AUTOMATICA BOOK REVIEW

Computational Principles of Mobile Robotics

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Reviewer

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List of Acronyms

- GPS. Global Positioning System.
- AGV. Automated Guided Vehicle.

Review

A practicing engineer involved in a mobile robotics project, specially if he or she must integrate a, say, automated manufacturing system rather than designing the robotic devices, is supposed to pose certain questions: Is a positioning system like GPS suitable for an indoor manufacturing system?, Is the state-of the art in computer vision suitable for my needs, or even affordable?. Answers to this type of question is difficult to find in most of the robotics literature, usually engaged with quite theoretical aspects of particular open problems that are the interest of researchers. Instead, this book deals with generality. Presenting the vast amount of technological issues and existing devices in a comprehensive but still useful fashion, is a difficult task. This books successfully tackles it, in a nice, clear and well organized manner, full of examples and historical details.

An outstanding feature is the organization of the book, where the topics are introduced in a natural manner, where each type of problem encountered in the interaction of the mobile robot with its environment gives way to a new chapter. In this sense, the text is divided into three major parts: Locomotion, Sensing and the largest, Reasoning (half of the book is devoted to the latter). Because of this layout and comprehensive explanation, the book can also be a handout for

a undergraduate six month introductory course on mobile robotics, while some parts of it (vision, reasoning) may be most suitable for postgraduate levels. This fact is corroborated by the inclusion on some exercises at the end of each chapter, with special interest in proposing the development of algorithms to solve situations that differ slightly from those explained in the text. The exercises are, however, mainly conceptual and rarely computational.

The first part, locomotion, is treated without great depth, as it is normally a subject for which standard solutions are very effective. It contains a well explained classification of the most common locomotion methods for terrestrial, aquatic and flying vehicles, space robots. The text is enriched with many historical tips and research experiences.

Regarding the second part, in the author's perspective, external sensors (those interacting with the environment) lie in one of two major categories: nonvisual and visual. For the former some basic concepts are defined, such as gyroscopes, accelerometers, and in some cases, e.g. sonar, some computational hints for sensor modeling are given. The explanation is admittedly very well enclosed by some sections on data interpretation, such as Kalman filtering, needed for integration of multiple sources usually present in mobile robots. The visual sensors chapter gives the fundamental practical concepts (devices, technology) and computational issues while it does not cover in depth any of the algorithms introduced. This would exceed the technicalities found in the overall style of the book.

The third part (reasoning), is the most detailed one for implementation issues. First, the problem of path planning is addressed. Most of its contributions can be read in detail in the well–known book of Latombe [1], while it is still a good introduction. A chapter entitled Operational Environment is original in its contents. It deals with the challenge of integrating the heterogeneous components into a working robot, which is a major subject, sometimes ignored in the literature. In the section where reactive control is treated some insight on laboratory implementations based on fuzzy logic would possibly make the chapter more complete. The Neural Network section deals this interesting subject superficially, and some mention on other learning algorithms supposedly more efficient than backpropagation could be added. A chapter is devoted to pose maintenance, illustrating the various methods for obtaining the robot coordinates, such as triangulation. This problem is explained with precision, and some algorithms illustrated can be directly used researchers wanting to implement these techniques. The problem of creating maps of the environment and related task is addressed from a quite general point of view, rather skeptic. Nevertheless, this is a subject often obviated (the absence of a Further Reading section is a clear sign) but very interesting for research and space applications.

Two ending chapters introduce real-world tasks where mobile robotics is currently in use, and expected future developments in each the fields presented, from an optimistic perspective.

The main drawback from the reviewer's point of view is that to be completely coherent with the book title, some material on motion control and feedback theory should have been included, e.g. the topics treated in [2], as this is a major issue in the successful development of robust mobile applications. Moreover the first two parts are rather descriptive, and cannot serve as material for computational analysis of sensor performance or equipment design. These two remarks can possibly be argued from the application engineer perspective, but from the research community (the majority of professionals involved nowadays in this area), a more detailed exposition would be appreciated.

The presentation of the book has good quality in general, a large number of images, schemes supporting the explanation. The only exception is the way in which algorithms are presented. Very rarely, some misspelled words appear, (e.g. the title of section 3.3 should read "inertial sensors"). The author's attitude towards the subject might be slightly optimistic, as he presents the technology

as mature enough for its use in real applications without risk, and no great investment in research and development. In the reviewer's opinion this is true only in some applications within a controlled environment, such as AGVs for transporting loads in a manufacturing system, with free or well defined paths. But when it comes to cope with unstructured environments a lot of research must still be done. Feasible solutions are only available for particular cases, and no general solutions guarantee applicability in different situations. This fact could be underscored with more emphasis on the text, to avoid giving the novel reader the feeling that this type of project can be developed without the appropriate group of experts and investment.

As a conclusion, this work conveys a vast knowledge and experience on the field of mobile robotics, specially in vision, and reasoning about space. It is presented in a readable and very well organized manner, while some computational aspects of interest for researchers are left aside. Possibly, many technicalities have been avoided in favor of completeness. The result is a comprehensive handout for teaching purposes and a great aid for a practicing engineer facing the cumbersome world of devices and techniques associated to the development of a new mobile robotics application.

References

[1] J. C. Latombe, Robot Motion Planning. Kluwer, Nower, Norwell, MA, 1991.

[2] Spong, M.W., and Vidyasagar, M., Robot Dynamics and Control, John Wiley & Sons, New York, 1989.

Biographical Sketch of The Reviewer

Fabio Gómez-Estern was born in Seville, Spain, in 1972. He received the Ingeniero de Telecomunicación degree in 1996 from the Escuela de Ingenieros, Seville, Spain. He joined communications and electronics companies in Spain (Abengoa) and France (France Telecom) as a R&D engineer. Since 1999 he holds a teaching position at the Department of Systems Engineering at the University of Seville. He has been visitor at the Laboratoire des Signaux et Systemes (CNRS, France) repeatedly. His research fields are communication networks traffic control, nonlinear control systems, Hamiltonian and Lagrangian systems and robot motion control.

Automatica is an IFAC journal, published monthly. It is a leading archival publication in the field of systems and control, featuring a characteristic blend of theoretical and applied papers of lasting value, reporting cutting edge research results by authors across the globe. All submissions undergo a rigorous review process.Â Papers demonstrating the contribution of automation and control in improving the performance, quality, productivity, sustainability, resource and energy efficiency, and Automatica is a leading archival publication in the field of systems and control. The field encompasses today a broad set of areas and topics, and is thriving not only within itself but also in terms of its impact on other fields, such as communications, computers, biology, energy and economics.Â It features articles in distinct categories, including regular, brief and survey papers, technical communiquÃ©s, correspondence items, as well as reviews on published books of interest to the readership. Reviewed by Petr Zagalak. Automatica, Vol. 36, no. 5, pages 83-84, 2000. "This is a book on practical feedback control and not on system theory generally" is the first sentence of Preface and, I am sure, many a reader will certainly be pleased by that. The authors' aim was to write a book that would also be an introduction to robust control, could be used as a text for graduate courses, and be useful for control engineers. This is quite an ambitious goal which was, in my opinion, successfully realized to a great extent.