SURVEY REPORT ON PARKING MANAGEMENT SYSTEM USING OPENCV AND IMAGE PROCESSING

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Abstract - The Parking Management System utilizing OpenCV techniques represents a technological advancement in the domain of parking operations. This system makes use of image processing and computer vision techniques to automate and improve a number of parking facility operations. It provides license plate recognition for safe access control along with real-time vehicle tracking and detection for effective monitoring of parking space occupancy. This creative approach claims to increase parking effectiveness, lessen traffic, boost security, and provide a more convenient parking experience for car owners and operators. It could be challenging to obtain a suitable parking spot, especially in big cities. The suggested method analyzes parking lots using computer vision techniques based on deep learning. The technology distinguishes between occupied and vacant parking spaces by dividing the parking area into blocks and determining each one's occupancy status. Users are then informed of this information through an intuitive interface, which offers real-time updates on parking availability. Sometimes it's challenging to obtain a suitable parking spot. Our system performs better than others compared to commercially available solutions because it offers higher accuracy

Keywords - *Parking management, Automatic parking, Slot recognition, Parking space detection.*

I. INTRODUCTION

Many parking lots still lack automated monitoring systems and are maintained manually. Finding empty parking spaces is a common problem for drivers, particularly in some areas which have high traffic density like malls and hospitals. It can take a while to find a suitable parking spot because you have to keep going around the lot in circles. Ineffective parking management acts as a factor in both traffic clogged and ineffective use. We suggest a fix: using a smartphone app to the monitor and show the available space, we can improve the parking efficiency.

All the Standard parts for paper have been established with their use cases. The method proposes a Smart Parking System with OpenCV and Python and utilizing cutting-edge image processing methods [19], Semantic representation of a parking lot that provides an overview of autonomous real-time vehicle mapping and localization [15]. The implementation of electric vehicle speed control improves automation and steering control for improved path following. It also incorporates intelligent detection of vertical parking scenarios, which improves parking space suitability and convenience [20] and improper parking detection in real time IoT technology integration for improved parking management and automated parking charge collecting for effective revenue management [11] .

In this study, we explore how OpenCV and image processing are integrated, highlighting their critical role in developing a smart parking management system. In addition to increasing parking space recognition accuracy, the system aims to provide better traffic flow, less traffic, and an all- around optimal urban parking experience. The approach, benefits, and possible effects of using OpenCV and image processing to transform parking management will be covered in this paper.

II. LITERATURE SURVEY

A literature survey plays a crucial role by examining various analyses and research conducted in the relevant field. It delves into the outcomes already published, considering different project parameters and the project's scope. The primary purpose of a literature survey is to scrutinize the background of the current project, identifying weaknesses in most of the existing system and highlighting unresolved issues to address. The topics covered not only offer perceptions into the project's background but also reveal the problems and deficiencies that inspired the proposal of solutions and the initiation of the project.

[1] “SSD: Single Shot MultiBox Detector”: SSD incorporates scales and ratios into a neural network framework to improve speed and accuracy.

[2] “Modelling smart road traffic congestion control system using machine learning techniques”: In order to alleviate traffic congestion in smart cities, this study suggests MSR2C-ABPNN, a novel solution that combines artificial intelligence and transportation management.

[3] “East: an efficient and accurate scene text detector”: a reliable and effective scene text detection system EAST is

faster and accurate than the previous methods in text detection across a variety of datasets.

[4] "Smart mobility in smart city": This study classifies smart mobility initiatives in smart cities, emphasizing their effects, and stakeholder roles in urban development.

[5] "Detection and simulation of vacant parking lot space using east algorithm and haar cascade": This study presents a simulation program for parking space detection that improves efficiency through real-time tracking.

[6] "Model ic design lesson for improving the use of the higher education system": In order to improve the use of Mentor Graphics' HEP software in IC design education, this paper presents a tiered architecture.

[7] "A novel architecture of parking management for smart cities": This study highlights the advantages and difficulties of IPA, which integrates technology for optimal parking in smart cities.

[8] "Intelligent Transportation System (ITS) for Smart cities using Mamdani Fuzzy Inference": In order to model traffic in smart cities, this article suggests integrating MFIS with ITS and using fuzzy logic.

[9] "Sensor technologies for real-time parking prediction in urban areas": This study offers sensor-based models for parking occupancy prediction in cities.

