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Security and Safety-Based Parking Area Monitoring System

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ABSTRACT

Security became a major concern these days in parking areas. Nowadays vehicles are rapidly increasing due to the rapid increase in parking traffic. Vehicle-safe parking has become a serious problem for organizations and Universities. Some vehicles do not register them legally or utilize the license plates of other vehicles. Those license plates can be used to determine the identification of a vehicle accused of committing a crime around the organization. So only detecting the number plate as the Vehicle identification at the parking entrance is not safe. For that proposing a novelty-based Smart Parking Area Monitoring System to overcome this problem. Here, train the vehicle model using the neural network transfer learning technique to identify the vehicle model and classify the vehicles. The entrance of the organization detects and compares the vehicle models with number plate details and operates the barrier system based on the vehicle's authorization status. Nowadays parking systems detect wrong-parked vehicles using sensors in every parking slot. It is very costly and not efficiently working. This research proposes a wrong parking detection system by using only the CCTV cameras of parking areas. Here using Yolo object detection and OpenCV line detection algorithms to detect parking slots and wrong-parked vehicles.

Keywords— Vehicle Identification, Wrong Parked Vehicle Detection, Yolo Model, OpenCV

I. INTRODUCTION

A. Background

A parking monitoring system based on technology is an automated and advanced system that monitors vehicles from the time they enter the organization until they depart. —The parking monitoring system monitors parking lots and cars with unique cameras and modern technology. The global vehicle count estimate is an imperfect method. However, research has shown that the rate of increase is exponential. According to studies, the current global car count is estimated to be approximately 1.2 billion. The population will approach 2 billion by 2035 [1]. As the number of cars increases, automated vehicle parking analysis is becoming more important in a variety of applications.

Parking space shortages and growing traffic induced by parking demand are only a few instances of common parking issues at companies and universities [2]. The parking system is critical in minimizing car congestion in the parking lot [3], parking area accidents, and security hazards in the surrounding region. The parking monitoring system saves time and makes the entire procedure more efficient. Parking lot security and privacy must be prioritized [4]. Parking management systems may also include the most recent security features. This system also prohibits unauthorized vehicle entry or exit, guaranteeing that no threat enters or escapes without being detected. As a result, parking systems are a great alternative for parking lots at organizations, institutions, and businesses. so, entrance identification and authorization are important these days.

According to studies [14][15][16], incorrect parking has been a major problem in recent times. Organizations find it difficult to make full use of the parking lot due to incorrectly parked automobiles. Hiring specific people to manage parking places may require more time, effort, and money. Wrong parking entails parking in two lots or failing to park correctly and/or in the correct space. As a result, authorized authorities are required to penalize parking violators.

Several companies and current research [16][7] employ sensors to deal with inappropriate parking difficulties, and they require at least one sensor and LCD in each parking space, which raises the cost and introduces a new difficulty. Furthermore, no study or technology exists to detect several inaccurate parking detecting systems. Parking detection systems that are useless and have single slots might be pricey. Therefore, we were able to demonstrate that studies that simply counted the number of vehicles in the parking lot or the number of vacant parking spots and floors did not address one of the most critical issues we face. In this case, incorrect parking refers to drivers who fail to properly park between white-lined parking spaces.

Various strategies for detecting automobile accidents have recently been developed because of the increasing deployment of CCTV [20]. A technique for detecting vehicle accidents using multi-view cameras has been described. These approaches are intended to reduce automobile accidents at first-time junctions. As a result, they're useless when it comes to detecting automobile accidents in parking lots. Because it is incapable of analyzing and making judgments based on human judgment. As a result, we want to implement an intelligent monitoring system to support the observer's judgment. It is used to track traffic accidents. When there is an accident, the video footage is reviewed. A large shift in the direction is quickly discernible [19] [21].

B. Literature Review

Most of the previous research detected number plates as vehicle identification and authentication at the entrance of organizations. Although there are research and studies related to vehicle identification and authentication. According to the available research papers [5] [6] [7] [8] [9] [10] [11] [12] and resources, there are several research developed and analyzed vehicle identification and authentication.

Automatic license plate recognition using a mobile device is concerned with an android program that converts an image obtained by the mobile device's built-in camera into a number plate and saves it to a database for later use. They are converting number plate photos to machine-encoded text utilizing OCR technologies in this process [5]. CampusSense has been preoccupied with efficiently monitoring, administering, and securing parking spaces on university campuses, ANPR cameras, and android-based mobile applications have been created [6]. iParking using the OpenALPR open-source library built a way for a license plate detection system to recognize vehicles arriving and departing. The license plate recognition device automatically recognizes the license plate registration number and distinguishes it from the user registration description when the vehicle approaches the barrier. If there is a match, open the entry door\cite [7].

