CAR PARKING SLOT DETECTION USING YOLO ALGORITHM

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Abstract **- Finding free slots in the parking area has become a major problem that the modern society is facing nowadays, which also leads to traffic overcrowding at the parking area. As the number of vehicles are increasing at a quick pace find parking slots has become difficult. The proposed paper helps to solve the parking problem. In traditional parking system a person has to find vacant slot or a gate keeper needs to inform about the available parking slot at parking area. To address the issue, a system where the user will be able to know the number of vacant slots in a particular parking area along with total number of slots at the entrance of the parking area. As a critical component of this project, by built a car parking slot detection system which collects data from a camera at parking area. Today's most popular object detection model YOLO, is trained to achieve desired results with good precision scores at real-time speed. The model will be getting all the parking slots that are present in the parking area, to which marking boxes are drawn around for training. Real time processing is performed on the obtained data by the model to find whether the slot is vacant or occupied. Thus, it gives the information of available vacant slots to park the car at parking area.**

Key Words: **YOLO, Object detection, Computer vision, Machine learning.**

I.INTRODUCTION

Over the past decade, the number of vehicles has soared significantly, straining the existing transportation infrastructure and parking facilities. This has led to widespread traffic congestion and parking shortages. To address these issues, real-time detection of available parking spaces is crucial. By providing drivers with up-to-date information about empty stalls, it can reduce traffic buildup, enhance the efficiency of parking lot operations, and minimize the time spent searching for an empty space. Considerable efforts have been made to tackle the transportation challenges posed by the surge in vehicles. To address parking challenges, various technologies like sensor-based computer vision classifiers have emerged. However, their high cost and limitations in efficiency and robustness present obstacles. To resolve these issues, researchers have devised parking lot recognition techniques utilizing resources like video cameras and sensors to identify occupied and unoccupied parking spaces. One such approach leverages YOLO (You Only Look Once), an object detection algorithm powered by Convolutional Neural Networks (CNN). This project aims to address parking space limitations through video footage from surveillance cameras. By analyzing these videos, the system can accurately identify vacant parking spaces, making it easier for drivers to locate available spots. This solution eliminates the time-consuming process of searching for parking, ensuring that drivers can park quickly and efficiently.

II. LITERATURE SURVEY

In [1] an automated vehicle parking slot detection system utilizes Mask R CNN and PSDL for efficient instance segmentation, marking point detection, and free space identification between vehicles. The approach focuses on vision-based car parking technology using web cameras and addresses infrastructure maintenance and cost concerns associated with sensor-based systems. Successful implementation demonstrates high accuracy in object detection, emphasizing practical implications for real-world applications.

In [2] a car detection-based algorithm for automatic parking space detection aims to automate mapping by emphasizing car detection and available space identification. It indicates potential for a 90% reduction in human effort and nearly 100% detection when all spots are occupied. The approach's adaptability across varied parking lots and camera angles is attributed to its focus on car features rather than parking lot features.

In [3] a method for small target detection utilizes dilated modules, feature fusion, and passthrough modules. It integrates 1x1 convolutions to reduce network dimension and improve detection speed. Evaluation with VEDAI and DOTA datasets shows its effectiveness compared to state-of-the-art algorithms.

In [4] a method for judging parking status using the YOLOv2 target detection algorithm was developed, employing machine vision to differentiate parking spaces. Over 600 images of moving and stationary vehicles were collected using a drone, leading to the creation of a vehicle contour recognition model. The YOLOv2 algorithm was then applied to identify parking spaces and determine vehicle occupancy, providing a comprehensive approach to smart transportation.

In [5] compares R-CNN, Fast R-CNN, Faster R-CNN, YOLOv1-4, and SSD for object detection, emphasizing a trade-off between precision and speed. It highlights data augmentation's role in improving robustness and optimizing training for precision. Single-stage detection models are favoured, and the selection should align with specific application requirements.

In [6] the method integrates YOLOv4 with an efficient channel attention mechanism, improving object detection accuracy in deep learning. It evaluates using mAP and detection speed and compares with other works. Experimental results demonstrate improved detection accuracy, highlighting the effectiveness of the approach.

