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Book Reviews

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MULTIPLE VIEW GEOMETRY IN COMPUTER VISION, by Richard Hartley and Andrew Zisserman, CUP, Cambridge, UK, 2003, vi+560 pp., ISBN 0-521-54051-8. (Paperback £44.95).

This is a rapidly growing subject area with countless potential applications from robotics to surveillance, from remote inspection to virtual realty. The initial steps were take in the 1960s but it became clear that simple Euclidean geometry wasn't sufficient for the purpose and that a fundamental appraisal of the nature of computer vision and of the types of geometries needed had to be undertaken. In the event, the task turned out to be quite formidable and it is only in the last ten years that real progress has been made.

Since then progress has been quite rapid and there has been a real need for a book which could present a thorough explanation the present state of the subject. This text has been written by two of the leaders in the field and their enthusiasm shines through. The result is a book which is timely, extremely thorough and commendably clear. The introductory chapter presents a quick but clear tour of projective geometry and the basic problems associated with reconstructions from more than one point of view. The rest of the book is split into four parts: Part zero starts with the foundation of projective geometry and the various representations and notations used in the rest of the book. It then deals with one of the crucial topics in this subject area: the problem of the estimation of geometry from image measurements. Part one deals with perspective views and the associated problems: one to one correspondence, the effects of camera geometry and scene structure when using a single camera. Part two gets to the meat of two-view geometry and part three does the same for three-view geometry. The final part extends the work to N-view geometry.

Overall the approach is masterly. The geometries and the associated mathematical ideas are presented with commendable clarity and the foundations at each stage are so carefully explained that the most abstract ideas seem to be crystal clear. However, be warned that the topic, of necessity, involves some very sophisticated mathematical notions and does not shirk from the use of matrices and tensor notation. There are seven superb appendices which explain most of the background mathematics. Each chapter suggests some background textbooks and there is a 12 page bibliography.

The authors have managed to present the very essence of the subject in a way which the most subtle ideas seem natural and straightforward. I have never seen such a clear exploration of the geometry of vision. I would wholeheartedly recommend this book. It deserves to be in the library of every serious researcher in the field of computer vision.

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INTRODUCTION TO AUTONOMOUS MOBILE ROBOTS, by Roland Siegwart and Illah R. Nourbakhsh, MIT Press, 2004, xiii+321 pp., ISBN 0-262-19502-X. (Hardback, £27.95).

The book provides a timely and important contribution to the subject. It covers in one volume a range of topics suitable for both the undergraduate and graduate robotics student. It provides an introduction to the fundamentals of mobile robotics encompassing mechanical, motor, sensory, perceptual and cognitive aspects. Its main focus is on the technology that affects the mobility of these devices rather than robotics in general. Although pitched at an introductory level, there is sufficient depth in the subject material to provide the student with the background knowledge and analytical tools they will need to evaluate and appraise mobile robot designs at both conceptual and implementation levels.

The book has six chapters in which the first surveys the field of mobile robots, giving some interesting examples of existing usage. An overview of the content of the book is also given which serves as a useful summary of the relevant technology.

In Chapter 2, the mechanisms required for locomotion are considered. A range of practical examples illustrates the use of legs, wheels, and a combination of both. The clear advantages of the wheel are recognised and much of the chapter relates to their design, assembly configurations and manoeuvrability. Examples considered include the standard wheel, the castor wheel and the omni-directional Swedish wheel.

Chapter 3 considers the kinematics of wheeled robots. The constraints on the motion of different kinds of wheels are identified and their effects combined for particular chassis configurations to determine the kinematic behaviour of the moving platform of the robot. Matrix algebra is used to compute the motion of the robot by considering the combined motions of the wheels and their constraints. The effects of steerability and manoeuvrability on the degrees of freedom of particular robot configurations are examined.

Chapter 4 addresses the issues of robot perception using sensors. A classification by use in mobile robotics applications is made of a wide range of sensors. The behaviour of each sensor is also categorised according to its sensing function in the robot, whether it measures internal quantities, e.g. wheel speeds or external quantities such as distances. Active and passive behaviour is also defined according to whether there is an input or output of energy between sensor and environment. Much of the chapter examines the principles of operation of different types of sensors particularly vision systems.

Chapters 5 explores issues of localisation in which the robot finds its position in the environment. Typically, localisation is map-based using sensors to enable the robot's position to be ascertained. Much of the chapter examines aspects of a map-based approach. Alternative approaches using behavioural concepts, which can avoid the need for accurate position locating and path planning, are also discussed. Probabilistic map-based localisation, using Markov and Kalman filters, is fully explained through the use of a number of case studies.

The final chapter deals with planning and navigation elements of mobile robot motion. The robot's need to be able to undertake cognitive action to make purposeful decisions to reach its goal positions as efficiently and reliably as possible is examined. In path planning, the requirement is to identify a trajectory and if necessary to modulate it in the presence of obstacles. Much of the work that has been done in this area is surveyed. A description of the most popular navigation architectures is given in which their relative strengths and weakness are given. These are expressed by the manner in which they decompose the problem of robot control.

A list of 163 references is given together with some useful websites.

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