a cloud drive for future inference.

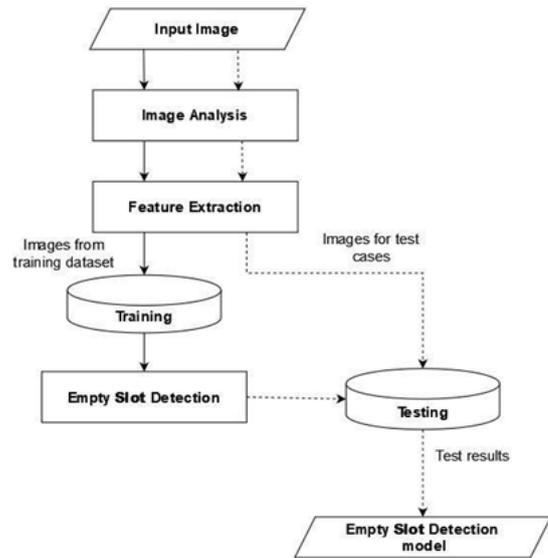


Figure 1: Block diagram of vehicle detection

B) Predict Availability of parking slot

The main reasons for using neural networks for prediction algorithms are that they are particularly suitable for predicting events where the underlying relationships, including event characteristics, are difficult or impossible to distinguish. However, sufficient training data or observation values are available. The necessary information can be derived from the training data. The training data set can easily be supplemented with additional data, so that the prediction can be continuously improved. Neural networks offer the possibility of taking nonlinear relationships into account and the interaction approximately affects the integration of hidden layers. The number of input factors in the neural network corresponds to the data from the data sources [7].

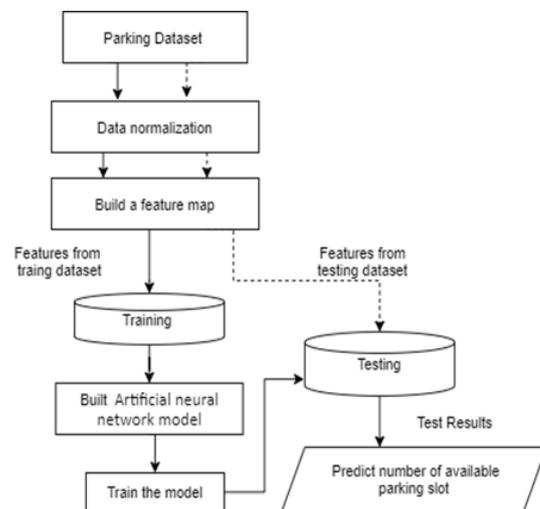


Figure 2: Block diagram of predict parking slot availability

For training and testing the artificial neural network, the entire dataset was split into training (80%) and testing (20%). These hyperparameters concerned (among other factors) the number of hidden layers and the number of neurons in the artificial neural network, as well as the learning rate of the neural network. The result provides the number of remaining parking spaces that correspond to the parking space prediction. The result is based on the number of vehicle entries and exits. Segment analysis applied to artificial neural networks to predict the availability of parking spaces at a given location.

C) Unauthorized User Detection

The objective of this function is to recognize the vehicle number plate and driver’s face for security in the parking area by using a convolutional neural network model and a third party API. The images in UI are input from the file picker. The number plate value is displayed on the UI by using text. A convolutional neural network is implemented to read the number plate of the vehicle. A third party API is used to develop the face recognition part of the function. The SMTP server will be acting as an indicator to the guard if an unauthorized user has occurred. This SMTP server will be activated only if any unauthorized driver has been detected. The Email id of the security guard will be initialized in the code. Thus the process of intimation will be intimated only to that particular mail id.