An automatic number plate recognition system for vehicle identification using optical character recognition has introduced observation for vehicle number differentiating proof supplied OCR. OCR is used to read a printed character license plate that has been optically created and relies on layout coordination. This calculation is tested on a variety of brightening vehicle images. The final stage of vehicle license plate recognition is OCR. As well as operating a barrier system [8].

An automatic vehicle license plate recognition system for smart transportation has used automobile number plates to create an automated number plate recognition system. The proposed method may be used to teach people how to recognize country-specific car license plates. Obtaining over 1200 genuine number plate photos and training and analyzing performance [9]. The use of Hough lines and template matching in automated number plate recognition has resulted in a proven method for number plate detection and recognition based on Hough lines. The suggested ANPR approach is divided into two parts: One is the Canny detector is used in the number plate detection module. Another one is the template-matching number plate recognition module [10]. An algorithm-based approach for extracting number plates from automotive pictures was followed by character segmentation, rearrangement, and building of an automated parking charge collecting system using license plate data [11]. License plate recognition from still images and video sequences has been a concern about the different strategies for Number Plate Recognition in still photos or video sequences that have been created, and the goal of this study is to identify and evaluate them. Finally, this study provides researchers with a connection to a public picture collection that may be used to establish a standard benchmark for Number Plate Recognition algorithmic evaluation [12].

For wrong parking detection, previous researchers [17][18][19] and currently available systems used sensors to detect the wrong parked vehicle. Recent studies [18] identified, that two cameras attached to a mobile system made with Arduino, four DC motors, and a PIR sensor strategically placed to monitor parking space, especially within the marked rectangular lines of each parking lot, comprise a smart and effective system for the detection of wrong cars parking. Any movement that the remote monitoring system recognizes as a car in a parking space along the lines of parking lots is immediately addressed. After being identified, MATLAB software is used to process the obtained images. The cameras will identify any improperly parked vehicles, take a picture of them, and store them in a database. This system requires many hardware components and it’s not reliable because every vehicle should be treated individually by using DC motors and cameras. Another research [19] is for detecting wrong-parked vehicles using an Arduino, an ultrasonic sensor, a PIR motion sensor, and a Nextion display to show the results. From three ultrasonic sensors in a Moving Arduino, the Moving Arduino analyzes the signal and converts it to code, then sends the code to the Fixed Arduino through a wireless radio frequency. The results will be displayed on the Nextion display touchscreen via the fixed Arduino. Even though wrong-parked vehicle prediction accuracy is higher than other researched systems, this system’s budget is high, and this system is not cable of detecting multiple wrong-parked vehicles.

II. METHODOLOGY

A. Vehicle Identification and Authorization

Register the vehicle and the owner's information first. The parking and Monitoring System gathers information on the owner's personal information as well as photos and model data of the car during registration. Following the registration process, a monitoring system trains a dataset of vehicle images and forecasts the model of the vehicle. The architecture of the vehicle make and model recognition system is depicted in ‘Fig. 1’.

