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Automated Parking Space Detection

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Abstract

Searching a suitable parking space in populated metropolitan city is extremely difficult for drivers. Serious traffic congestion may occur due to unavailable parking space. Automatic smart parking system is emerging field and attracted computer vision researchers to contribute in this arena of technology. In this paper, we have presented a vision based smart parking framework to assist the drivers in efficiently finding suitable parking slot and reserve it. Initially, we have segmented the parking area into blocks using calibration. Then, classify each block to identify car and intimate the driver about the status of parking either reserved or free. Potentially, the performance accuracy of recommended system is higher than state of the art hardware solutions, validating the supremacy of the proposed framework. Finding a parking space nowadays becomes an issue that is not to be neglected, it consumes time and energy. We have used computer vision techniques to infer the state of the parking lot given the data collected from the University of The Witwatersrand.

Keywords: smart parking management; automatic parking; slot recognition; parking space detection; machine learning.

I. INTRODUCTION

So many researches on traffic congestion analysis reveal that an estimated 70 per cent of all drivers currently on the road are searching for effective parking. This will intensify traffic congestion as the vehicles spend more time on the road. Drivers may also tend to drive at low speed when they are searching for a parking space. Researches in this area have found out that vehicles spend an average of 15 minutes looking for a parking space, travelling at an average of 10 mph and covers only half a mile in the meantime.

Now a day's most of the parking areas are manually managed by human manpower and there is no automatic system to manage the parking area in an efficient way. There is great analogy that when a driver enters any of the parking lot he must look for some kind of information board that tells him about the status of the parking lot that whether it is fully occupied, partly occupied or vacant. Most of the times the drivers have to circle around the parking area in search of the free parking space. This kind of problem mostly occur in cities near the shopping malls, hospitals etc., where the number of vehicles is greater as compared to the parking spaces. The process for searching the free parking space is time consuming and also wastage of fuel. Most of the times the parking spaces remain unoccupied, however the total occupancy is low because of bad management of parking lot. This causes ineffective use of the parking area and also results in traffic jams and congestion near the parking lots. To properly manage the parking lot and display each parking division's information to the drivers before entering the parking lot have become an important issue to be resolved. In this paper, a system is proposed that will detect the total number of available parking spaces and displays the information to the drivers so that they can easily parked their cars. A web camera is used to get the images of the parking area and image processing techniques are used to detect the presence or absence of cars to count and locate the available parking spaces. The status of the parking lot is updated whenever a car enters or leaves the parking lot.

The result is frequent traffic congestion. When the drivers are in search of a parking space, the possibility for accidents increases as they give less attention to the road. A sophisticated car parking system can only solve these problems. That is why numerous research works are taking place in this area all around the world. Empty parking slot detection is the first phase of any smart parking system. The second phase is sharing this information to the drivers who are in search of parking lots. There are many methods used for detecting empty parking slots.

Fig 1: Parking System

II. BACKGROUND STUDY

The study highlights the significance of data acquisition through sensors and cameras installed in parking lots, contributing to the training and validation of machine learning models. The integration of deep learning techniques, such as convolutional neural networks, enables accurate and swift identification of parking space occupancy. Moreover, the study emphasizes the potential benefits, including reduced traffic congestion, optimized parking utilization, and improved overall urban mobility. As cities continue to grow and face parking challenges, the application of machine learning in parking space detection emerges as a promising solution with wide-ranging societal and environmental impacts.

Parking space detection using machine learning has gained prominence as a solution to urban congestion and efficient parking management. The background study delves into the increasing challenges of limited parking availability in urban areas, leading to traffic congestion and environmental concerns. Traditional methods for parking management are often inefficient, prompting the exploration of innovative technologies like machine learning. Machine learning algorithms, particularly computer vision models, are employed for real-time analysis of parking spaces. These models utilize image processing techniques to detect and classify vacant and occupied parking spots.

III. LITERATURE SURVEY

Various methods and techniques have been proposed to overcome the problem of parking in the congested areas. Ming-Yee Chiu et al. proposed a method for counting the vehicles at the checkpoint from which the number of available parking spaces can be counted. The counting is performed by installation of the induction loop sensors under the road surface. Although the usage of sensors was less costly, not easily affected by environmental conditions and it detects accurately however, it installation was difficult and cause damage to roads. It was also difficult to maintain it in case of malfunction. Moreover, the exact locations of free parking area cannot be determined because the counting method is not able to give the detail information, it just records the number of vehicles passing the checkpoints.

The other kinds of detection methods are presented based on vision-based methods. Through vision-based methods, the whole parking area available for parking can be examined though the camera, the data is than processed and the result generated will determine the exact number and location of the free parking spaces. Zhang Bin et al. proposed that vision-based parking space detection methods are very easy to install, low in cost and the detector can be easily adjusted according to requirements. Moreover, the data obtained from images is very rich. However, the defects in the vision method are that the accuracy is highly dependent upon the position of the camera.

The other detection methods were based on use of sensors like ultrasonic, infrared and microwave for the detection of vehicles. These sensors are placed beneath every parking space. Wan-Joo Park et al. proposed the use of ultrasonic sensors mounted on the cars to search for a free parking space. The disadvantage of this method was that the sensors are easily affected by weather conditions like rain, temperature, snow and fast air breeze. Another method was presented by Vamsee K. Boda et al. based on wireless sensor nodes. This method was less costly and it uses the wireless sensor nodes implemented at the critical places like the lane turns, entrance and exit positions of the parking lot. The total number of cars in the parking area can be determined by the difference of incoming and outgoing cars.

IV. METHODOLOGY

4.1. Data Collection: Gather a dataset of images or video frames that capture parking spaces in various conditions. Acquire a diverse dataset of parking lot images, capturing various lighting conditions, weather, and vehicle types. Annotate the dataset to label parking spaces as vacant or occupied.