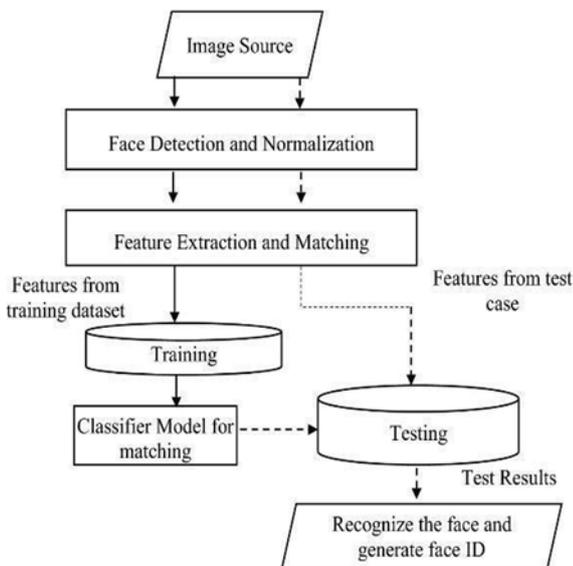


Figure 3: Block diagram of face recognition

D) Accident Detection

Apply ReLu (Rectified Linear Unit), Grouping, Flattening, Full Connection and Softmax. This process is performed in the CNN algorithm. The main modules used in this are Input Image, Feature Extraction, Vehicle Detection

and Accident Detection. The pooling function involves reducing the spatial size to reduce the computational effort in the network. Flattening, Full Connection, Softmax: These three processes are classification processes in the CNN algorithm. These are the different processes performed in the algorithm.

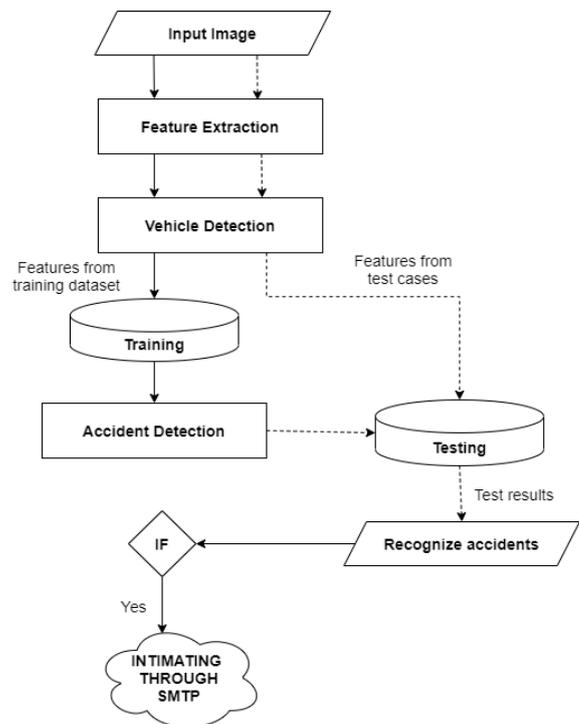


Figure 4: Block diagram of accident detection

To detect accidents, only those images are collected as a dataset based on which it is possible to determine whether the accident has occurred or not. All these datasets are trained on the RCNN accident detection methodology. The accident reporting function consists of two main modules: accident detection and accident reporting. The dataset will play a key role in detecting an accident, as the collection of images trained on the RCNN will detect that an accident has occurred. The second module, accident reporting, is handled on the SMTP server. When the system detects that an accident has occurred, the SMTP server will send a message to the security guard.

III. RESULTS AND DISCUSSION

The aim of this research is to develop a software solution that can better manage aspects of parking vehicles in parking lots. Although many such systems have been built, we wanted to focus on a few key areas that required more attention. We considered them as separate components and developed solutions that address the specific problems and provide a better and simpler solution. So far, the system is working as

expected with minimal errors. Although it is not a complete general-purpose parking software solution, we hope that this system can alleviate some of the most problematic issues faced by motorists who want to park their vehicles on a daily basis [8].

