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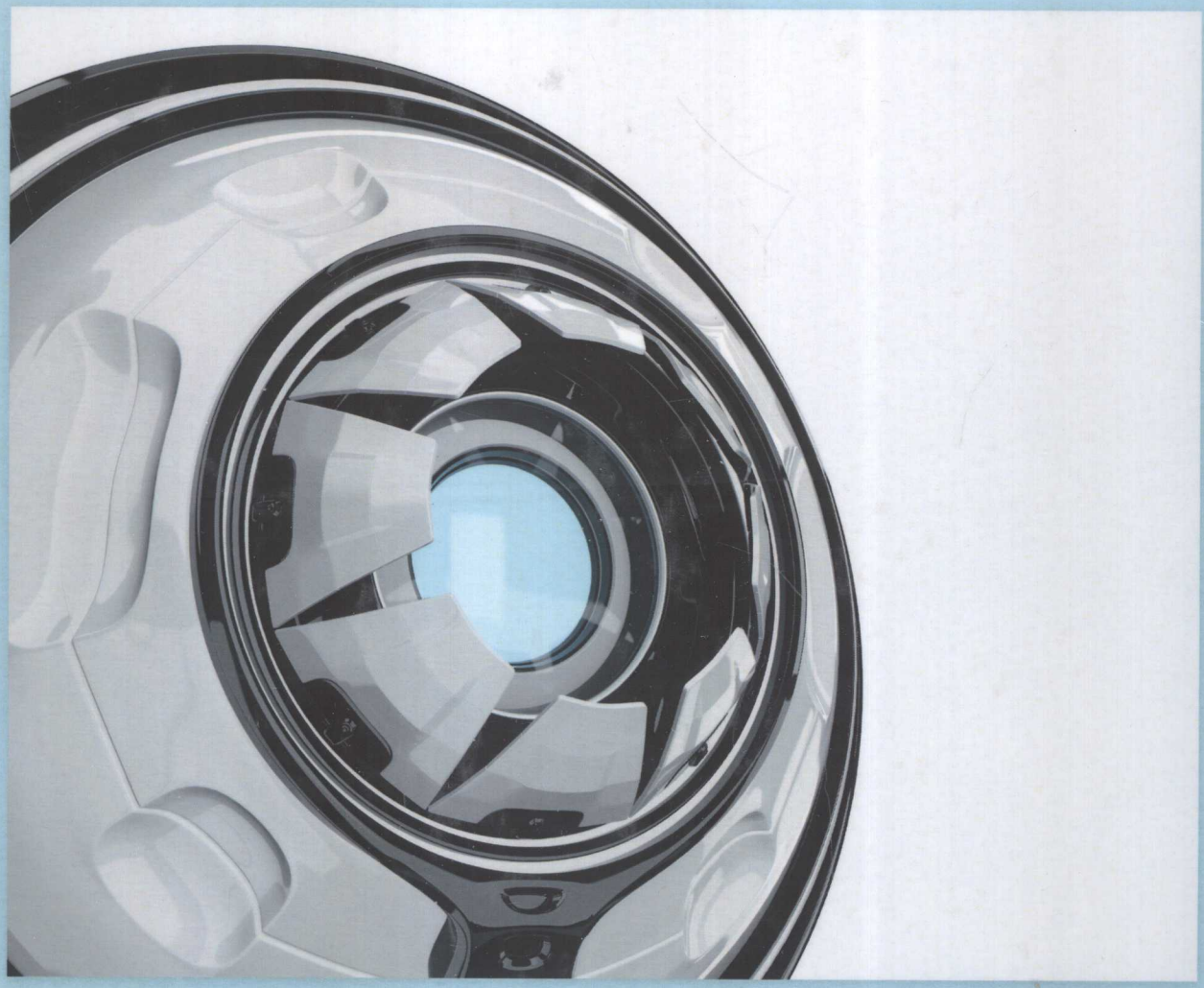
Robotic Vision

Technologies for Machine Learning and Vision Applications



Jose Garcia-Rodriguez & Miguel A. Cazorla Quevedo

Robotic Vision:

Technologies for Machine Learning and Vision Applications

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Foreword

The application of vision to robotics has seen an enormous progress in the last decade with the introduction on new algorithms and very powerful computer hardware. This progress has also been extended to a number of very dissimilar areas such as automation, medicine, and surveillance to name a few. Computer vision has seen very successful application in field and service robots, in particular in autonomous machines and automotive applications. This has been possible not only by the improvement of computer hardware but from the development of new very efficient algorithms.

Until a few years ago, fundamental problems affected computer vision that makes most algorithms not viable for real time application. This has started to change dramatically. Over the last few years, we have seen an enormous growth of very successful practical implementation of computer vision for robotics. Furthermore, some of them have exploited mass production of proprietary hardware to make the deployment of impressive applications at very reduced costs. This has also been possible due to a number of significant breakthroughs in the underlying algorithms and techniques, including feature detectors, classifiers and a large variety of very efficient machine learning algorithms.

This book presents a comprehensive introduction and the latest development to the fields of computer vision and applications to robotics, social robotics, visual control, and visual attention. The material is organized in various sections with a number of contributions from world experts in the different areas.

The target audience of this book includes robotics scientist, engineers, and students interested in getting a comprehensive background in the rapidly developing field of robotics and computer vision.