[10] "Recent developments in human motion analysis": This paper examines human motion analysis based on computer vision, describing important fields, uses, and a thorough taxonomy.

[11] "The Smart parking management system": It makes use of Android apps, Arduino components, and the Internet of Things.

[12] "Car Parking Space Detection Using OpenCV": This paper describes an effective space recognition technique for car parking detection that makes use of OpenCV.

[13] "Smart parking system based on embedded system and sensor network": Introducing RSPS, a smart parking system that relies on reservations and uses sensors and the Internet of Things to reduce traffic.

[14] "Research on Automatic Parking Systems Based on Parking Scene Recognition": Using scene recognition to improve intelligent vehicle systems, an automated parking system is suggested.

[15] "Vehicle detection and car park mapping using laser scanner": This study describes a real-time mapping system that uses laser scans for parking lot mapping and vehicle localization. The system uses a laser scanner for vehicle detection.

[16] "A Cloud-Based Smart-Parking System for Internet of Things Technologies": The IoT smart parking system that this study suggests would optimize parking costs and user experiences. It is cloud-based.

[17] "An IoT-based E-parking system for smart cities": In order to improve smart parking management and address issues with payment and congestion, this study presents an IoT-based E-parking system.

[18] "Parking Management System using Open CV": In order to improve image quality and increase precision of vehicle detection in smart parking management systems, this paper presents Background Removal image enhancement.

[19] "Smart Parking System using Python and OpenCV": In order to improve intelligent vehicle systems, this study suggests an automated parking system that makes use of scene recognition.

[20] "Research on Automatic Parking Systems Based on Parking Scene Recognition": This paper enhances the capabilities of intelligent car systems by proposing an automated parking system that makes use of scene recognition.

[21] "Mobilenets: Efficient convolutional neural networks for mobile vision applications: Exploring MobileNets": Compact CNNs designed for efficient performance in mobile vision applications.

III. ALGORITHMIC APPROACHES

Our parking management system combines several algorithmic strategies, combining object recognition, text detection, and predictive modelling methods. A comprehensive solution covering all facets of parking lot monitoring and traffic forecasting is ensured by this integration.. Combining these approaches guarantees thorough parking surveillance and effective traffic projections.

A. Convolution Neural Network

Three separate layers make up Convolutional Neural Nets (CNNs): the convolutional, activation, and pooling layers. Important features of the image are produced by the convolutional layer, which uses filters to process data through sliding operations, similar to machine vision kernels. [12] The FCN model in the EAST pipeline streamlines the process while preserving efficiency and high accuracy in natural text detection. It allows for accurate text prediction in a variety of orientations and forms.[3] They are also used by researchers to improve segmentation models with richer input.

Advantages:

1) Vital element CNNs are capable of identification tasks without human oversight.
2) They are excellent at classifying and recognizing visual content.

Disadvantages:

1) It functions well, but requires a large amount of data.

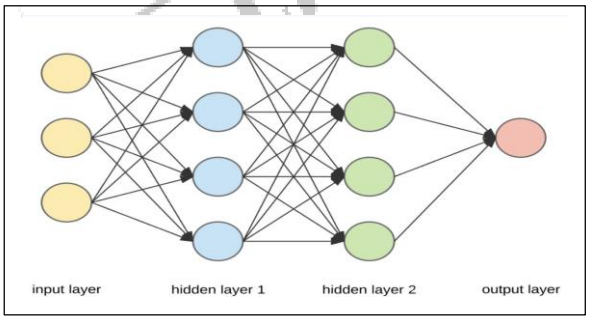

Fig. 1. CNN Algorithm

B. SSD: Single Shot MultiBox Detector

This study presents a novel object identidication method called SSD (Single Shot MultiBox Detector), which uses concept of deep neural network. SSD eliminates the need for conventional object proposal steps by discretizing bounding box outputs into default boxes across different aspect ratios or scales per feature map location.[1] SSD achieves high accuracy in predicting category scores and box adjustments by applying tiny convolutional filters to various feature maps. This approach incorporates predictions from multiple scale ratios, which significantly improves detection speed and simplifies end-to-end training. Experimental validation across benchmark datasets shows that SSD performs better while maintaining real-time efficiency compared to slower techniques like Faster R CNN. It is possible to integrate and implement the code.

Advantages:

1) The detection pipeline is made simpler by the SSD method, which achieves high accuracy without the requirement for separate proposal stages.
2) It greatly accelerates detection speed, surpassing slower methods such as Faster RCNN, while preserving accuracy that is competitive.

