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Autore: COGNETTI, MARCO

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Sommario: This thesis handles the motion planning problem for various robotic platforms. This is a fundamental problem, especially referring to humanoid robots for which it is particularly challenging for a number of reasons. The first is the high number of degrees of freedom. The second is that a humanoid robot is not a free-flying system in its configuration space: its motions must be generated appropriately. Finally, the implicit requirement that the robot maintains equilibrium, either static or dynamic, typically constrains the trajectory of the robot center of mass. In particular, we are interested in handling problems in which the robot must execute a task, possibly requiring stepping, in environments cluttered by obstacles. In order to solve this problem, we propose to use offline probabilistic motion planning techniques such as Rapidly Exploring Random Trees (RRTs) that consist in finding a solution by means of a graph built in an appropriately defined configuration space. The novelty of the approach is that it does not separate locomotion from task execution. This feature allows to generate whole-body movements while fulfilling the task. The task can be assigned as a trajectory or a single point in the task space or even combining tasks of different nature (e.g., manipulation and navigation tasks). The proposed method is also able to deform the task, if the assigned one is too difficult to be fulfilled. It automatically detects when the task should be deformed and which kind of deformation to apply. However, there are situations, especially when robots and humans have to share the same workspace, in which the robot has to be equipped with reactive capabilities (as avoiding moving obstacles), allowing to reach a basic level of safety. The final part of the thesis handles the rearrangement planning problem. This problem is interesting in view of manipulation tasks, where the robot has to interact with objects in the environment. Roughly speaking, the goal of this problem is to plan the motion for a robot whose assigned a task (e.g., move a target object in a goal region). Doing this, the robot is allowed to move some movable objects that are in the environment. The problem is difficult because we must plan in continuous, high-dimensional state and action spaces. Additionally, the physical constraints induced by the nonprehensile interaction between the robot and the objects in the scene must be respected. Our insight is to embed physics models in the planning stage, allowing robot manipulation and simultaneous objects interaction. Throughout the thesis, we evaluate the proposed planners through experiments on different robotic platforms.

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