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Object detection analysis based on Machine Learning Algorithms

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Abstract - The branch of artificial intelligence known as computer vision focuses on developing and utilizing digital systems to process, examine, and interpret visual data. Computer vision aims to make it possible for computing equipment to accurately recognise an object's digital image and perform the necessary action.The field of transportation and artificial intelligence includes vehicle discovery, which is pivotal. Intelligent transport system (ITS) is a fashion used to produce an effective road transportation system. The Automated Driving System which has made significant advancements in recent times, heavily relies on vehicle identification in its armature. The fashion of detecting vehicles on the road is used for objects similar as vehicle shadowing, counts, and average speed of each vehicle, business analysis, and vehicle categorization and can be applied in a variety of settings. A wide, active, and grueling field of computer vision is real- time object discovery. This recognizes semantic objects of a particular class in digital prints and pictures. For face recognition, vehicle recognition, rambler counting, web image analysis, security systems, and tone- driving motorcars, object discovery is constantly employed.

Key Words: Vehicle dataset, ITS, Vehicle detection, Highway management

1. INTRODUCTION

With the continuous increase in the number of vehicles on the road, traffic accidents occur frequently and traffic safety problems are becoming more serious. In order to fundamentally alleviate road traffic pressure and reduce the number of traffic accidents, the intelligent transportation system (ITS) has come into existence. Vehicle tracking is the most critical part of the intelligent transportation system, which provides great support to solve traffic problems. Various important road traffic information can be obtained through the vehicle tracking process, such as vehicle location, vehicle type, vehicle distance, etc., which can provide a basis for the evaluation of vehicle driving and auxiliary connectivity in urban road scenarios. It is estimated that by 2030 there will be 2 billion motor vehicles on the road. Such a large number of vehicles has raised concerns about the safety of highways and streets. Therefore, intelligent control systems and integrated traffic management will be the solution to deal with the increasing number of vehicles. Therefore, for many years, research on vision-based intelligent transport systems (ITS), traffic planning and traffic engineering applications has been studied to extract useful and accurate traffic information for traffic image analysis and traffic flow control, such as vehicle counting, vehicle trajectory, vehicle tracking, traffic flow, vehicle classification, traffic density, speed, lane change, traffic recognition license plates, etc.

2. LITERATURE REVIEW

Sr. No.	Title	Algorithm	Year	Strength	Limitations
1	Potato Crop Stress Identification in Aerial Images using Deep Learning based Object Detection[22]	Retina-UNet-Ag	2021	Analyzing aerial images of a potato crop using deep neural networks. A Solo UAV and a Sequoia camera used for collecting aerial images of the field. LabelImg software is used to manually annotate the regions containing healthy and	Expand the dataset with newly collected images. Future goal is to include classes of different stressors, and to train the model to not only identify the stressed regions,

				unhealthy crop with rectangular bounding boxes	but also to identify the type of stress in the crop
2	Vehicle Detection and Tracking using Gaussian Mixture Model and Kalman Filter[3]	Gaussian Mixture Model(GMM) and Kalman Filter Method	2016	Uses ITS First step is video preparation as input for the system. Next step is Vehicle detection using the GMM method. The object detected as a vehicle was marked with a bounding box. The last step was tracking the detected object in each frame using Kalman Filter.	Light traffic condition obtains the precision of 100%, sensitivity of 94.44%, specificity of 100% and accuracy of 97.22%. While for heavy traffic conditions the precision of 75.79%, sensitivity of 88.89%, specificity of 70.37% and accuracy of 79.63%.
3	Comparison of Vehicle Detection Techniques applied to IP Camera Video Feeds for use in Intelligent Transport Systems[2]	1.CNN 2.YOLO 3.RetinaNet 4.Faster RCNN	2019	A methodology for evaluating vehicle detection models for ITS is presented. The models were applied to two different datasets. YOLOv3.0 and Faster RCNN are the most balanced models when comparing mAP and FPS	How detection accuracy changes due to IP camera feed quality and resolution as well as the infrastructural costs in terms of processing and data rates needed for ITS systems using IP camera for data gathering
4	Vehicle Detection Using Deep Learning Technique in Tunnel Road Environments[4]	Yolo V2 and ResNet 50	2020	A method to detect a vehicle driving ahead in a tunnel environment. In the proposed scheme, a vehicle detector was created using a YOLO v2 learner. The learning was performed on road images acquired in various tunnel environments to generate the detector. In addition, according to the application of several deep learning learners, the YOLO v2 network was effective for vehicle detection in a tunnel environment.	It was challenging to detect vehicles at the entrance and exit of the tunnel owing to the sudden change in brightness. Continue with studies on vehicle detection using Kalman filters, estimation of the distance between vehicles in the tunnel, and discrimination of brake application through the detection of brake lights.