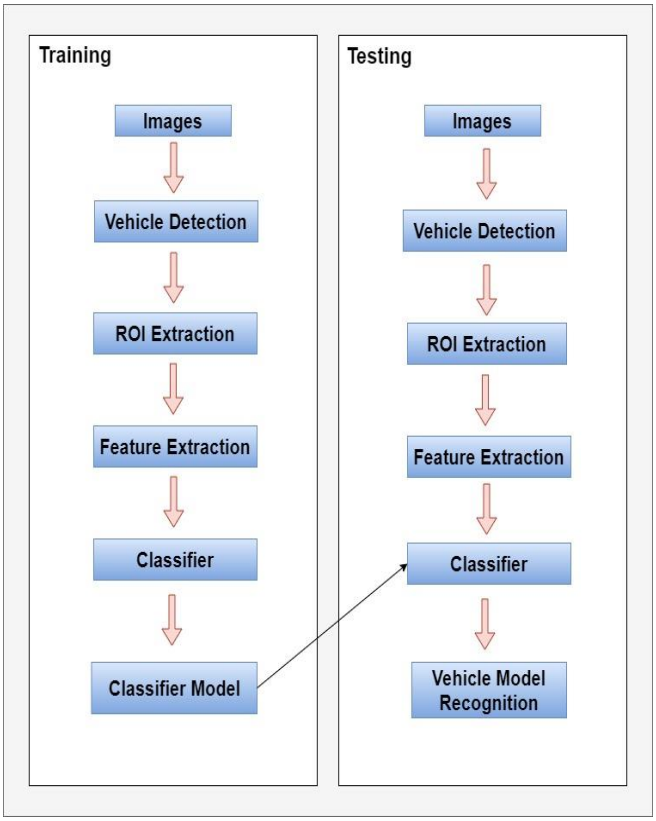

Figure 1: Architecture of a Vehicle Model Recognition System

For the vehicle recognition procedure in this instance, we use the Stanford Cars dataset [14]. More than 16,000 unique images representing 166 different vehicle classifications may be found in this dataset. 8 041 training images and 8 144 images for testing make up the data, which is roughly split 50/50 between the two groups. Classes are typically divided into Make, Model, and Year categories, such as the 2012 Tesla Model S or 2012 BMW M3 Coupe. Use a machine learning technique to train the dataset's images for this process. The first way of vehicle detection establishes if a vehicle is visible in each image, while the second method pinpoints the car's location within the picture. If there is a car in the image, additional processing is applied. The area of the car in the image that provides particular and conspicuous characteristics is known as the ROI. Different cars' particular and conspicuous features are simple to recognize. In order to build the system, we used vehicle model pictures from the registration process and an ROI that took the bonnet, front lights, and bumper region into consideration. Any image that is unfit for classification and could affect classification results is removed by the ROI extraction module, along with a section of the vehicle. For vehicle detection and ROI extraction, we will use an approach developed by Chen et al. [13].

Then, using a trained model, the Parking and Monitoring System detects the vehicle model and license plate when the vehicle approaches the organization's entry. When a car enters a parking lot, the Parking and Monitoring System identifies it and takes a picture for the model recognition procedure. The second technique then locates the vehicle inside the image after determining whether a vehicle is present in each image. If the image contains a vehicle, it is further processed. The ROI is defined as the portion of the vehicle in the image that has particular and conspicuous attributes. The particular and conspicuous features of various vehicles are easily identified. The Monitoring System's ROI was the bonnet, front lights, and bumper region. The ROI extraction module removes the backdrop and a piece of the vehicle from any image that cannot be identified. The trained model is then used by the Monitoring System to recognize the vehicle model. The Monitoring System then uses OpenCV and EasyOCR to detect number plate details. EasyOCR reads the vehicle's license plate characters here. Finally, the monitoring system confirms that the vehicle's registration and license plate information are correct. If the vehicle model and license plate data match, the vehicle is declared authorized. In that instance, the vehicle is permitted through the entrance barrier. Otherwise, the barriers prevent the vehicle from entering, and those vehicles must register.

B. Wrong Parked Vehicle Detection

As demonstrated in the "Fig. 2" diagram, to detect incorrectly parked vehicles, the system must identify the parking lines as well as the precise length and width of the vehicle, and the system must detect the parking line at the same time. To recognize the parking lines, we employed image processing techniques from open CV environments such as image HSV conversation, white extraction, and binarization.

Acquiring an output of vehicle detection by a machine learning method is not sufficient to acquire the precise length and width of the vehicle since that would identify the overall boundary line of the image. So, to determine the precise line and width, this system uses the Yolo model neural network-based algorithm to recognize the vehicle wheel.

The algorithm will then add threshold values for that line. The driving vehicle will be able to obtain the exact length and width from that system. Following that, the algorithm will determine if the car is outside of the parking slot or not, whether the vehicle is crossing the parking slot, and the distance between the vehicle and the parking slot.