Disadvantages:

1) The accuracy of SSD may be impacted by its limited adaptability to specific object variations and shapes due to its reliance on predefined default boxes.
2) Difficulty in Detecting Smaller Objects: Because of its multi-scale architecture, SSD may have trouble correctly identifying smaller objects within images.

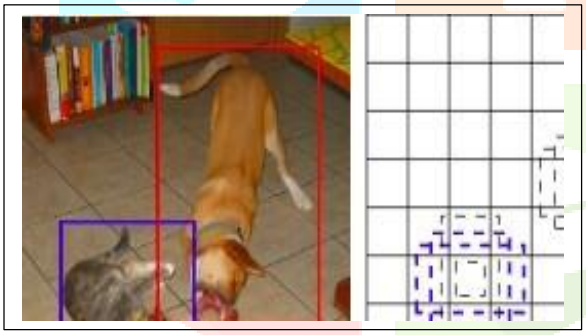

Fig. 2. SSD Algorithm

C. Mobilenets

A class of effective models designed for embedded and mobile vision applications is called MobileNets. By employing depth-wise separable convolutions, these models provide a simplified architecture that uses global hyper-parameters to trade off latency and accuracy. They enable developers to choose the right size models according to particular limitations. Robust performance of MobileNets in ImageNet classification, object detection, fine-grain classification, face attributes, and geo-localization is proven by extensive experiments.[22] Their emphasis on more efficiency makes it suitablefor applications such as augmented reality, robotics, and self- driving cars that require processing power on limited platforms. Their ability to perform well on a variety of visual recognition tasks highlights their adaptability and suitability for practical implementation in resource-constrained settings. In the field of embedded vision applications, MobileNets continue to be a crucial option for bridging the accuracy-computation efficiency gap as the need for robust yet efficient models increases.

Advantages:

1) Depth-wise separable convolutions are used by MobileNets to reduce the computational complexity without sacrificing accuracy.
2) They provide customization based on particular application constraints for mobile and embedded vision tasks, allowing flexibility through global hyper- parameters..

Disadvantages:

1) When compared to larger and complex models that have been optimized exclusively for high precision tasks, MobileNets may have to give up some accuracy.
2) In contrast to bigger, more intricate models that have only been fine-tuned for extremely precise tasks.

III. DISCUSSION

A. Objectives

Real-Time Parking Spot Detection: The main goal is to create a real-time parking management system using OpenCV, [13]by utilizing sensor networks or IoT- integrated devices, this system seeks to detect and monitor available parking spaces through computer vision techniques.

Smart Surveillance and Traffic Optimization: This project uses OpenCV to integrate smart surveillance capabilities. In addition to parking spot detection, this goal calls for clever traffic optimization techniques.[11] By providing required information on parking availability, the system can help us reduce traffic congestion and improve urban living.

User Interface Enhancement: The project's goal is to create an intuitive and user-friendly interface.[10] The goal is to develop an application or platform that the users can easily use to reserve parking spaces, check parking availability, and receive real-time updates through OpenCV-driven functionalities**.**

Algorithm Optimization and Efficiency: To minimize computational load and boost system performance without compromising parking space detection accuracy, optimize OpenCV algorithms and image processing methods.

Thorough System Assessment: Carry out thorough testing and assessment of the developed system's precision, speed, and dependability in various parking situations, confirming its efficacy and appropriateness for real-world implementation.

B. Challenges

Reliability in Adverse Conditions: In place a parking management system that depends on camera-based systems and sensor technologies presents a challenge in terms of maintaining consistent performance during inclement weather or reduced visibility.[5] Reliability of system operation depends on maintaining accuracy in detecting available parking spots despite such challenges.

Initial Deployment Costs: One major obstacle is the upfront costs related to the deployment of

infrastructure.[7] The implementation of sensors, transceivers, communication networks, and predictive models may result in significant expenses, which could hinder their broad acceptance by local governments or parking management organizations.

Technology Dependency and Maintenance: There are maintenance-related issues brought about by the reliance on wireless networks and sensor technologies.[9] Regular maintenance of sensors and communication infrastructure is necessary to ensure consistent functionality and accuracy. To preserve system dependability, potential problems like sensor malfunctions or communication breakdowns must be resolved right away.

