Chapter 6
Application in Planning

This chapter demonstrates the use of the capability map in planning tasks. Using two examples, it is demonstrated how the capability map can be used to restrict the search space. The algorithms thus address the gap between task planning and path planning that is indicated in Figure 6.1 by the red rectangle. In the first application covered in this chapter a robot is placed to perform a given trajectory. Its suitability for the task is evaluated. In the second application the capability map is used to

Fig. 6.1 Different levels of abstraction during the planning and execution of a service task are shown. The task of fetching a cup from a closet is used as an example. High-level planning is equivalent with task planning. Possibly parallel running actions are mapped to low-level planners. The planning results are then executed by divers robot controllers. The red rectangle indicates that the capability map is used to address the gap between task planning and path planning.
obtain good parameters for a path planner and bias the path planning process. The methods are evaluated using the mobile humanoid robot *Rollin’ Justin* (Figure 6.2).

### 6.1 Placement for 3D Trajectories

Kitchen tasks require fetching and carrying things, as well as manipulating and interacting with the environment. To accomplish these tasks, the robot has to use knowledge about the specific environment and knowledge about its own capabilities. It has to know how to open a closet or how well it can grasp objects. The robot also has to decide when to use which part of its body. Not only the question when to use the upper body is important but also when to use the mobility of the base. To execute simple trajectories with the robot arm it is not always necessary to use the mobile base. On the contrary, if the mobile base is unnecessarily used, e.g. while opening a kitchen closet, additional forces acting on the arm have to be compensated. These forces are due to the fixed grasping of the door handle and the navigation errors of the mobile base.

#### 6.1.1 Detailed Problem Analysis

In service robotic applications, unconstrained pick and place tasks are often encountered. In these tasks, the robot moves an object from a start to a goal position. To