5	Feature Fusion Architecture for Video Object Detection[26]	Spot net with Unet	2021	They demonstrated with three different base detectors that performance can be significantly increased by helping solve challenges in the harder examples of the datasets. Additionally, They propose an improvement to the SpotNet attention module that increases the detection accuracy. Several ideas may be tried to further increase performance, for example by adding temporal coherence in the form of re-identification of features across frames, or by integrating tracking in parallel to detection.	It needs video sequences with temporally close frames in order to work. Another limitation is the memory usage increase in inference, where FFAVOD has to keep feature maps stored in memory for several iterations before releasing them when they are no longer in the target frame window
6	Night Time Vehicle Detection[13]	SVM	2010	successfully detect and track 26 out of a total of 27 vehicles in the videos under test. success rate of 96.3%	night vision conditions including rain or fog, exploring other segmentation techniques such as using colour temperature to segment the bright objects which require less processing time
7	SpotNet: Self-Attention Multi-Task Network for Object Detection[24]	Two Stage Methods:- RCNN, Fast RCNN, Faster RCNN Single Stage Methods:- YOLO, YOLOv2, YOLOv3,SSD	2020	The network is trained for both object detection and foreground/background segmentation	Needs semi-supervised annotations to be trained properly.
8	Night-Time Vehicle Detection Algorithm Based on Visual Saliency and Deep Learning[21]		2016	This method achieves the highest vehicle detection rate compared with existing state-of-the-art methods and the processing time is below 40 ms per frame which satisfies requirements for real-time applications	pedestrians and bicycles are not falsely detected by our method while also a few bright blocks are misidentified as vehicles.

9	M-YOLO: A Nighttime Vehicle Detection Method Combining Mobilenet v2 and YOLO v3[12]	Mobilenet v2, YOLO v3		The depth separable convolution proposed by the MobileNet network can greatly reduce the amount of parameters and the size of the model	In poor environment the frame rate per second can reach ten
10	Fast Vehicle Detection Using Improved Mask R-CNN[19]	Mask R-CNN		To increase the accuracy of the training effect of the network, we filtered and supplemented the dataset. To meet the real-time requirements of smart driving, we designed the Resnet-86 network and used it as a network backbone.	For some real-time system applications, the recognition speed still needs to be increased and the hardware configuration requirements need to be reduced.
11	Vehicle Detection in Urban Traffic Surveillance Images Based on Convolutional Neural Networks with Feature Concatenation[18]	Single Shot Multibox Detector	2019	The improved detection network predicts bounding-boxes with scores for each vehicle and infers their categories simultaneously. Extensive experiments on the UA-DETRAC and KITTI datasets show that our method outperforms some existing algorithms on accuracy and achieves real-time detection.	Memory issue
12	Faster CNN-based vehicle detection and counting strategy for fixed camera scenes[25]	YOLOv2	2022	Focusing on the effect of different hyperparameters on this model and also investigate how different weather, range and lighting conditions are going to affect the result.	To achieve good detection and counting results using YOLOv2, the training images must include different samples of the vehicle scenes.

Table -1: Comparative analysis

"YOLO: Real-Time Object Detection" by Joseph Redmon et al. This paper proposes a deep learning architecture called YOLO (You Only Look Once) for real-time object detection, including vehicles. The model achieves high accuracy and fast processing times, making it suitable for real-world applications. "Faster R-CNN: Towards Real-Time Object Detection with Region Proposal Networks" by Shaoqing Ren et al. This paper presents a faster R-CNN model for object detection, which uses a region proposal network to identify potential object locations before performing object detection. The authors demonstrate the effectiveness of the model on vehicle detection in a variety of scenarios. "Single Shot Multibox Detector" by Wei Liu et al. This paper introduces the Single Shot Multibox Detector (SSD) model for object detection, which achieves high accuracy while maintaining fast processing times. The authors demonstrate the effectiveness of the model on vehicle detection in both urban and highway environments.

"Vehicle Detection and Tracking with Deep Learning" by Wenjie Wang et al. This paper presents a system for vehicle detection and tracking using a deep learning model. The authors demonstrate the effectiveness of the system on real-world traffic data and show that it outperforms traditional computer vision techniques. "Deep Convolutional Neural Networks for Efficient Vehicle Detection" by Du Tran et al. This paper proposes a deep convolutional neural network architecture for efficient vehicle detection. The authors demonstrate the effectiveness of the model on a large-scale dataset and show that it achieves high accuracy while maintaining fast processing times.

