Development and manipulation planning of small mobile robot

Adopting robots in the manipulation of big-sized objects in domestic environments, human could be emancipated from such trivial works. However, big-scaled robots are not available in narrow domestic spaces. Owing to the small size and motion flexibility, small mobile robots are desirable for such tasks, because they can perform non-prehensile manipulation substituting manipulators by working cooperatively.

In our earlier work, we proposed the method to transport big object by using multiple mobile robots [1]. Based on that method, we developed a small-sized mobile robot [2-5], whose linear manipulator can exert a large force to push the object while robot flipping over can be avoided regardless the scale of output force. A group of our developed robot can conduct various manipulations to objects by working coordinatively, such as inclining, pushing, and pivoting.

To realize the cooperation among robots, manipulation planning is important. To deal with the distinct multi-level configuration space caused by the varying constraints in the robot-object system, a hierarchical method is adopted in our work. Defining a mode as a set of specific configurations that hold the same constraint, we specially focused on the modal planning, by which the manipulation action sequences could be determined to narrow down the configuration space for searching tasks [6-8]. Our proposed method determined the number of robots for manipulation stability, and investigate the mode transitions caused by the robots' motions and by the object's motions. With our method, the possible number of modes and their transitions was obviously reduced, and the determined mode sequences can be used to guide the further searching task for configuration planning.

Keywords: mobile robot, large force, manipulation planning, hierarchical planning, optimal placement

Reference

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[3] C. Fan, S. Shirafuji, J. Ota. Modal Planning for Cooperative Non-Prehensile Manipulation by Mobile Robots. Applied Sciences, 2019, 9.3: 462.

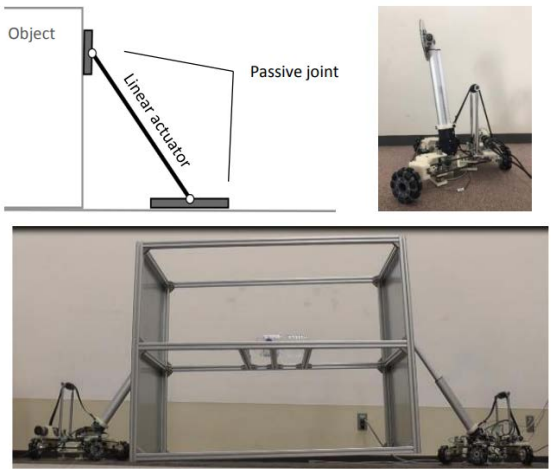

Fig 1. Developed mobile robot (above) and tilting manipulation using two mobile robots (bottom).

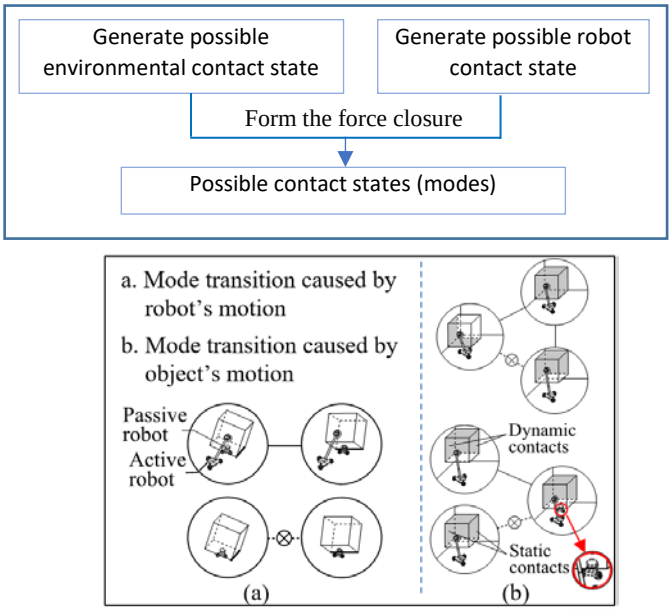

Fig 2. Modal planning for the robots' manipulation to the object (generating the modes and the principle for mode transition).