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, to 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) provide traning cues 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 detector. Our results on 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.

I. INTRODUCTION

Vision-based driving assistance is now commercially available and enables vehicles to plan a path within the preferred drivable space while avoiding other traffic. However, unusual and unexpected obstacles lying on the road remain a potential danger. Since not every vehicle has stereo cameras or 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 robots in social environments. Given that such objects are rare, obtaining exhaustive datasets of real images annotated with such obstacles for training purposes is impractical. Hence, many state-of-the-art deep learning approaches rely on synthetically generated training data, for example by cutting out objects and inserting them into individual frames of the Cityscapes dataset.

However, these methods fail to leverage, both while generating training data and performing the actual detection, the predictable perspective foreshortening in images captured by vehicles' front-facing cameras. It is a standard practice 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 that, given a calibrated camera, the relationship between real and perspectival sizes is known.

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 in pixels of a hypothetical motor-wide object placed at that point on the road. We then exploit this information in two complementary ways:
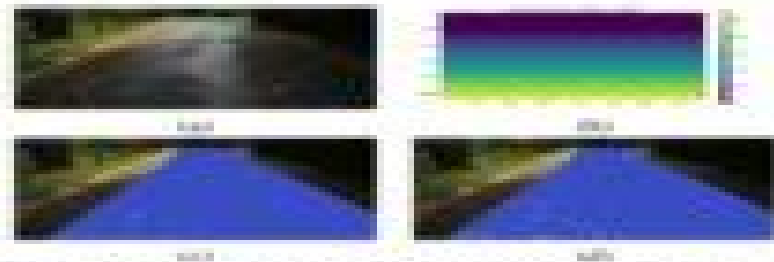
Fig. 1: **Far and relevant vs close and irrelevant.** (a) Original image. The coloured lines denote a real obstacle far away, and the red coloured marks denote the location of the hypothetical object. (b) The perspective map determines, at each pixel, the size in pixels of a hypothetical motor-wide object at that location. (c) Our approach only fits perspective map to distinguish relevant objects from irrelevant ones. It correctly flags as red the pixels of the real obstacle while ignoring the location. (d) Without the perspective aware strategy on a network with a similar architecture flags them all.

- **Perspective-Aware Synthetic Object Injection.** Instead of uniformly inserting synthetic objects into road scenes to synthesized training data, as in [4], [5], [7] we use the perspective map to appropriately set the projected size of the objects we insert.
- **Perspective-Aware Architecture.** We feed the perspective map at multiple levels of a feature pyramid network, enabling it to learn the realistic 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 leaves here, because their size at this image location does not match that of real threats to the vehicle. 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 Me If You Can [3] benchmark's obstacle track and the LostAndFound [8] test subset. We demonstrate that it significantly outperforms state-of-the-art 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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learning algorithms with the use of many layers of nonlinear units has gained considerable attention in recent times Unlike other books on the market this volume addresses the challenges of deep learning implementation computation time and the complexity of reasoning and modeling different type of data As such it is a valuable and comprehensive resource for engineers researchers graduate students and Ph D scholars **Department of Transportation and Related Agencies 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 **Robotics Diploma and Engineering Interview Questions and Answers: Exploring Robotics** Chetan Singh, Robotics Diploma and Engineering Interview Questions and Answers Exploring Robotics is an extensive guide designed to help individuals navigate the competitive world of robotics interviews Whether you are a fresh graduate an experienced professional or an aspiring robotics engineer this robotics book equips you with the knowledge and confidence to ace your interviews Structured as a question and answer format this book covers a wide range of topics relevant to robotics diploma and engineering interviews It begins with an overview of the fundamentals including the history evolution and importance of robotics ensuring you have a solid foundation before diving into the interview specific content Delve into various technical areas of robotics such as mechanical engineering electrical and electronic engineering computer science and programming control and automation

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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 Karaş,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 domain context attracts tremendously academics researchers and practitioners who provide efforts in theoretical proofs approaches architectures and in applied researches The importance of smart cities comes essentially from the significant growth of populations in the near future which conducts to a real need of smart applications that can support this evolution in the future cities The main scope of this book covers new and original ideas for the next generations of cities using the new technologies The book involves the application of the data science and AI IoT technologies and architectures smart earth and water management smart education and E learning systems smart modeling systems smart mobility and renewable energy It also reports recent research works on big data technologies image processing and recognition systems and smart security and privacy **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 **Proceedings of the XXIV International Congress of Psychology of the International Union of Psychological Science (I.U. Psy. S.), Sydney, Australia, August 28-September 2, 1988** Nigel William Bond,Douglas Vickers,Joseph P Forgas,J. Michael Innes,Ronald C King,Barry J. Fallon,Philip L Smith,Adrienne F Bennett,H. Peter Pfister,John Brebner,Kevin M McConkey,John A Keats,David A. T Siddle,Mary A Luszcz,Ted Nettelbeck,John K Collins,Peter F Lovibond,Peter H Wilson,1989 *American Architect* ,1889 **The American Architect and Building News** ,1889 **American Architect and the Architectural Review** ,1889 **Assistive Technology Solutions for Aging Adults and Individuals With Disabilities** Pandey, Rajiv,Maurya, Pratibha,Prajapati, Jigna Bhupendra,Halder, Raju,Tyagi, Kanishka,2025-01-15 Assistive technology solutions enhance the quality of life for aging adults and individuals with disabilities These innovative tools and devices support daily activities

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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

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