

Preface

Autonomous Versus Conventional Robots

It is at least two decades since the conventional robotic manipulators have become a common manufacturing tool for different industries, from automotive to pharmaceutical. The proven benefits of utilizing robotic manipulators for manufacturing in different industries motivated scientists and researchers to try to extend the applications of robots to many other areas. To extend the application of robotics, scientists had to invent several new types of robots other than conventional manipulators. The new types of robots can be categorized in two groups: redundant (and hyper-redundant) manipulators and mobile (ground, marine, and aerial) robots. These two groups of robots have more freedom for their mobility, which allows them to do tasks that the conventional manipulators cannot do.

Engineers have taken advantage of the extra mobility of the new robots to make them work in constrained environments. The constraints can range from limited joint motions for redundant (or hyper-redundant) manipulators to obstacles in the way of mobile (ground, marine, and aerial) robots. Since these constraints usually depend on the work environment, they are variable. Engineers have had to invent methods to allow the robots deal with a variety of constraints automatically. A robot that is equipped with those methods that make it able to automatically deal with a variety of environmental constraints while performing a desired task is called an autonomous robot.

Purpose of the Book

There are many books that discuss different aspects of Robotics. However, they mostly focus on conventional robotic manipulators and at best, add a brief section to address mobile robots. Recently, the application of autonomous robots (redundant and hyper-redundant manipulators, and ground, marine, and aerial robots) is finding its way into industries and even into people's everyday life. One can mention several examples such as robotic helicopters for surveillance, aerial photography, or farm spraying, high-end cars that park themselves, robotic vacuum cleaners, etc. It is becoming more important that our students learn about autonomous robots and our

engineers have information resources for designing, analyzing, and controlling these robots.

Since most of the robotic books only deal with conventional robots, nowadays, students do not have a chance to learn about autonomous robots and engineers who design autonomous robots have to resort to extracting information from research literature to design them, which is tedious for them. The present book provides the theories and methods that are useful for understanding and designing autonomous robots to students and engineers in a form that is detailed and easy to follow.

The purpose of this book is to familiarize the Mechanical and Electrical Engineering students and engineers with the methods of modeling/analysis/control that have been proven efficient through research.

Scope of the Book

Similar to the conventional robotic manipulators, the autonomous robots are multi-disciplinary machines and can be studied from different points of view, i.e., industrial, electrical, mechanical, and controls points of view. Autonomous robots can also be studied from the Artificial Intelligence point of view. Covering all these aspects of autonomous robots in one book is almost impossible and each of these aspects has their own audience. For these reasons, the scope of the present book is the mechanics and controls of autonomous robots. The book covers the kinematic and dynamic modeling/analysis of autonomous robots as well as the methods suitable for their control.

Level of the Book

This book is useful for last-year undergraduate and first-year graduate students as well as engineers. The readers should have passed a second year course in Dynamics and a third year course in Automatic Control (or similar) to be able to fully take advantage of this book. The mentioned prerequisites are not an obstacle for Mechanical or Electrical Engineering students and engineers, since these courses are offered in ABET (or CEAB for Canadian higher education) accredited engineering programs.

Features of the Book

The key feature of the present book is its contents, which have never been gathered within one book and have never been presented in a form useful to students and engineers.

- The present book contains the theoretical tools necessary for analyzing the dynamics and control of autonomous robots in one place. The topics that are practical and are of interest to autonomous robot designers have been picked from advanced robotics research literature. These topics are sorted appropriately and will form the contents of the book.

- This book presents the theoretical tools for analyzing the dynamics of and controlling autonomous robots in a form that is comprehensible for students and engineers. The advanced robotics research literature have usually been authored with the research community in mind. The mathematical notation and the presentation method of these publications are not easy to understand. These publications normally lack the necessary details and intermediate steps. The current book uses a uniform notation, provides the mathematical background of the theories presented, expands the details, and includes the intermediate steps and comprehensive examples to ease and accelerate the reader's comprehension.
- The current book has problems at the end of each chapter. The problems allow the reader to practice the theories presented in each chapter. The solution to most of the problems need some computer aided analysis. Some of the longer problems are more suitable for term projects.

The author hopes that the present book becomes an asset for learning the application of dynamics and controls in the field of autonomous robots.

Edmonton, Alberta, Canada
July 2008

Farbod Fahimi



<http://www.springer.com/978-0-387-09537-0>

Autonomous Robots

Modeling, Path Planning, and Control

Fahimi, F.

2009, XVIII, 340 p. 86 illus., Hardcover

ISBN: 978-0-387-09537-0