4.2. Data Annotation: Annotate the dataset by labeling each parking space as "occupied" or "vacant." You may use bounding boxes or pixel-level annotation, depending on the project's complexity.

4.3. Data Preprocessing: Clean and preprocess the data. Resize images, normalize lighting, and augment the dataset with techniques like rotation and scaling to enhance model robustness. Resize and normalize images to a standard format. Augment the dataset with techniques such as rotation, flipping, and changes in brightness to enhance model generalization.

4.4. Model Selection: Choose a machine learning model suitable for object detection. Common choices Shot MultiBox Detector), or MobileNet-SSD for real-time include.

4.5. Validation and Testing: Evaluate the model's performance on the validation set, adjusting hyperparameters as needed. Split the dataset into training and validation sets. Train the selected model using the annotated images to learn features and patterns associated with vacant and occupied parking spaces. Fine-tune the model to improve performance.

4.6. Real-Time Detection: Integrate the trained model into a system that can process video streams or images in real-time from cameras placed in parking areas.

4.7. Testing and Deployment: Test the trained model on new, unseen data to ensure its generalization capability. Deploy the model to the target environment, integrating it with cameras or sensors for real-time parking space detection.

4.8. Monitoring and Maintenance: Regularly monitor the model's performance in the deployed environment. Update the model as needed to adapt to changes in the parking lot conditions, such as alterations in infrastructure or lighting.

V. CLASSIFICATION

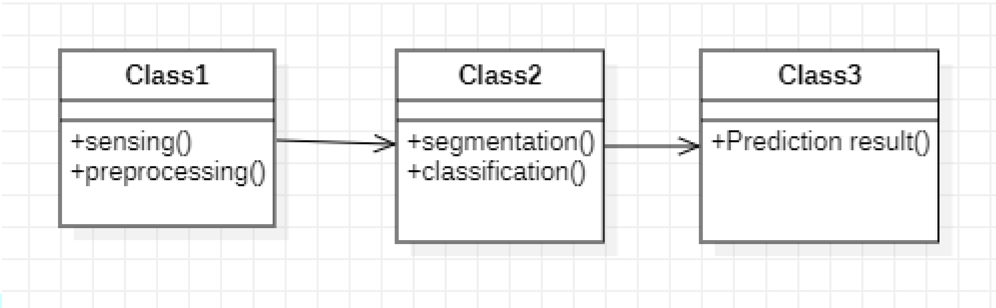

Fig 1: Class Diagram

5.1. Sensing: Utilize sensors or cameras placed in parking lots to capture images or video frames. Sensors can include cameras, LiDAR, ultrasonic sensors, or other technologies capable of detecting the presence of vehicles in parking spaces. Data from sensors provide the raw information for the subsequent stages of the detection process.

5.2. Preprocessing: Resize and normalize the captured images or video frames to a standard format for consistency. Enhance the quality of images through techniques like contrast adjustment or noise reduction. Augment the dataset through transformations to improve the model's ability to generalize.

5.3. Segmentation: Use image processing techniques or deep learning methods to segment the parking lot image into distinct regions corresponding to individual parking spaces. The segmentation step helps isolate each parking space for further analysis and reduces complexity for subsequent classification.

5.4. Classification: Apply a machine learning model, often based on classification algorithms, to each segmented parking space. Train the model using labeled data to distinguish between vacant and occupied parking spaces. Features extracted during preprocessing and segmentation contribute to the classification decision. Common classification models include Support Vector Machines (SVM), Random Forest, or neural networks.

5.5. Prediction Result: Once the model is trained and deployed, it predicts the occupancy status (vacant or occupied) for each segmented parking space. The prediction results provide real-time information on the availability of parking spaces in the monitored area. Results can be visualized in a user interface, transmitted to a central server, or integrated into smart parking systems to guide drivers to available spaces.

VI. FUTURE SCOPE

As smart city initiatives gain momentum, parking space detection systems will play a crucial role in optimizing urban mobility, reducing traffic congestion, and supporting sustainable transportation practices. The evolution towards predictive analytics and behavioural analysis may empower these systems to anticipate parking space availability, offering drivers proactive information and contributing to a more streamlined and environmentally conscious urban landscape. Overall, the future holds great promise for machine learning-based parking space detection, fostering smarter and more efficient urban environments. The evolution towards smart cities will see parking space detection becoming an integral part of urban infrastructure. Seamless integration with navigation apps and in-vehicle systems will guide drivers to available parking spaces, reducing traffic congestion and fuel consumption. the future may witness the incorporation of sustainability features, allowing parking space detection systems to contribute to environmental goals by optimizing parking infrastructure and minimizing unnecessary vehicle circulation. As technology continues to advance, the application of machine learning in parking space detection holds great potential to address urban challenges, streamline transportation, and create more sustainable and user-friendly urban environments.

VII. CONCLUSION

The main contribution of this study is to optimize the identification of available parking slots to possibly reduce the congestion in parking arena. Due to advancement in machine learning and vision base technology cost effective automatic parking systems facilitate the drivers to locate available spaces at parking arena. Future researchers can focus on allocation specific location to customers already registered from online parking management system. The first section of the smart parking system is the parking slot detection. This can be done using sensors placed at different locations of the parking lot. But this is a very costly system with a lot of drawbacks. The image processing based empty parking lot identification has made the system simple as well as cheap. Here we need only to use images captured by the surveillance camera in the parking lot for empty slot detection. OCR based solution will be an integral part of future smart parking systems. Using suitable image processing algorithms the accuracy of detection can be improved.

VIII. ACKNOWLEGMENT

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