Variable Lighting Conditions: Handling a variety of lighting conditiodns can be difficult for reliable detection accuracy. OpenCV's robust algorithms are needed to handle changes in brightness, shadows, and glare in various parking situations.

V. CONCLUSION

Finally, this survey explores the terrain of OpenCV-enabled parking management systems, gleaned from a thorough examination of 21 reference articles. An important development in this field is the application of OpenCV algorithms, which provide flexible tools for computer vision, image processing, and object detection in parking surveillance. By examining these reference papers, a comprehensive understanding that highlights the various applications and approaches used to improve parking management with OpenCV comes to light.

The compilation of these reference papers highlights how OpenCV can be used to tackle a wide range of complex parking management issues. A sophisticated method for maximizing parking space utilization is presented by the combination of multiple OpenCV-based techniques, which range from vehicle identification and classification to space identification and monitoring. The potential for real-time monitoring, predictive analysis, and adaptive parking solutions that meet the changing needs of contemporary urban environments is further demonstrated by the convergence of these methodologies.

Still, this survey provides a solid starting point for future research and development. Future research could focus more on integrating edge computing for improved real-time processing, integrating machine learning models with OpenCV for more reliable object recognition, and integrating IoT for seamless connectivity within smart parking ecosystems. As the field develops, combining cutting-edge technologies with OpenCV techniques has the potential to transform parking management paradigms and promote more effective and sustainable urban mobility solutions.

REFERENCES

[1] Wei Liu1, Dragomir Anguelov, Dumitru Erhan et al. “SSD: Single Shot MultiBox Detector”, 2020.

[2] Ata, A., Khan, M.A., Abbas, S., Ahmad, G., Fatima, A. “Modelling smart road traffic congestion control system using machine learning techniques”, 2019.

[3] Zhou, Xinyu, et al. “East: an efficient and accurate scene text detector”, 2017.

[4] Benevolo, C., Dameri, R.P., D’Auria B. “Smart mobility in smart city ” , 2016.

[5] Harahap, Rizki Alfarizi, Eri Prasetyo Wibowo, and Robby Kurniawan Harahap. “Detection and simulation of vacant parking lot space using east algorithm and haar cascade” 2021.

[6] R. K. Harahap no-E. P. Wibowo, “Model ic design lesson for improving the use of the higher education system”, 2023.

[7] Giuffrè, T., Siniscalchi, S.M., Tesoriere, G., “A novel architecture of parking management for smart cities,” 2012.

[8] Kashif, I., Muhammad, A.K., Sagheer, A., Zahid, H., Areej, F., “Intelligent Transportation System (ITS) for Smart cities using Mamdani Fuzzy Inference,” ,2018.

[9] Vlahogianni, E.I., Kepaptsoglou, K., Tsetsos, V., Karlaftis, M.G., “Exploiting new sensor technologies for real-time parking prediction in urban areas”, 2014.

[10] Wang, Liang, Weiming Hu, and Tieniu Tan, “Recent developments in human motion analysis,”, 2003.

[11] Amira. A. Elsonbaty1 and Mahmoud Shams, “The Smart parking management system” , 2020.

[12] Rahul Tekam, Pranav Rathi, et al, “Car Parking Space Detection Using OpenCV” , 2023.

[13] Shaikh, Faiz Ibrahim, et al. "Smart parking system based on embedded system and sensor network.", 2016.

[14] S. Ma, H. Jiang, M. Han, J. Xie and C. Li, “Research on Automatic Parking Systems Based on Parking Scene Recognition,” , 2017.

[15] Keat, C.T.M.; Pradalier, C.; Laugier, “Vehicle detection and car park mapping using laser scanner” , 2005.

[16] Thanh Nam Pham, Ming-Fong Tsai, Duc Binh Nguyen, Chyi-Ren Dow, and Der-Jiunn Deng, “A Cloud-Based Smart-Parking System for Internet of Things Technologies” , 2015.

[17] P. Sadhukhan, “An IoT-based E-parking system for smart cities” , 2017.

[18] Priyanshu Singh, Divya K , “Parking Management System using Open CV,” , 2023.

[19] Jashwanth Dasari, Shivani Vodnala, Swapna Enugala “Smart Parking System using Python and OpenCV”, 2017.

[20] D. Ashok,A. Tiwari, V Jirge “Smart Parking System using IoT Technology” , 2020.

[21] Howard, Andrew G., et al. "Mobilenets: Efficient convolutional neural networks for mobile vision applications.", 2017.