It is impossible to select a number of papers to cover all the recent progress in computer vision. Nevertheless, the editors have chosen a number of fundamental aspects of robotic vision that are addressed in a very comprehensive manner in this book. The material presented is intended to be a fundamental first step towards understanding the main challenges involved in robotic vision application.

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Eduardo Nebot, *BSc. EE, UNS, Argentina and MS and PhD CSU, USA, is a Professor at the University of Sydney and the Director of the Australian Centre for Field Robotics. His main research areas are in field robotics automation. The major impact of his fundamental research is in autonomous system, navigation, and mining safety.*

Preface

Computer vision and robotics connections have grown dramatically in the last years. Any robotic system includes object or scene recognition, vision-based motion control, vision-based mapping, and dense range sensing. Developments in hardware and sensing permit most vision algorithms to work in real-time and using cheap and flexible sensors.

"Robotic Vision: Technologies for Machine Learning and Vision Applications" is an edited collection of contributed chapters of interest for both researchers and practitioners in the fields of computer vision and robotics.

Written by leading researchers in the field, the chapters are organized into six sections. The first two sections deal with computer vision basics and computer vision applications. Section 3 is devoted to 3D data processing applied to robotics. In section 4, some works describing social robotics systems are presented, while section 5 presents works related with vision control, and section 6 introduces some research in visual attention.

SECTION 1: COMPUTER VISION

Barros de Lima Klavdianos, Mattos Brasil, and Simão Santana Melo propose a systematic and practical approach regarding to one of the most current techniques applied on face recognition, known as AAM (Active Appearance Model). Different methodologies of uniform sampling over the 3D rotation group, SO(3), for building unbiased 2D shape models from 3D objects are introduced and reviewed by Perez-Sala, Igual, Escalera, and Angulo. A comparative analysis of basic segmentation methods of video sequences and their combinations is presented by Saval-Calvo, Azorín-López, and Fuster-Guilló.

SECTION 2: COMPUTER VISION APPLICATIONS

Sasi presents a system for identifying what are valuable, what can be ignored, and what demands immediate attention, in a vision security system. In the chapter "Visual Detection in Linked Multi-Component Robotic Systems" by Lopez-Guede, Fernandez-Gauna, Moreno, and Graña, a system to identify the different elements of a Linked Multi-Component Robotic System (L-MCRS) is specified, designed, and implemented. Almomani and Dong propose a novel multiple objects tracking system in video sequences that deals with occlusion issues. The proposed system is composed of two components: An improved KLT tracker, and a Kalman filter. Moreno, Graña, and Madani introduce a watershed and region merg-

ing segmentation algorithm based on the zenithal and azimuthal angles of the spherical representation of colors in the RGB space. Garcia-Rodriguez et al. demonstrate the capacity of self-organizing neural networks to solve some computer vision an image processing tasks presenting different examples like image segmentation and compression, tracking, or 3D reconstruction.

SECTION 3: 3D COMPUTER VISION AND ROBOTICS

In chapter "A Review of Registration Methods on Mobile Robots" by Morell-Gimenez, Orts-Escolano, García-Rodríguez, Cazorla, and Viejo, the authors provide a review of the main registration methods in the literature, where registration is a process to find the transformation between two consecutive poses, from 3D data. In "Methodologies for Evaluating Disparity Estimation Algorithms" by Cabezas and Trujillo, the chapter is dedicated to present and discuss methodologies for evaluating disparity estimation algorithms. An online method for estimating 3D structure (with proper scale) of moving objects seen by a moving camera is developed by Dani, Kan, Fischer, and Dixon. Two different intelligent approaches to assess the traversability of the terrain in front of a stereo vision-equipped robot are presented by Nalpantidis, Kostavelis, and Gasterato.

SECTION 4: SOCIAL ROBOTICS

Bandera, Rodríguez, Molina-Tanco and Bandera describe a learning by imitation architecture that uses stereo vision to perceive, recognize, learn and imitate social gestures. An overview of a typical scenario of Ambient Assisted Living (AAL) in which a robot navigates to a person for conveying information is presented by Yan, Torta, van der Pol, Meins, Weber, Cuijpers and Wermter. Da Silva and Romero deals with Computer Vision for learning to interact socially with humans presenting a robotic architecture for a simple interaction between a caregiver and a robot face. Sridharan describes an integrated framework that jointly addresses the learning, adaptation, and interaction challenges associated with robust human-robot interaction in real-world application domains.

SECTION 5: VISION CONTROL

The chapter by Puig and Aviles presents a framework for simultaneous localization and mapping based on an active coordination of a team of robots. Cavestany Olivares, Herrero-Pérez, Alcaraz Jiménez, and Martínez Barberá describes their vision system used in the Standard Platform League (SPL), one of the official leagues in RoboCup competition. Alkurdi and Fisher applied visual control by using a fuzzy logic controller on the robotic blimp to achieve autonomous waypoint tracking.

SECTION 6: VISUAL ATTENTION

García, Rodríguez, and Matellán make a review of some of the most representative visual attention models, which can be used for reducing the time to process images by a robot. Vega, Perdices, and Cañas propose a visual perceptive system for a robot with a mobile camera on board that copes with two challenges arising when using cameras: to extract useful information from captured images and to manage the small field of view of regular cameras. The chapter by Antúnez, Haxhimusa, Marfil, Kropatsch, and A. Bandera proposes a visual attention model using a hierarchical grouping process that encodes the input image into a Combinatorial Pyramid.

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