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EDITORIAL

Editorial: Task planning and motion control problems of service robots in human-centered environments

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Service robots in our everyday life situations are one of the ultimate applications of robots. When we called a robot for a drink delivery service at home, we might simply want to order the robot by saying that "get me some water, please" just like we did to a human server as opposed to by giving a list of tasks such as "go to kitchen, find a refrigerator, open the door of the refrigerator, find a water bottle, take out the bottle, pour some to a class-cup, and deliver the water-filled glass-cup to me". Even if those tasks are given to a robot, it must be specified about the motion of the mobile platform for the robot to move to the kitchen area, precisely making arm motions to do the following tasks.

Therefore, a practical service in a human-centered environment requires well-planned robot tasks which are often represented in abstract manners as well as precise and adequate motions of each part of the robot system, which often requires metric data. Furthermore, physical interaction of the robot with the human centric environment or objects in human living space and robust perception of such environments make the problem even harder. Recent advances in robotic systems, manipulation technologies, sensory systems, perception technologies, computing powers, and artificial intelligence provide tangible building-blocks toward human-care service robot technologies.

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This special issue establishes corner stones for the intelligent service robots by providing scientific methods and technologies that step toward the realization of service robots. This special issue on task planning and motion control problems of service robots in human-centered environments presents four papers that were selected by the guest editors, Hyungpil Moon, Byoung-Tak Zhang, and Changjoo Nam, based mainly on the relevance and contributions to task planning and motion control of service robots. The papers went through the normal multistage peer review process of the ISR journal.

Combined task and motion planning (CTAMP) for the service robot is a study of reasoning a full path plan by simultaneously performing task planning and motion planning. Often a task planner finds a list of tasks to perform and evaluation of the feasibility of them followed by a motion planner, but seamless integration of them is still a challenge. In "Combined task and motion planning system for the service robot using hierarchical action decomposition," authors provide a framework that integrates knowledge inference, task planning, motion planning, and recognition for autonomous task performance. Hierarchical action decomposition and action library are introduced to allow symbolic task plan to be converted into geometric motion plans. This work exhibits a showcase of a home service robot in various tasks that are involved in object manipulation.

Service robots for human-centered environments often have a redundant degree of freedom. Such a characteristic can help robots to perform multiple tasks efficiently. For example, a humanoid robot that is in a standing posture by maintaining balance and performs a box-taping with dual-arm collaboration needs to perform multiple tasks. Depending on the priority tasks are desired to be easily switched or replaced by others. In "Weighted hierarchical quadratic programming: assigning individual joint weights for each task priority," authors present a weighted hierarchical quadratic programming framework to utilize the redundancy of the high-dimensional service robots. It can handle various equality and inequality tasks with differently weighted joint motion. The idea can be further extended to other types of redundant systems such as aerial manipulator and multi-agent systems.

Mobile service robots in human-centered environments often face dynamic obstacles in cluttered environments. Representing such environments including dynamic objects is one of key challenges to task and motion planning of service robots. In “Remote object navigation for service robots using hierarchical knowledge graph in human-centered environments,” authors present an automated method of constructing scene knowledge graph (SKG) and a two-stage navigator composed of a global path planner and a local search engine. Authors incorporate reasoning modules in SKG that enable the robot to perform a high-level task such as to find and navigate to the unseen object in the human-centered environment.

For a robot to follow an instruction that was intended for a human worker involves a series of task abstraction and planning through sensing the environment, motion planning, and control of the robot. In “Robotic furniture assembly: task abstraction, motion planning, and control,” authors present a framework for the chair assembly based on the assembly instructions. They incorporate task templates and task compilers to make the assembly instruction drawings to robot tasks and motion planning. The task and motion planning, assembly control, and failure recovery problems are all integrated and implemented to a chair assembly using three manipulators. This work shows that robots can complete an assembly job without having a list of motion schedule, but with an instruction that was intended for human workers.

Finally, we appreciate all the authors for their contributions and enthusiastic cooperation to make this special issue valuable. We also show our gratitude to all the reviewers and editors of Intelligent Service Robotics. We hope that the readers enjoy the interesting outcomes in this special issue.