Chapter 11
Expert Guided Autonomous Mobile Robot Learning

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ABSTRACT

In the control of autonomous mobile robots there exist two types of control: global control and local control. The requirement to solve global and local tasks arises respectively. This chapter concentrates on local tasks and shows that robots can learn to cope with some local tasks within minutes. The main idea of the chapter is to show that, while creating intelligent control systems for autonomous mobile robots, the beginning is most important as we have to transfer as much as possible human knowledge and human expert-operator skills into the intelligent control system. Successful transfer ensures fast and good results. One of the most advanced techniques in robotics is an autonomous mobile robot online learning from the experts’ demonstrations. Further, the latter technique is briefly described in this chapter. As an example of local task the wall following is taken. The main goal of our experiment is to teach the autonomous mobile robot within 10 minutes to follow the wall of the maze as fast and as precisely as it is possible. This task also can be transformed to the obstacle circuit on the left or on the right. The main part of the suggested control system is a small Feed-Forward Artificial Neural Network. In some particular cases – critical situations – “If-Then” rules undertake the control, but our goal is to minimize possibility that these rules would start controlling the robot. The aim of the experiment is to implement the proposed technique on the real robot. This technique enables to reach desirable capabilities in control much faster than they would be reached using Evolutionary or Genetic Algorithms, or trying to create the control systems by hand using “If-Then” rules or Fuzzy Logic. In order to evaluate the quality of the intelligent control system to control an autonomous mobile robot we calculate objective function values and the percentage of the robot work loops when “If-Then” rules control the robot.

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INTRODUCTION

Every day in the world we have more and more robots. We already cannot imagine our lives without them. Autonomous mobile robots (AMR) have a wide range of applications. Nowadays it is produced robots toys, robots applicable in daily life needs, industry, agriculture, military, special robots, and, of course, and the ones applied in science. Robot toys become more and more sophisticated; eventually they become learning tools for children. In Japan a life-like female robot Saya can teach the fifth-graders. Robots which are applied in daily life needs relieve people of everyday cares, save a lot of their time. Robots replace people in industry. In such a way productivity and production quality are increasing, whereas expenses are decreasing. Military robots are used to complete military operations. They save troop lives. Special robots are used for cleaning polluted environments, rescuing and completing other special operations. Robots that are designed for research extend the potential boundaries of research. Scientists can use them for the research of deep water in the oceans, volcano craters, even other planets (Maimone et al., 2006). Robots for research are important for one more thing – they are used in the research of methods and algorithms applied in the intelligent robot control.

However, today AMR still cannot move, communicate, recognize and orient in the environment in the same way as the living creatures can. Intelligent control systems (ICS) are neither universal nor powerful enough to guarantee a good working of AMR in our today’s environment. In the robotics it is necessary to improve both the hardware and the software as well as to pay exclusive attention to the intelligent hybrid control systems and robots learning from demonstrations. In this chapter, there will be shown that on-line learning from demonstrations technique is much faster than other (evolutionary) techniques. The objective of this chapter is to show that the AMR can learn some tasks much faster under skilled operator-expert guidance than it could learn that without guidance.

BACKGROUND

In the control of AMR there exist two types of control: global control and local control. The requirement to solve global and local tasks arises respectively. In the figure 1 the situation when an AMR – an unmanned ground vehicle must navigate from the start position to the finish position is represented. The first task is a global path planning. To solve this global task GPS tracking devices or/and GPS auto navigator should be used. It depends where a car must drive: on road or off-road terrain. For example, in the 2005 DARPA Grand Challenge project no global path planning was required (Thrun et al., 2006). The route definition data format defined the approximate route that robots would take. What concerns a local task, Sebastian Thurn et al. write: “When a faster robot overtook a slower one, the slower robot was paused by DARPA officials, allowing the second robot to pass the first as if it were a static obstacle. This eliminated the need for robots to handle the case of dynamic passing”. These facts show that there still are a lot of unsolved problems in local and global control and encourage roboticists to continue their work on these tasks.

In the figure 1 it is shown that AMR must solve several local tasks: recognize moving objects, detect the pits and obstacles on the road, see road marking and signs, understand traffic-light signals, and cope with prediction of the movement of other cars, people, and even segways or horsemen.

It is obvious that one of the most important tasks in mobile robotics is a local task: obstacle detection, its avoidance and circuit. Local task can be described when the AMR is in a certain environment and via sensors gets information about this environment. Having this information the AMR must make intelligent decisions and send the commands to the motors and ac-
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