

Perspective-Aware Road Obstacle Detection

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Abstract. While road obstacle detection techniques have become increasingly effective, they typically ignore the fact that, in practice, the apparent size of the obstacles decreases as their distance to the vehicle increases. In this paper, we account for this by computing a scale map encoding the apparent size of a hypothetical object at every image location. We then leverage this perspective map to (i) generate training data by injecting synthetic objects onto the road in a scene-specific fashion (thus avoiding overfitting) and (ii) incorporate perspective information in the decoding part of the detection network to guide the obstacle detection. Our results are standard benchmarks show that, together, these two strategies significantly boost the obstacle detection performance, allowing our approach to consistently outperform state-of-the-art methods in terms of instance-level obstacle detection.

1. Introduction

Vehicle-based driving assistance is now commercially available [3] and enables vehicles to plan a path within the predicted obstacle space while avoiding other traffic. However, missed and unexpected obstacles lying on the road remain a potential danger. Since not every vehicle has access to a LiDAR sensor to detect them in 3D, much effort has recently been made to achieve detection in a monocular fashion via learning-based strategies. Such road obstacle detection can also be beneficial for vehicles in rural environments. Given that such objects are under-represented obtaining sufficient datasets of real images associated with such obstacles for training purposes is impractical. Hence, many state-of-the-art deep learning approaches [24, 17, 34, 17] rely on synthetically generated training data, for example by creating real objects and inserting them into rendered frames of the Cityscapes dataset.

However, these methods fail to leverage the vehicle generating training data and performing the actual detection, the predictable perspective knowledge in images captured by cameras’ monocular camera. It is a standard practice [34–36, 17] to insert objects of arbitrary sizes at any image location in the training data used to detect objects at multiple scales irrespective of where they appear in the image. This does not exploit the well-known fact that more distant objects tend to be smaller and thus, given a calibrated camera, the relationship between real and perceived sizes in images.

In this work, we show that leveraging the perspective information substantially increases performance. To this end, as shown in Fig. 1, we compute a scale map, where pixel values denote the apparent size of pixels of a hypothetical meter-wide object placed at that point on the road. We then integrate this information in two orthogonal ways:

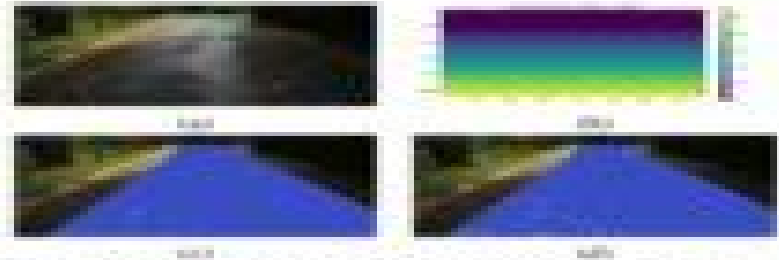


Fig. 1: **Real and virtual in close and faraway, car (green) image.** The **green** denotes a real obstacle (the car), and the **red** **scale** indicates specific far boundary sizes. (a) The perspective map inference, in each point, the size is given of a hypothetical meter-wide object at that location. (b) Our approach scale the perspective map to distinguish relevant objects from irrelevant ones. It correctly flags as relevant pixels of the real obstacle while ignoring the faraway car. (c) Without the perspective aware inference, we incorrectly scale a small car/boundary flag (blue) as 0.

- **Perspective-Aware Synthetic Object Injection.** Instead of uniformly injecting synthetic objects into road scenes to synthesized training data, as in [34, 36, 17] we use the perspective map to appropriately set the projected size of the objects in images.
- **Perspective-Aware Architecture.** We feed the perspective map at multiple levels of a feature pyramid network, enabling it to learn the multi-scale relationship between distance and size embedded in our training set and in real road scenes.

The bottom portion of Fig. 1 illustrates the benefits of our approach. It not only detects small faraway obstacles but also avoids false alarms arising from small irregularities near the car, such as the fence fence. Because there are at this image location there are much less of real objects in the image. Our results show that these strategies together contribute to significantly improving the accuracy of road obstacle detection, particularly in terms of instance-level detection, which is critical for a self-driving car that need to identify all potential hazards on the road.

We evaluate our approach on the Segment 3D of Car (Car 3D) benchmark’s obstacle task and the Localized (L) task subset. We demonstrate that it significantly outperforms most of the top techniques that use architectures similar to ours, but without explicit perspective handling. The code of our method will be made publicly available.

