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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 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 [1] and enables vehicles to plan a path within the predicted 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 varied environments. Given that such objects are rare and diverse, obtaining extensive datasets of real images annotated with such obstacles for training purposes is impractical. Hence, many state-of-the-art deep learning approaches [2], [3], [4], [5] 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 [4], [6], [7] to insert objects of arbitrary sizes at any image location in the training data and 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 projected 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, whose pixel values denote the apparent size in pixels of a hypothetical meter-wide object placed at that point on the road. We then exploit this information in two complementary ways:

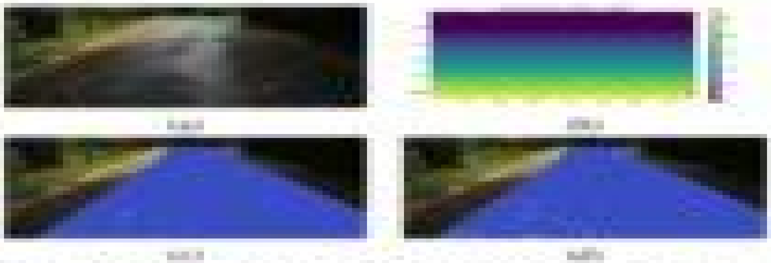
(a) (b)
(c) (d)

Fig. 1: **Far and relevant vs close and irrelevant.** (a) Original image. The green contour denotes a real obstacle far away, and the red circle indicates nearby but harmless bumps. (b) The perspective map indicates, at each pixel, the size in pixels of a hypothetical meter-wide object at that location. (c) Our approach uses the perspective map to distinguish relevant objects from irrelevant ones. It correctly flags as outlier pixels of the real obstacle while ignoring the bumps. (d) Without the perspective-aware training set, a network with a similar architecture flags them all.

- **Perspective-Aware Synthetic Object Injection.** Instead of uniformly injecting synthetic objects into road scenes to synthesize training data, as in [4], [6], [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 embodied 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 far-away obstacles but also avoids false alarms arising from small irregularities near the car, such as the bumps 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 needs to identify all potential hazards on the road.

We evaluate our approach on the Segment Me If You Can [8] benchmark's obstacle track and the Lost&Found [9] 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.

Obstacle Detection Answer Keys

Ensheng Dong

Obstacle Detection Answer Keys:

Robotics Interview Questions and Answers Manish Soni,2024-11-13 Welcome to Robotics Interview Questions and Answers a comprehensive guide designed to navigate the dynamic world of robotics through a lens of inquiry and exploration In the pages that follow you will embark on a journey through the fascinating realm of robotics uncovering a myriad of topics that span the breadth and depth of this transformative field This book seeks to provide not only a wealth of knowledge but also a practical resource for individuals aspiring to delve into the world of robotics or those seeking to enhance their understanding of its myriad facets In the age of automation artificial intelligence and the Internet of Things robotics has emerged as a pivotal force shaping our future From manufacturing floors to healthcare settings from deep space exploration to our own living rooms robots have become an integral part of our daily lives Whether you seek to gain knowledge for interviews academic pursuits or simply to satisfy your curiosity about the incredible world of robotics this book is designed to be your trusted companion It serves as a roadmap to understanding the fundamentals the nuances and the future possibilities that robotics holds **Udacity Ai Product Manager Certification Prep Guide : 350 Questions & Answers** CloudRoar Consulting Services,2025-08-15 Get ready for the Udacity AI Product Manager exam with 350 questions and answers covering AI concepts product lifecycle stakeholder management strategy metrics and best practices Each question includes practical examples and detailed explanations to ensure exam readiness Ideal for AI product managers and technology leaders Udacity AIProductManager ArtificialIntelligence ProductLifecycle StakeholderManagement Strategy Metrics BestPractices ExamPreparation CareerGrowth ProfessionalDevelopment TechLeadership ProductManagement AIManagement Innovation Handbook of Pattern Recognition & Computer Vision Chi-hau Chen,Louis-François Pau,1999 Annotation Presents the latest research findings in theory techniques algorithms and major applications of pattern recognition and computer vision as well as new hardware and architecture aspects Contains sections on basic methods in pattern recognition and computer vision nine recognition applications inspection and robotic applications and architectures and technology Some areas discussed include cluster analysis 3D vision of dynamic objects speech recognition computer vision in food handling and video content analysis and retrieval This second edition is extensively revised to describe progress in the field since 1993 Chen is affiliated with the electrical and computer engineering department at the University of Massachusetts Dartmouth Annotation copyrighted by Book News Inc Portland OR **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 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 *Interplay of Artificial General Intelligence with Quantum Computing* C. 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succeed in landing your dream job in the dynamic and rapidly evolving field of robotics *Automatic Control, Mechatronics and Industrial Engineering* Yigang He,Xue Qing,2019-03-20 Engineering technology development and implementation play an important role in making the industry more sustainable in an increasingly competitive world This book covers significant recent developments in both fundamental and applied research in the engineering field Domains of application include but are not limited to Intelligent Control Systems and Optimization Signal Processing Sensors Systems Modeling and Control Robotics and Automation Industrial and Electric Engineering Production and Management This book is an excellent reference work to get up to date with the latest research and developments in the fields of Automation Mechatronics and Industrial Engineering It aims to provide a platform for researchers and professionals in all relevant fields to gain new ideas and establish great achievements in 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The book delves into Obstacle Detection Answer Keys. Obstacle Detection Answer Keys is a vital topic that needs to be grasped by everyone, ranging from students and scholars to the general public. The book will furnish comprehensive and in-depth insights into Obstacle Detection Answer Keys, encompassing both the fundamentals and more intricate discussions.

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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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