Chapter 79
Biorobotics

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ABSTRACT

Biorobotics is an emerging discipline that merges biomedical engineering and robotics. Biorobotics is the science and engineering of robotics applied in the Biomedical field, with the development of biomedical devices for surgery and rehabilitation, as well as with the modeling of biological systems. In this sense, biorobotics is also the construction of physical models of the biological systems, as bioinspired and biomimetic robots. Although most technologies are derived from robotics at large, biorobotics possesses some distinguishing features in terms of methodology of design that deserve to be approached apart from robotics. Biorobotics represents today a field of evolution for biomedical engineering and for robotics, and the ideal ground for educating young engineers, by breaking the traditional barriers among the engineering sectors and those of biological sciences and medicine.

CHAPTER OBJECTIVES

The aim of this chapter is to define the science and engineering of Biorobotics, and to give an overview of the methods and of the robotics technologies and systems that are being developed in this field. Biorobotics is a relatively broad area, and accordingly a clear definition of its contents is given at the beginning of the chapter. The reader is expected to learn about the areas composing biorobotics, about the common methodology used for designing and developing biorobots, and about the latest achievements in this field. For each of the three main areas of biorobotics, the reader is given the fundamental problems roboticists have to address, the basic approaches adopted so far, the technologies developed, and the systems in use in real applications. Another objective of the chapter is to give both the fundamentals of biorobotics; i.e., the consolidated methods, tools, knowledge, and a glimpse on the research trends. In summary, the reader will be appraised of:

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- What biorobotics is;
- What are the three main areas of biorobotics;
- What is the common methodology in biorobotics design and development;
- What are the main problems requiring robotic solutions, in each biorobotics area;
- What are the methods and the technologies of each area of biorobotics;
- What are the current trends of research and the future challenges and expected achievements.

Finally, the chapter intends giving the reader the appropriate pointers, in terms of professionals and scientific societies in this field, in order to examine specific aspects of biorobotics in greater detail, and to track the evolution of this young and dynamic field.

INTRODUCTION

This chapter on Biorobotics begins with a comprehensive description of biorobotics, by defining the three main areas it comprises, and by defining the biorobotics methodology; in addition to providing a first synthetic illustration of the three main areas of biorobotics. Then, the main body of the chapter is composed of three sections, one for each of the three main areas of biorobotics:

- Robotics for therapy and surgery,
- Robotics for rehabilitation and assistance, and
- Bioinspired and biomimetic robotics.

Each of these three sections gives the general concepts and definitions of the area, and then illustrates a case-study chosen as a good example from an educational point of view, to end with concluding considerations, summarizing the take-home lessons.

Afterwards, a whole section is devoted to the future directions of biorobotics. The scientific and technological perspectives will be discussed, as well as the current challenges and bottlenecks, and the current trends in research.

The chapter ends with a section listing references to international scientific societies and web resources, and another section of bibliographical references.

A COMPREHENSIVE DEFINITION OF BIOROBOTICS

Biorobotics can be defined as the science and engineering of applying robotics to problems regarding biology and medicine (Dario, 2003). This field includes both science and engineering because, on the one hand, robotics technologies, devices, and tools can be used for studying biological systems and, on the other, biological systems offer new solutions for developing innovative, biomimetic, technologies and systems.

In terms of contents, biorobotics has three main areas:

1. Robotics for therapy and surgery,
2. Robotics for rehabilitation and assistance, and
3. Bioinspired and biomimetic robotics.

From a methodological point of view, biorobotics consists of the following phases (see Figure 1).

The first phase consists of studying and modeling a biological system, with the methods and tools of engineering and robotics. The biological system can be the human being on which the robot under development will operate, as in the case of surgical or rehabilitation robots (biomedical robotics). In this case the next phase is to use the model developed in the first phase to design the biomedical robot and, especially, to design the interaction with the human being. The