Chapter 6
Multidisciplinary Project-Based Learning of Robotics

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ABSTRACT

The interest in using mobile robots in education has increased over the last two decades, as it is a multidisciplinary exercise in which the student needs to apply different subjects related to robotics, control engineering, software engineering, and electronics. In this chapter, the design and development of a mobile robot focused on the assistance to people with restricted mobility is detailed. This application of the service robot in the assistance field has to be developed by the students of the last course of the Automatic Control and Electronic Engineering Career at the Engineering Faculty of Bilbao, resulting in a fully functional prototype. The aim of this design is to integrate the knowledge acquired through different subjects in order to design and develop a functional, low-cost assistance robot in the service robotics field.

INTRODUCTION

Service robotics is an emerging field that presents a great growth potential and a variety of application fields. The International Federation of Robotics classifies these robots in three main groups (IFR, 2007): 1) human assistance applications (personal, protection, entertainment, ...); 2) equipment service applications (maintenance, repairs, cleaning, ...); and 3) other autonomous applications (surveillance, data acquisition, transport, ...). Being the assistance to people the main focus of this chapter, the application detailed next can be included in the first group.
In recent years, several studies warned about the population aging phenomenon and its effects in society. The economical cost of the assistance to an increasing elderly population has lead to search for alternatives to cope with this phenomenon. In this context, the use of service robotics to assist elderly people has been proposed. Moreover, researchers predict an important evolution of the service robotics field in the assistance, healthcare and mobility areas (Kassler, 1993; Meng, 2000; Van der Loos, 2008). Roy describes the state-of-the art of a large-scale project, aimed towards the development of personal service robots for the elderly population (Roy, 2000).

The main focus of these robots is to provide greater degree of autonomy to these patients so that their quality of life is increased. Moreover, the robot can also be used under direct control as an assistant for those tasks the patient finds difficult to execute. An example of this approach is the Rolland autonomous wheelchair (Mandel, Huebner, & Vierhuff, 2005). Other interesting solution has been proposed by the Georgia Institute of Technology (Nguyen & Kemp, 2008), where service robots have been replaced by a robotic assistant. Control of the service robot is executed by using the voice commands used with service dogs, and effectively replacing them in guidance tasks. The main aim of this prototype is to cope with the log waiting lists for obtaining a service dog. Other approaches in this area also include the use of a fixed robot arm. However, in all cases, the main focus is to provide the handicapped patient a greater degree of autonomy in their daily life.

Other universities collaborate in similar challenges to aid the aging. For example, a team of researchers from Carnegie Mellon and the University of Pittsburgh developed Flo, a robot that can assist the physically dependent with daily living. This Nursebot helps the elderly live independently in their own homes, as a personal assistant, as opposed to an intelligent wheelchair or smart walking aid.

Besides the pure assistant robots, the use of mobile robots for medicine delivery in hospitals and nursing homes has increased in the last years. Commercial robots provided by Mobile Robots already work on this area. The robots manufactured by this company allow specific functions such as the transportation of medical instruments or medicines at pharmacies or hospitals, avoiding collisions with people and objects around its way (Adept, 2011).

Mobile robots systems are usually driven by microcontroller-based embedded control systems. This architecture provides the computational support for implementing the required functionalities of the robot: guidance, vision, object handling, etc. As mobile robots are designed to move in a two-dimensional plane, one of the main research topics in the mobile robotics area is the autonomous path planning, obstacle avoidance and navigation.

This chapter is dedicated to present a project-driven approach to design embedded systems as applied to the field of service robotics. The student faces at the different phases of the development cycle, from the requirements identification, through the architectural design and the detailed design of the control system and user interface to finally achieve the system implementation. Thus, he/she can apply the skills acquired in the different disciplines, robotics, control engineering, embedded systems, and electronics to build a remotely controlled mobile robot. The rest of the chapter is organized as follows: first, the motivation and objectives are detailed. In section 3, the design requirements are proposed. The architecture of the mobile robot and their construction are described in section 4. Section 5 focuses in the control system and the user interface of the robot. Finally, the most important ideas are summarized in section 6.

MOTIVATION AND OBJECTIVES

Engineering students must design a real application in order to obtain the Bachelor’s degree. This
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