In [7] a system using YOLOv4 integrates Korean License Plate Recognition with vehicle type detection for smart city applications. The methodology involves deep learning and open-source frameworks to train YOLOv4 for custom class detection. Multiple authors contributed to the comprehensive study, showcasing potential for urban mobility solutions.

In [8] an improved YOLOv4_AF model for vehicle detection utilizes an attention mechanism to enhance feature suppression and down-sampling. This enhances object detection and classification accuracy, outperforming other state-of-the-art models in mAP and F1 score. The method increases the receptive field in both channel and spatial dimensions, presenting a more precise vehicle detection and classification model.

In [9] covers vision-based deep learning methods for parking slot detection, categorizing them into four main categories: object detection, image segmentation, regression, and graph neural network. It analyses performance using datasets like PS 2.0, SNU, and PSV, highlighting the diversity and effectiveness of these datasets. The document also discusses techniques for reducing model FLOPS during inference and leveraging embedded systems for running deep learning models.

In [10] camera-based system combining computer vision techniques aims to address the limitations of traditional sensor-based methods in autonomous parking. The algorithm demonstrates robustness in detecting parking slot occupancy and obstacles like cars and trees in varying conditions. Despite the lack of a standard public dataset, the algorithm's functionality is depicted in a flow diagram to illustrate its effectiveness.

In [11] an improved fire detection system, SFDS, leverages YOLOv8 for real-time detection, with potential for broader object recognition. It utilizes Fog, Cloud, and IoT layers in smart city frameworks, emphasizing data security and open access infrastructure.

In [12] approach described introduces a low-cost system for tracking parking time violations using CCTV, YOLOv8 for object detection, and Deep SORT/OC-SORT for vehicle tracking. The conclusion emphasizes the effectiveness of the algorithm in a time series context, citing its accuracy and the innovative use of state-of-the-art detection and tracking models.

In [13] an improved YOLO v3 network model is used for vehicle and parking space detection, exhibiting enhanced accuracy and reduced missed detection rates. The model leverages three datasets – PASCAL VOC, COCO, and PKLot – focusing on car, bus, and truck categories, and employing a feature pyramid network structure for prediction.

In [14] T-YOLO is a state-of-the-art model for detecting vehicles of various sizes in parking lot scenarios. It utilizes a multi-scale mechanism, data augmentation techniques, and attention modules to significantly improve precision and reduce trainable parameters compared to the baseline YOLO-v5 architecture.

In [15] the study focuses on developing a method for object detection in traffic scenarios using the DAWN dataset, YOLOv4, and spatial pyramid pooling network, emphasizing adaptive data fusion for autonomous driving systems. It also extends the vehicle detection algorithm for trajectory analysis and includes image augmentation techniques for specific weather conditions.

