

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 according 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 more realistic fashion than existing methods, 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 more 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 scale while generating training data and performing the actual detection, the predictable perspective foreshortening in images captured by cameras’ front-facing cameras. 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 frames.

In this work, we show that leveraging the perspective information substantially improves 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 straightforward steps:

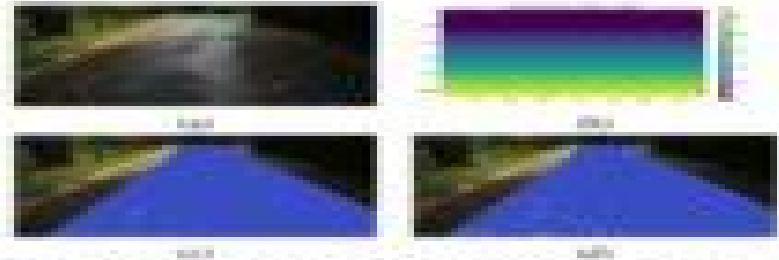


Fig. 1: **Size and distance in close and faraway car cropped images.** The **perspective map** denotes a real obstacle size, and the **red** and **green** rectangles denote two synthetic objects. (a) The perspective map indicates, at each point, the size in pixels of a hypothetical meter-wide object at that location. (b) Our approach uses the perspective map to distinguish synthetic objects from background ones. It correctly flags as smaller pixels of the real obstacle while ignoring the background. (c) Without the perspective aware insertion, we insert a car with a smaller rectangular flag than (a).

- 1. **Perspective-Aware Synthetic Object Injection.** Instead of uniformly inserting 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 pixels.
- 2. **Perspective-Aware Architecture.** We feed the perspective map at multiple levels of a feature pyramid network, enabling it to learn the relation inferring between distance and size combined to our training set and its 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 road, such as the fence here. 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 EuRoC [9] benchmark’s obstacle task and the Lund/Freiburg [6] test subset. We demonstrate that it significantly outperforms most of the-art techniques that use architectures similar to ours, but without explicit perspective handling. The code of our method and the results publicly available.

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Advanced Intelligent Computing Technology and Applications De-Shuang Huang, Qinhu 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

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Table of Contents Obstacle Detection Answer Keys

1. Understanding the eBook Obstacle Detection Answer Keys
 - The Rise of Digital Reading Obstacle Detection Answer Keys
 - Advantages of eBooks Over Traditional Books
2. Identifying Obstacle Detection Answer Keys
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Obstacle Detection Answer Keys
 - User-Friendly Interface
4. Exploring eBook Recommendations from Obstacle Detection Answer Keys
 - Personalized Recommendations
 - Obstacle Detection Answer Keys User Reviews and Ratings
 - Obstacle Detection Answer Keys and Bestseller Lists
5. Accessing Obstacle Detection Answer Keys Free and Paid eBooks
 - Obstacle Detection Answer Keys Public Domain eBooks
 - Obstacle Detection Answer Keys eBook Subscription Services
 - Obstacle Detection Answer Keys Budget-Friendly Options
6. Navigating Obstacle Detection Answer Keys eBook Formats

- ePub, PDF, MOBI, and More
- Obstacle Detection Answer Keys Compatibility with Devices
- Obstacle Detection Answer Keys Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Obstacle Detection Answer Keys
 - Highlighting and Note-Taking Obstacle Detection Answer Keys
 - Interactive Elements Obstacle Detection Answer Keys
- 8. Staying Engaged with Obstacle Detection Answer Keys
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Obstacle Detection Answer Keys
- 9. Balancing eBooks and Physical Books Obstacle Detection Answer Keys
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Obstacle Detection Answer Keys
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Obstacle Detection Answer Keys
 - Setting Reading Goals Obstacle Detection Answer Keys
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Obstacle Detection Answer Keys
 - Fact-Checking eBook Content of Obstacle Detection Answer Keys
 - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
- 14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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