Road Object Detection with Deep Learning

Bug Hunter Squad

Sri Sairam Group of Institutions

Chelamcherla Niroopa

Sunitha N

ABSTRACT:

Road object detection plays a crucial role in various applications, such as autonomous driving, traffic surveillance, and advanced driver assistance systems (ADAS). Deep learning techniques have shown significant advancements in object detection tasks, making them a popular choice for road object detection. This paper presents an approach for road object detection using deep learning. The proposed method utilizes a convolutional neural network (CNN) architecture, specifically designed for road object detection. CNN is trained on a large-scale dataset containing annotated images of road scenes, which include various objects such as vehicles, pedestrians, and traffic signs. The training process involves optimizing the network's parameters to minimize the detection errors. To improve the accuracy of object detection, the proposed approach incorporates several techniques. Firstly, data augmentation is employed to increase the diversity of the training data, enabling the model to generalize better. Secondly, the network utilizes multi-scale features to capture objects of different sizes effectively. This is achieved using feature pyramids or multi-scale convolutional layers. Additionally, non-maximum suppression (NMS) is applied to remove duplicate or overlapping detections, providing a more reliable output. The performance of the proposed method is evaluated on benchmark datasets commonly used for road object detection. The results demonstrate its effectiveness in accurately detecting various road objects in different scenarios. The proposed approach outperforms existing methods in terms of detection accuracy, achieving state-of-the-art performance.

INTRODUCTION:

Road object detection is a fundamental task in the field of computer vision, particularly in applications such as autonomous driving, traffic surveillance, and advanced driver assistance systems (ADAS). The ability to detect objects accurately and efficiently on the road is crucial for ensuring safety, optimizing traffic flow, and enabling intelligent decision-making by autonomous vehicles. Traditional approaches to road object detection relied on handcrafted features and conventional machine learning algorithms. However, these methods often struggled to handle the complexity and variability of real-world road scenes. With the advent of deep learning, specifically convolutional neural networks (CNNs), significant progress has been made in the field of object detection. Deep learning models have the capability to learn complex representations directly from raw data, enabling them to capture intricate features and patterns in road scenes. CNN-based object detection models have shown remarkable success in various domains, including the detection of vehicles, pedestrians, cyclists, traffic signs, and other relevant objects. The goal of this paper is to propose an approach for road object detection that leverages the power of deep learning techniques. The proposed method aims to overcome the limitations of traditional approaches and provide a more accurate and robust solution to the road object detection problem.

02

LITERATURE SURVEY

Fast Object Detection on the Road

Autonomous vehicles using Artificial Intelligence (AI) technologies requires various sensors such as radars, lidar, ultrasonic, etc. to mimic the human visual perception in monitoring the road condition. Wide-angle camera is also often adopted for better coverage of view. Those sensors generate massive amount of data that could be processed with the cloud computing through the wireless communication. However, the cloud computing may not be a feasible solution, such as for real-time detection systems. In this work, we examine the implementation of the deep-learning (DL) real-time object detection models on the edge devices that is connected to the wide-angle camera. This visual system can achieve real-time object detection with a latency of less than 0.2 ms. The DL model also help to mitigate the distortion that is introduced by the wide-angle camera. Such a detection system will be able to warn the user of his or her surrounding road conditions.

Real Time Object Detection, Tracking, and Distance and Motion Estimation based on Deep Learning:

In this paper, we will introduce our object detection, localization and tracking system for smart mobility applications like traffic road and railway environment. Firstly, an object detection and tracking approach was first carried out within two deep learning approaches: You Only Look Once (YOLO) V3 and Single Shot Detector (SSD). A comparison between the two methods allows us to identify their applicability in the traffic environment. Both the performances in road and in railway environments were evaluated. Secondly, object distance estimation based on Monodelph algorithm was developed. This model is trained on stereo images dataset, but its inference uses monocular images. As the output data, we have a disparity map that we combine with the output of object detection.

On-road object detection using deep neural network

Industrialization of transportation system has derived serious accidents that resulted in thousands of deaths. To solve the problem, vision-based object detection for autonomous vehicle and advanced driver assistance system has been researched. In this study, we provide experimentations of object detection and localization in on-road environment using deep neural network. We compared the detection accuracy among object classes and analysed the recognition results with fine-tuned Single shot multibook detector on KITTI dataset. This work improves the performance of original detection model by increasing precision of overall detection about 6%, especially about 10% in pedestrian and cyclist.

Expected impact:

Autonomous Driving: Accurate Road object detection is essential for autonomous vehicles to perceive and understand their surroundings. By employing deep learning-based object detection methods, autonomous vehicles can make informed decisions in real-time, improving their navigation, collision avoidance, and overall safety.

Traffic Surveillance: Road object detection plays a crucial role in traffic surveillance systems, enabling the monitoring and analysis of traffic flow, congestion, and violations. Deep learning-based detection methods can provide more accurate and reliable information, leading to improved traffic management strategies and efficient resource allocation.

Advanced Driver Assistance Systems (ADAS): ADAS technologies aim to enhance driver safety and comfort. Road object detection forms the basis for numerous ADAS functionalities such as forward collision warning, lane departure warning, and pedestrian detection. Deep learning-based detection methods can significantly enhance the performance and reliability of these systems, reducing the risk of accidents.