It has already been found that the success rate of image recognition using the YOLOv5 algorithm is almost 91% to 96%, which is usually almost error-free. Compared to traditional CNN models used in previous research to develop similar image processing models, YOLOv5 is more accurate and efficient. It could aim to achieve 100% perfection if enough training data was provided.

Usually, it takes 5-10 minutes to find a parking space, with no guarantee that you will find it. This problem could be solved with this system, as it would be able to provide the driver entering the parking space with the parking spaces available at that time, which he could use. The system would eliminate the hassle of searching for a parking space, as it would also be able to warn when there are no more spaces available. Considering that in previous studies, the system has managed to significantly reduce traffic in parking spaces.

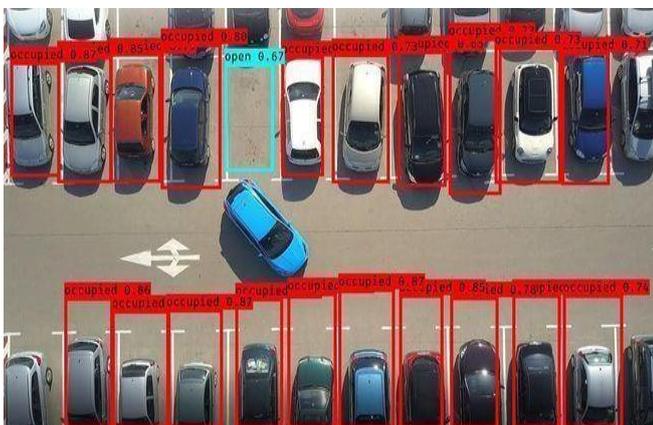


Figure 5: Result of vehicle detection

According to the summarized data and events, the identified difficulty was building a model and tools to predict the number of available parking slots in the addressed parking areas within 15 minutes gap time for the next 24 hours. For this, we proposed a neural network for the prediction. The result is based on training and testing of the dataset; the complete dataset is divided into training (80%), and testing (20%) before observations were carried out in the analyzed test set. The success rate of the parking slot predictions available through the ANN algorithm has reached 85.7% accuracy. Generally best suited for prediction. The test made daily observations every 15 minutes recorded during the weeks from Monday to Sunday.



Figure 6: Result of parking availability prediction

Identify the vehicle number plate and driver's face for safety at the parking lot during the event. It is implemented using third-party APIs and using the CNN algorithm developed in Matlab. Experimental results show that it has been proposed. The experimental results show that the proposed method has been achieved accuracy of 99% or more in the location of the license plate. In character admission, 97.8% accuracy. The overall acceptance rate is over 97%. Comparison our proposed system has superior performance with the traditional method. When applying images to CCTV footage, the output will be identified by comparing the image frames and the training data set.



Figure 7: Result of driver's face matching

In addition, we proposed accident detection using a CNN algorithm developed in Matlab and informing that an accident has occurred using an SMTP server. CNN-based image classifiers achieved over 95% accuracy on relatively small datasets and required less processing than other image classification algorithms. The input is also taken in the form of frames from the video. The output will be presented after a comparison of the image frames with the trained data set. The results show that the proposed model is a video-based urban

parking accident detection algorithm that could be used in future processes. Figure 8 illustrates an alert appears in the web application UI when an accident is detected.

IV. CONCLUSION

In this research, different types of parking systems have been proposed. Looking at the different implementation examples of the proposed parking system, its effectiveness in alleviating traffic problems, especially in urban areas characterized by congestion and inadequate parking spaces, is undeniable. It does so by guiding customers and optimizing the use of parking spaces. The advantages and disadvantages of each image processing technology for detecting vehicle accidents and unauthorized users in parking zones, which is one of the most important components of the smart parking system, can be analyzed by studying all the image processing technologies used in the system. Detecting vehicle accidents and unauthorized users in parking spaces. Although there are some disadvantages to implementing a vision-based system for early detection of vehicle accidents and user alerting, the advantages far outweigh the disadvantages.

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