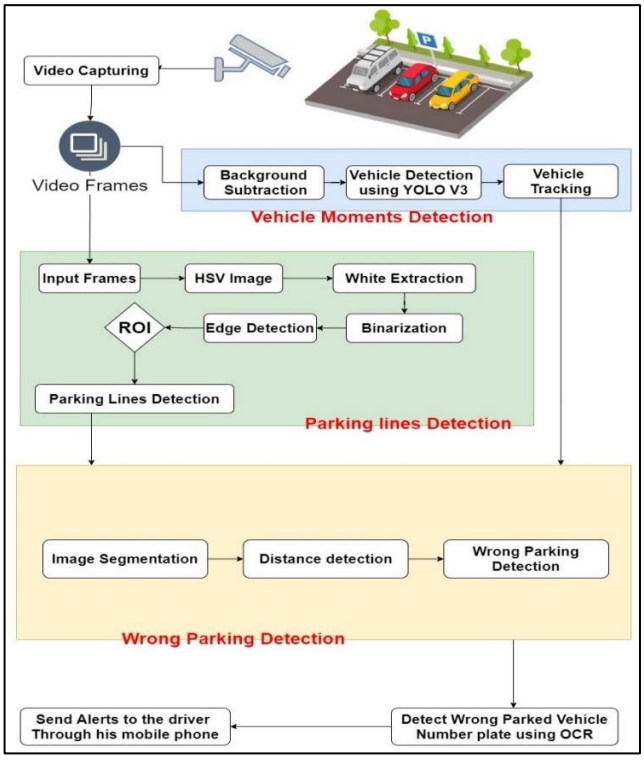

Figure 2: Wrong parking detection system Architecture

As demonstrated in 'Fig. 5,' that system will be able to detect incorrectly parked automobiles. If the system identifies an incorrectly parked car, it will get the vehicle's license plate information using OCR technology. The number plate information system will then send notifications to the driver's mobile phone.

III. RESULTS AND DISCUSSION

The vehicle Model Identification system predicts vehicles at the organization's entry using a trained dataset model with greater accuracy. As illustrated in 'Fig. 3', the vehicle recognition system correctly identifies the sample vehicle (Nissan Leaf) Make and Model with 97% accuracy. 'TABLE 1' also shows various vehicles, along with their make and model prediction accuracy rates.

Figure 3: Sample Predicted Vehicle Image

After predicting the vehicle model, the monitoring system uses OpenCV and EasyOCR to identify and read the vehicle license plate, as illustrated in 'Fig. 4'.

Table I: Sample Vehicle Model Predicted Accuracy

Vehicle Make, and Model	Prediction Accuracy
Nissan Leaf	97%
Suzuki Alto	95%
Suzuki WagonR	96%
Honda Vezel	93%
Suzuki Maruti	95%
Toyota Aqua	91%
Toyota CHR	96%
Honda Fit	97%
Toyota Prius	95%
Toyota Premio	94%

Finally, the monitoring system confirms that the vehicle's registration and license plate information are valid. If the vehicle model and license plate information match, the vehicles are considered authorized. In that instance, the vehicle is permitted through the entrance barrier. Otherwise, the barriers prevent the vehicle from entering, and those vehicles must register.

Figure 4: Number Plate Recognition

When the vehicles reach the parking area, the algorithm will precisely recognize the parking slots as well as the vehicle length and width using OpenCV, the Yolo model, and the vehicle space detection technique. The system will precisely decide whether the vehicle is correctly parked or not based on the parking line, vehicle detection distance, and vehicle positioning, as shown in 'Fig. 5'. Finally, if the system identifies an incorrectly parked vehicle, it will obtain the vehicle's license plate information and notify the driver via his mobile phone.

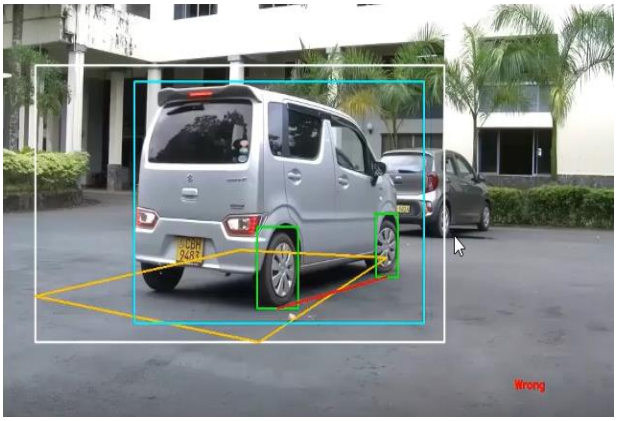

Figure 5: Wrong parked vehicle detection

IV. CONCLUSION

Security and vehicle safety have become key concerns in parking lots these days. We presented a smart parking area security and vehicle safety management system in this study. Our suggested system's primary concerns are parking area security and parked vehicle safety. This suggested system is divided into two primary components: vehicle identification at the entrance, and wrong parking vehicle detection. The first component is at the entrance of the organization of this suggested system detects and analyzes vehicle models with number plate details and controls the barrier system based on the vehicle's authorized status. As a result of its implementation, this proposed system detects the vehicle model and license plate with greater than 90% accuracy. As a result, the use of fake license plates near organization parking lots will be reduced.

The second component is detecting incorrectly parked vehicles. Consuming the YOLO model and OpenCV outputs, this system accurately detects incorrectly parked vehicles while using fewer resources. As a result, organizations will save costs on detecting incorrectly parked vehicles.

Our future research projects involve introducing more vehicle classes for vehicle recognition. So that will work in any real-world situation. And the addition of parked cars deliberates damage detection by people or animals. In addition, there is an automated parking space allocator for unmarked open area spaces.

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