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Handbook of Deep Learning Applications Valentina Emilia Balas, Sanjiban Sekhar Roy, Dharmendra Sharma, Pijush Samui, 2019-02-25 This book presents a broad range of deep learning applications related to vision natural language processing gene expression arbitrary object recognition driverless cars semantic image segmentation deep visual residual abstraction brain computer interfaces big data processing hierarchical deep learning networks as game playing artefacts using regret matching and building GPU accelerated deep learning frameworks Deep learning an advanced level of machine learning technique that combines class of

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Appropriations for Fiscal Year 1998 United States. Congress. Senate. Committee on Appropriations. Subcommittee on Transportation and Related Agencies,1998 [Self Driving Cars Demystified](#) StoryBuddiesPlay,2024-10-28 This chapter delves into the intricate world of path planning for autonomous vehicles highlighting the critical algorithms and techniques that enable self driving cars to navigate safely and efficiently Covering everything from global and local planning to behavioral decision making it addresses the challenges posed by dynamic environments and complex scenarios like intersections and merging As technology evolves we explore how machine learning and real time data enhance path planning capabilities ensuring that autonomous vehicles can adapt to changing conditions while prioritizing safety and passenger comfort Whether you re a developer engineer or enthusiast this chapter provides valuable insights into the future of autonomous navigation path planning autonomous vehicles self driving cars obstacle avoidance motion planning behavioral planning navigation algorithms traffic rules machine learning dynamic environments **Spoken Natural Language Dialog Systems** Ronnie W. Smith,D. Richard Hipp,1995-02-02 As spoken natural language dialog systems technology continues to make great strides numerous issues regarding dialog processing still need to be resolved This book presents an exciting new dialog processing architecture that allows for a number of behaviors required for effective human machine interactions including problem solving to help the user carry out a task coherent subdialog movement during the problem solving process user model usage expectation usage for contextual interpretation and error correction and variable initiative behavior for interacting with users of differing expertise The book also details how different dialog problems in processing can be handled simultaneously and provides instructions and in depth result from pertinent experiments Researchers and professionals in natural language systems will find this important new book an invaluable addition to their libraries [Interplay of Artificial General Intelligence with Quantum Computing](#) C. Kishor Kumar Reddy,Shenson Joseph,Herat Joshi,Mariya Ouaisa,Marlia Mohd Hanafiah,2025-08-12 This book investigates the dynamic relationship between artificial general intelligence AGI and quantum computing AGI refers to a form of AI capable of performing any intellectual task that a human can while quantum computing utilizes quantum mechanics principles to process information in fundamentally different ways compared to classical computing This interplay explores how quantum computing might enhance AGI by accelerating complex computations and optimizing learning algorithms potentially enabling AGI systems to solve problems beyond the reach of traditional computers It also examines the challenges and opportunities presented by combining these technologies including theoretical implications and practical applications in advancing AI capabilities This book examines the groundbreaking

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Huang, Qinhua Zhang, Chuanlei Zhang, Wei Chen, 2025-07-17 The 12 volume set CCIS 2564 2575 together with the 28 volume set LNCS LNAI LNBI 15842 15869 constitutes the refereed proceedings of the 21st International Conference on Intelligent Computing ICIC 2025 held in Ningbo China during July 26 29 2025 The 523 papers presented in these proceedings books were carefully reviewed and selected from 4032 submissions This year the conference concentrated mainly on the theories and methodologies as well as the emerging applications of intelligent computing Its aim was to unify the picture of contemporary intelligent computing techniques as an integral concept that highlights the trends in advanced computational intelligence and bridges theoretical research with applications Therefore the theme for this conference was Advanced Intelligent Computing Technology and Applications

Innovations in Smart Cities Applications Volume 5 Mohamed Ben Ahmed, Anouar Abdelhakim Boudhir, İsmail Rakıp Karas, Vipul Jain, Sehl Mellouli, 2022-03-03 This book sets the innovative research contributions works and solutions for almost all the intelligent and smart applications in the smart cities The smart city concept is a relevant topic for industrials governments and citizens Due to this the smart city considered as a multi

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Computational Intelligence Techniques for 5G Enabled IoT Networks Mohit Kumar, Sukhpal Singh Gill, Vijay Kumar, Prabal Verma, 2025-07-26 This book explores emerging interdisciplinary themes and applications reflecting advancements in Computational Intelligence CI for IoT and 5G networks It is divided into four sections Section 1 introduces Computational Intelligence and Sustainability Solutions for Next Gen IoT Networks Section 2 covers Optimization and Resilience Strategies for 5G Enabled IoT Networks Section 3 delves Intelligent Resource Allocation and Service Optimization in 5G IoT Networks Section 4 presents Case studies on Applied Computational Intelligence and 5G IoT Innovations for Industry 4.0 This comprehensive work is essential for researchers and professionals interested in leveraging CI IoT and 5G technologies across diverse applications

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