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Spatial Representation and Motion Planning

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To Marián, for her unconditional love and understanding.
To Angel, María and Javier for making us so happy.

Angel P. del Pobil.

To Eduardo and Elizabeth Bayo, for their hospitality while I stayed in Santa Barbara and their warm friendship.

Miguel Angel Serna.

Preface

The work presented in this book is based on the results of the research of the authors during the last years at the *Robotic Intelligence Group* of Jaume I University and at the *Advanced Robotics and AI Laboratory* of C.E.I.T. and the University of Navarra. However, the topic of spatial representation and motion planning was first discussed by the authors while they were at the University of California at Santa Barbara in 1988.

We consider spatial representation and motion planning as a substantial part of Artificial Intelligence (AI) and Robotics. The AI community has been traditionally devoted to vision, language and different kinds of reasoning. However, if AI is to deal with real-life problems, intelligent systems will have to interact with the world in the way persons do: by moving around and manipulating things. Those are the main goals of robotics.

A good representation must be simple enough and, at the same time, contain all the necessary information to deal with the problem at hand. In the case of spatial representation for motion planning a trade-off is needed: too-simple models may be inappropriate to solve the motion planning problem, and too-accurate representations often lead to inefficient algorithms in complex real-world scenarios.

In this work we present a spatial representation that uses the simplest geometric object —the sphere— together with a hierarchical representation, to model three-dimensional objects. The model is composed of two representations: an exterior representation, made up of outer spheres, provides an upper bound limit; an interior representation, made up of inner spheres, is used as a lower bound limit. Each representation can be refined as required, hierarchically converging towards the real object.

By combining the simplicity of the sphere and the powerful hierarchical representation, the issues of obstacle-free spaces and motion planning can be addressed in a very simple manner. The algorithms make use of the fact that the sphere is the only 3D object that has only three degrees of freedom. Besides the simplicity of dealing with spheres, the hierarchy of detail allows the tuning up of the model to the required accuracy in each particular case.

The content of this book can be of interest for graduate students and researchers in the fields of AI and robotics. Those lecturers working in motion planning will find it very suitable for seminars and group discussions. Nevertheless, since most of the problems and concepts are presented in a simple and clear language, undergraduate students should not find many difficulties in understanding its content.

October 1995,

Angel Pasqual del Pobil
Miguel Angel Serna

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