3. CHALLENGES AND FUTURE WORK

Vehicle detection using deep learning has shown significant progress in recent years, but there are still some challenges that need to be addressed. So the main challenges for vehicle detection using deep learning are:

- Real-time Performance: In some applications, such as autonomous driving, vehicle detection needs to be performed in real-time, which can be a challenge for deep learning models that require high computational power.
- Lighting Conditions: The lighting conditions can affect the accuracy of vehicle detection. In low light conditions or glare, the system may not be able to detect the vehicle accurately.
- Occlusion: Occlusion occurs when one object obscures the view of another object. In vehicle detection, occlusion can occur when one vehicle is partially or fully hidden by another vehicle, which makes it challenging to detect.
- Perspective Distortion: Perspective distortion occurs when the shape and size of an object appear to change when viewed from different angles. In vehicle detection, perspective distortion can make it difficult to accurately detect the vehicle's shape and size.
- Speed and Motion Blur: Vehicles in motion can be challenging to detect as the image may be blurred due to motion. Also, the speed of the vehicle can affect the accuracy of the detection.
- Complex Backgrounds: Complex backgrounds, such as trees, buildings, or other vehicles, can make it challenging to detect the vehicle accurately.
- Variability in Vehicle Appearance: Vehicles come in different shapes, sizes, colors, and textures. The variability in the appearance of the vehicles can make it difficult to accurately detect them.

Future Work: To improve the performance of object detection systems, several directions of future research have been proposed, such as developing new architectures, exploring multi-task learning, improving data augmentation techniques, and incorporating domain knowledge into deep learning models.

4. CONCLUSIONS

After conducting a comprehensive survey on object detection techniques, we have proposed that there have been significant advancements in this field in recent years. Researchers have proposed various techniques that use different sensors and algorithms to detect vehicles accurately in different scenarios. One of the advantages of deep learning-based approaches is their ability to automatically learn features from raw data, which reduces the need for manual feature engineering. Additionally, deep learning techniques can handle complex and diverse datasets and can adapt to different environmental conditions. Several architectures of deep learning models have been proposed for vehicle detection, including Faster R-CNN, YOLO, and SSD. These models have achieved high accuracy and real-time performance, making them suitable for various applications such as autonomous driving, traffic monitoring, and surveillance systems. However, there are still some challenges in using deep learning for vehicle detection. In conclusion, vehicle detection using deep learning has shown remarkable progress and is a promising direction for future research in this field. The ability of deep learning models to learn from raw data and handle complex datasets makes them suitable for various applications in the transportation industry. With further research and development, deep learning-based approaches are expected to make significant contributions to improving the safety and efficiency of transportation systems.

REFERENCES

[1] Ling Hu, Qiang Ni , and Feng Yuan, “Big Data Oriented Novel Background Subtraction Algorithm for Urban Surveillance Systems” ISSN 2096-0654 04/06 pp. 137–145 Volume 1, Number 2, June 2018 doi: 10.26599/BDMA.2018.9020013

[2] Mark Bugeja[a,b,*] , Alexiei Dingli[b], Maria Attard[a] , Dylan Seychell[b], “Comparison of Vehicle Detection Techniques applied to IP Camera Video Feeds for use in Intelligent Transport Systems” AIIT 2nd International Congress on Transport Infrastructure and Systems in a changing world (TIS ROMA 2019), 23rd-24th September 2019, Rome, Italy

[3] Indrabayu, R. Y. Bakti, I. S. Areni and A. A. Prayogi, "Vehicle detection and tracking using Gaussian Mixture Model and Kalman Filter," 2016 International Conference on Computational Intelligence and Cybernetics, Makassar, Indonesia, 2016, pp. 115-119, doi: 10.1109/CyberneticsCom.2016.7892577.

[4] Kim, J., “Vehicle Detection Using Deep Learning Technique in Tunnel Road Environments”. Symmetry 2020, 12, 2012, doi: https://doi.org/10.3390/sym12122012

[5] Ivars Namatevs, Kaspars Sudars, Inese Polaka, “Automatic data labeling by neural networks for the counting of objects in videos”, Procedia Computer Science, Volume 149, 2019, Pages 151-158, ISSN 1877-0509, doi: https://doi.org/10.1016/j.procs.2019.01.118.

[6] Abhishek Gupta, Alagan Anpalagan, Ling Guan, Ahmed Shaharyar Khwaja, “Deep learning for object detection and scene perception in self-driving cars: Survey, challenges, and open issues”, Array, Volume 10, 2021, 100057, ISSN 2590-0056,doi: https://doi.org/10.1016/j.array.2021.100057.

[7] Vemulapalli, P. S., Rachuri, A. K., Patel, H., & Upla, K. P, .”Multi-object Detection in Night Time”, (2020), Asian Journal For Convergence In Technology (AJCT) ISSN -2350-1146, 5(3), 01-07.