Table 1: Summarization of various Authors

Authors	Title	Research focus	Remarks
Bandi Sairam and Gopi Krishna [1], 2020	"Automated Vehicle Parking Slot Detection System Using Deep Learning"	Using Mask R CNN architecture and PSDL for automated parking slot detection, emphasizing vision-based technology and addressing challenges of sensor-based systems.	Limitations in computation, data needs, accuracy, real-time processing, robustness, and cost.
Raj Patel and Praveen Meduri [2], 2020	"Car Detection Based Algorithm for Automatic Parking Space Detection"	Automate parking space mapping and detection through car detection, reducing human effort and improving parking management.	Automated parking space mapping and detection through car and reduces human effort.
Moran JU and Haibo LUO [3], 2020	"A Simple and Efficient Network for Small Target Detection"	Develop a fast, efficient network for small target detection, comparing it to state-of-the-art algorithms.	Limited by the network's simplicity and speed, which may trade off some accuracy compared to more complex models.
Hanbo Zhoua and Wei Xiangc [4], 2021	"Method for judging parking status based on yolov2 target detection algorithm"	Use YOLOv2 and machine vision to detect parking spaces and vehicle presence for smart transportation.	Scalability and real-time processing constraints.
Aakash K. Shetty and Yashkumar J. Patel [5], 2021	"A Review: Object Detection Models"	Compare object detection methods, considering performance, challenges, and optimizations.	Limitations in terms of speed, accuracy, and effectiveness in detecting small objects.
Cui Gao and Qiang Cai [6], 2020	"YOLOv4 Object Detection Algorithm with Efficient Channel Attention Mechanism"	Enhancing YOLOv4 with efficient channel attention to improve accuracy in computer vision.	Computational complexity, tuning sensitivity, small object detection, and false positives.
Se-Ho Park and Hyoseok Yoon [7], 2022	"An All-in-One Vehicle Type and License Plate Recognition System Using YOLOv4"	To develop a smart city application for Korean License Plate Recognition (LPR) and vehicle type detection using YOLOv4.	Limited accuracy in complex environments for vehicle type recognition.
Jingyi Zhao, Zhanlin JI and Ivan Ganchev [8], 2021	"Improved Vision-Based Vehicle Detection and Classification by Optimized YOLOv4"	Enhancing object detection in intelligent transportation with modified YOLOv4 and attention mechanism.	Enhancing transportation system object detection with YOLOv4, attention mechanism, and down-sampling.
Guan Sheng Wong, Kah Ong Michael Goh and Aznul Qalid Md. Sabri [9], 2023	"Review of Vision-Based Deep Learning Parking Slot Detection on Surround View Images"	To categorize deep learning methods for parking slot detection on surround view images.	Vision-based deep learning for parking slot detection on surround view images.

Upendra Suddamalla and Balaji Ravichandiran [10], 2020	“Camera Based Parking Slot Detection For Autonomous Parking”	To detect free parking spots using a side-mounted car camera in dynamic environments.	Improve the accuracy and robustness
Fatma M. Talaat and Hanaa Zain Eldin [11], 2023	“An improved fire detection approach based on YOLO-v8 for smart cities”	To improve fire detection accuracy in smart cities via deep learning & IoT/Cloud/Fog integration.	Requiring further research to enhance accuracy and reduce false alarms.
Nabin Sharma and Rathachai Chawuthai [12], 2023	“Parking Time Violation Tracking Using YOLOv8 and Tracking Algorithms”	low-cost parking time violation tracking using CCTV, Deep Learning models, and object tracking algorithms.	Limitations include cost, complexity, data quality, privacy, security, and maintenance.
Xiangwu Ding and Ruidi Yang [13], 2019	“Vehicle and Parking Space Detection Based on Improved YOLO Network Model”	Developing an improved YOLO network model for accurate and robust vehicle and parking space detection in complex parking lot scenes.	Complex and variable parking IOT scenes may challenge accurate vehicle and parking space detection.
Daniel Padilla Carrasco and Domènec Puig [14], 2021	“T-YOLO: Tiny Vehicle Detection Based on YOLO and Multi-Scale Convolutional Neural Networks”	To improve tiny object detection accuracy in images using a multi-scale mechanism and attention modules.	Increased computational complexity and potential for overfitting with additional parameters.
Mamoona Humayun and Marwah Khalid Alsadun [15], 2022	“Traffic Management: Multi-Scale Vehicle Detection in Varying Weather Conditions Using YOLOv4 and Spatial Pyramid Pooling Network "	To improve object detection in traffic scenarios for autonomous driving systems using the DAWN dataset and adaptive data fusion.	limited real-world scenarios and potential bias.

III. CONCLUSION

One of the most common problems is to find parking slots, which has become a serious issue in contemporary urban mobility as the number of vehicles are increasing day by day. The traditional system of finding parking slots manually is quite challenging in practical usage. Based on the literature survey, the implementation of the YOLO (You Only Look Once) algorithm for car parking lot detection showcases its effectiveness in accurately identifying and delineating parking spaces. Research papers consistently demonstrate YOLO's capability to efficiently detect vehicles within parking lots, aiding in occupancy detection and management. The algorithm's real-time processing and high accuracy make it a promising solution for automating parking space monitoring systems, contributing significantly to smart city initiatives and traffic management.

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