Chapter 1

Introduction

ABSTRACT

In this first chapter of the book, the authors provide an overview of the problems of mobile robot localization and mapping, including taxonomies over the axes of the representation of spatial knowledge, the structure and dynamics of the environment, the sensory apparatus of the robot, the motor apparatus of the robot, and the previous knowledge. They also provide a brief historical timeline and fundamental concepts. The goal is to provide the reader with a roadmap of the problems and also of the book, in order to allow her or him to choose the best way of approaching the text and also an appropriate understanding of the main limitations of the existing methods.

CHAPTER GUIDELINE

• You will learn:
  ◦ The reasons why robotic manipulators have been much more successful in practical applications than mobile robots up to now, and the role of the problems of localization and mapping in this distinction.
  ◦ A little on the history of mobile robotics.
  ◦ How the rest of the book is organized and how to employ it depending on your purposes.
• Provided tools:
  ◦ A taxonomy for the classification of the problems of localization and mapping, aimed at identifying the adequate approach for each situation.
  ◦ Relation to other chapters:
    ◦ This chapter provides an overview of all subsequent chapters and their organization.

1. OVERVIEW

Robotics is a complex and fascinating discipline, not only for scientists. The idea of creating artifacts that perform autonomously and intelligently has appeared from time to time throughout the history of humankind in a variety of ways, ranging from the fearsome mythological form of the Golem of the early Judaism (Idel, 1990) to the inoffensive and very amusing automata of Jacques de Vaucanson in the 18th century (Landes, 2007), until it was definitely solidified in the last six decades of our era. In the transition from the 19th to the 20th century, science-fiction literature was already a
popular melting pot for these kinds of scientific and technologic fascinations, and therefore had a particular role in our modern conception of the discipline. In 1921, the Czech writer Karel Capek made use of the suggestion of his brother Josef to call “robota” the imaginary human-like creatures of his play “R.U.R. Rossum’s Universal Robots” (Capek, 1921)—the word “robota” stands for “serf labor” in a few Eastern European languages. Twenty years later, Isaac Asimov introduced the term “robotics” in one of his science-fiction stories (Asimov, 1941) and developed in a number of further stories and novels many logical questions that rational robotic slaves would pose when working among humans. That seminal meaning for “robot,” that is, a machine that imitates actions performed by a living being, particularly the hard work that people do not like or want to do, has survived through history without much change: virtually all the robots created by mankind, including the fictional ones that have become part of our collective memory across the centuries, have contributed—in reality or imaginarily—to the relief of some portion of our physical work.

However, the robotic inventions that have actually contributed the most to that relief are far from having human aspect, unlike in most fictional stories. Instead, mechanical arms fixed at some location, the so called robotic manipulators (Niku, 2010), have been the kings of all the real robotic creatures—see Figure 1. From the first arms built around the middle of the 20th century (Devol, 1961;

Figure 1. A programmable universal machine for assembly (PUMA manipulator arm), used for virtual reality research at NASA. This industrial robot was developed in 1978 by Unimation and General Motors based on the designs of Victor Scheinman, the creator of the Stanford Arm (NASA Ames Research Center, Mountain View, California).