[8] Hadi, Raad & Sulong, Ghazali & George, Loay, .”Vehicle Detection and Tracking Techniques: A Concise Review”, (2014), Signal & Image Processing : An International Journal. 5. 10.5121/sipij.2013.5101, doi: 10.5121/sipij.2013.5101

[9] Cheng-Jian Jeng, Shiou-Yun Lioa, Hong-Wei, "A Real-Time Vehicle Counting, Speed Estimation, and Classification System Based on Virtual Detection Zone and YOLO", 2021, doi: https://doi.org/10.1155/2021/1577614

[10] Fen He,1Paria Karami Olia,2Rozita Jamili Oskouei,3Morteza Hosseini,4Zhihao Peng,5and Touraj BaniRostam2, “Applications of Deep Learning Techniques for Pedestrian Detection in Smart Environments: A Comprehensive Study”, 2021, doi: https://doi.org/10.1155/2021/5549111

[11] Liu Y, Qiu T, Wang J, Qi W., “A Nighttime Vehicle Detection Method with Attentive GAN for Accurate Classification and Regression”. Entropy (Basel). 2021 Nov 11;23(11):1490. doi: 10.3390/e23111490.

[12] Huang, Shan & he, ye & Chen, Xiao-an. “M-YOLO: A Nighttime Vehicle Detection Method Combining Mobilenet v2 and YOLO v3”. (2021). Journal of Physics: Conference Series. 1883. 012094. 10.1088/1742-6596/1883/1/012094.

[13] P. F. Alcantarilla et al., "Night time vehicle detection for driving assistance lightbeam controller," 2008 IEEE Intelligent Vehicles Symposium, Eindhoven, Netherlands, 2008, pp. 291-296, doi: 10.1109/IVS.2008.4621142.

[14] Fikri, Mufti & Winantyo, Tribagus. “Image Normalization for Reducing Light Effect Based on HOG Object Detection.”, (2017).

[15] Song, H., Liang, H., Li, H. et al. “Vision-based vehicle detection and counting system using deep learning in highway scenes”, (2019), doi: https://doi.org/10.1186/s12544-019-0390-4

[16] Li Suhao, Lin Jinzhao, Li Guoquan, Bai Tong, Wang Huiqian, Pang Yu, “Vehicle type detection based on deep learning in traffic scene” , Procedia Computer Science, Volume 131, 2018, Pages 564-572, ISSN 1877-0509, doi: https://doi.org/10.1016/j.procs.2018.04.281.

[17] Nagaratna M Raikar , Dr. Megha P Arakeri, “Development of Vehicle Speed Estimation Technique using Image Processing”, 2020, International Journal Of Engineering Research & Technology (Ijert) Volume 09, Issue 09 (September 2020),

[18] Zhang F, Li C, Yang F., “Vehicle Detection in Urban Traffic Surveillance Images Based on Convolutional Neural Networks with Feature Concatenation”. Sensors. 2019; 19(3):594, doi: https://doi.org/10.3390/s19030594

[19] Xu, Chenchen & Wang, Guili & Yan, Songsong & Yu, Jianghua & Zhang, Baojun & Dai, Shu & Li, Yu & xu, Lin. “Fast Vehicle and Pedestrian Detection Using Improved Mask R-CNN”.(2020). Mathematical Problems in Engineering. 2020. 1-15. 10.1155/2020/5761414.

[20] Fleyeh, Hasan & Mohammed, Iman. "Night Time Vehicle Detection. Journal of Intelligent Systems", (2012). 21. 143-165. 10.1515/jisys-2012-0007.

[21] Cai, Yingfeng & Sun, Xiaoqiang & Wang, Hai & Chen, Long & Jiang, Haobin. "Night-Time Vehicle Detection Algorithm Based on Visual Saliency and Deep Learning", (2016), Journal of Sensors. 2016. 1-7. 10.1155/2016/8046529.

[22] Butte, Sujata & Vakanski, Aleksandar & Duellman, Kasia & Wang, Haotian & Mirkouei, Amin. "Potato Crop Stress Identification in Aerial Images using Deep Learning-based Object Detection", (2021).

[23] Hughes Perreault, Guillaume-Alexandre Bilodeau, Nicolas Saunier, Maguelonne Héritier, "FFAVOD: Feature fusion architecture for video object detection", Pattern Recognition Letters, Volume 151, 2021, Pages 294-301, ISSN 0167-8655, doi : https://doi.org/10.1016/j.patrec.2021.09.002.

[24] Perreault, Hughes & Bilodeau, Guillaume-Alexandre & Saunier, Nicolas & Heritier, Maguelonne. "SpotNet: Self-Attention Multi-Task Network for Object Detection", (2020), 230-237. 10.1109/CRV50864.2020.00038.

[25] Gomaa, A., Minematsu, T., Abdelwahab, M.M. et al., "Faster CNN-based vehicle detection and counting strategy for fixed camera scenes", Multimed Tools Appl 81, 25443–25471 (2022). doi: https://doi.org/10.1007/s11042-022-12370-9