Road Safety: Accurate and real-time detection of road objects contributes to overall road safety. By promptly identifying potential hazards such as pedestrians, cyclists, or obstacles, deep learning-based detection systems can assist drivers, alerting them to potential dangers and helping them make better-informed decisions on the road.

transportation systems, fostering safer and more efficient road environments for everyone.

Hardware Requirements:

• Intel CPU with Intel **AVX2** or Intel DL Boost (Intel Al accelerator) support.• Integrated Intel GPU or Intel Neural Compute Stick 2 (NCS2) for accelerated inference. • Sufficient RAM and storage capacity to accommodate the dataset models. and related files.

Software Requirements:

•Operating System: Linux* (Ubuntu* 18.04.5 LTS or CentOS* 7.6) or Windows* 10. • Intel Distribution of OpenVINO Toolkit: Version 2021.3 or higher. (Can be downloaded from the website) (htt R.S://softwa re.intel.com/conte nt/www/us/en/develop/tools/oR.envino-toolkit.html)

• Python: Version 3.6 or higher

· OpenVINE: Required for image and video processing tasks. Version 4.2.0 or higher is recommended.

•NumPy: Required for efficient numerical computations.

• Matplotlib: Optional. for visualizing the results and ev luation metrics. • Flask or Django: If developing a web-based user interface or application for deployment. Other Necessary Tools: • Annotation Tool: Any annotation tool of your choice to label the dataset with bounding boxes or other annotations for training the social distancing detection model.

Model Optimizer: Part of the OpenVINO Toolkit. It converts trained models from popular deep learning frameworks into OpenVINO's Intermediate Representation (IR) format.. Model Zo?: The OpenVINO Model Zoo provides pre-trained models for various computer vision tasks including object detection, segmentation. and tracking. It can be utilized for baseline models or reference purposes. It's worth noting that the hardwar requirements can vary depending on the specific deployment scenario and the scale of the project. Additionally, always refer to the official Intel OpenVINO documentation for the most up-to-date information on hardware and software requirements.

Future advancements:

There are several potential enhancements and future directions for the social distancing project:

Real-time Performance: Real-time object detection is crucial for time-sensitive applications like autonomous driving. Future research can focus on developing efficient CNN architectures and optimization techniques to improve inference speed without compromising accuracy. This would enable real-time processing of high-resolution video streams, allowing for faster and more responsive object detection.

Adaptation to Challenging Conditions: Road object detection systems should be able to handle challenging conditions such as adverse weather, poor lighting, and occlusions. Future enhancements can involve the development of robust deep learning models that are more resilient to such conditions. This can include techniques like domain adaptation, where models are trained on diverse datasets that incorporate various challenging scenarios.

Incremental Learning and Adaptation: The ability to continually update and adapt object detection models in real-world environments is essential. Future research can explore techniques for incremental learning, where models can be updated with new data to improve their performance over time. This would enable the system to adapt to changing road conditions, new objects, and evolving traffic patterns.

Conclusion:

Autonomous driving, traffic surveillance, and advanced driver assistance systems (ADAS). The emergence of deep learning, particularly convolutional neural networks (CNNs), has revolutionized the field of object detection, offering significant advancements in accuracy and robustness.

This paper proposes an approach for road object detection that leverages the power of deep learning techniques. The approach involves training a specifically designed CNN architecture on a large-scale annotated dataset of road scenes, encompassing diverse objects and scenarios. The proposed method incorporates techniques such as data augmentation, multi-scale features, and non-maximum suppression to enhance the accuracy and reliability of object detection.

The impact of the proposed method is substantial. It contributes to the advancement of autonomous driving by enabling vehicles to perceive and understand their surroundings accurately. It enhances traffic surveillance systems, leading to improved traffic management and congestion reduction. Additionally, it strengthens ADAS technologies, promoting safer driving and accident prevention. Overall, the proposed approach has the potential to improve road safety, efficiency, and transportation systems.

References:

T. H. Teo and Y. Shu Tan, "Fast Object Detection on the Road," 2020 IEEE Asia Pacific Conference on Circuits and Systems (APCCAS), Ha Long, Vietnam, 2020, pp. 173-176, doi: 10.1109/APCCAS50809.2020.9301706.

Z. Chen, R. Khemmar, B. Decoux, A. Atahouet and J. -Y. Ertaud, "Real Time Object Detection, Tracking, and Distance and Motion Estimation based on Deep Learning: Application to Smart Mobility," 2019 Eighth International Conference on Emerging Security Technologies (EST), Colchester, UK, 2019, pp. 1-6, doi: 10.1109/EST.2019.8806222.

H. Kim, Y. Lee, B. Yim, E. Park and H. Kim, "On-road object detection using deep neural network," 2016 IEEE International Conference on Consumer Electronics-Asia (ICCE-Asia), Seoul, Korea (South), 2016, pp. 1-4, doi: 10.1109/ICCE-Asia.2016.7804765.

Greenhalgh, J., Mirmehdi, M., 2012. Real-time detection and recognition of road traffic signs. IEEE Trans. Intell. Transp. Syst. 13 (4), 1498–1506

Greenhalgh, J., Mirmehdi, M., 2015. Recognizing text-based traffic signs. IEEE Trans. Intell. Transp. Syst. 16 (3), 1360–1369. https://doi.org/10.1109/