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. Working cooperatively, multiple robots can perform non-prehensile manipulation substituting manipulators.

In our earlier work, a small-sized mobile robot was developed [1], 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. Various manipulations would be conducted by multiple robots cooperation, such as transferring objects [2].

To realize the cooperation among robots, manipulation planning in the multi-mode configuration space of object-robot system is needed. A hierarchical method is adopted in our work to deal with this multi-modal planning problem, as shown in Fig. 4. The modes in the multiple-robot non-prehensile manipulation is prior identified, with the determined amount of robots for manipulation stability. With the separated modes, sampled-based methods can be used for the planning task in the single-modes.

Since the manipulator joints are passive, the robot could not adjust the output position and direction of force in manipulation. Therefore, the optimal contact position of robot manipulator on a targeted object is derived in our work. Exerting contact on the optimal region of object surfaces, robots can work with highest efficiency of the output force to push the object, with a force balance achieved in the robot-object system.

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

Reference

[1] S. Shirafuji, Y. Terada and J. Ota: “Mechanism Allowing a Mobile Robot to Apply a Large Force to the Environment,” International Conference on Intelligent Autonomous Systems. Springer, Cham, 2016: 795-808.

[2] F. Ohashi, K. Kaminishi, J. Heredia, H. Kato, T. Ogata, T. Hara and J. Ota: “Realization of Heavy Object Transportation by Mobile Robots Using Handcarts and Outrigger,” ROBOMECH Journal, 2016, 3.1: 27.

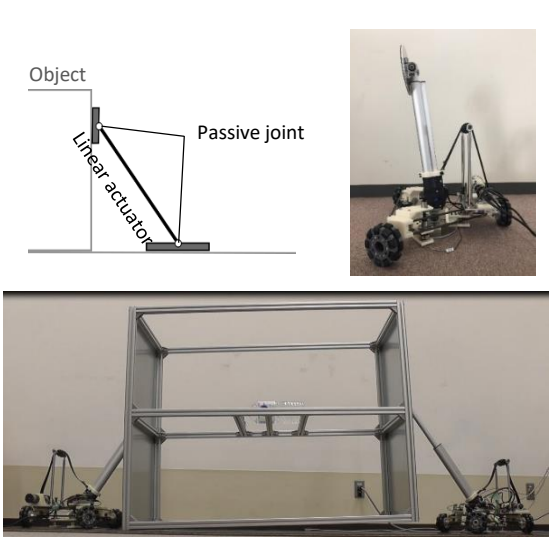

Fig 1. Developed mobile robot (above) and tilting manipulation using two mobile robots (bottom).

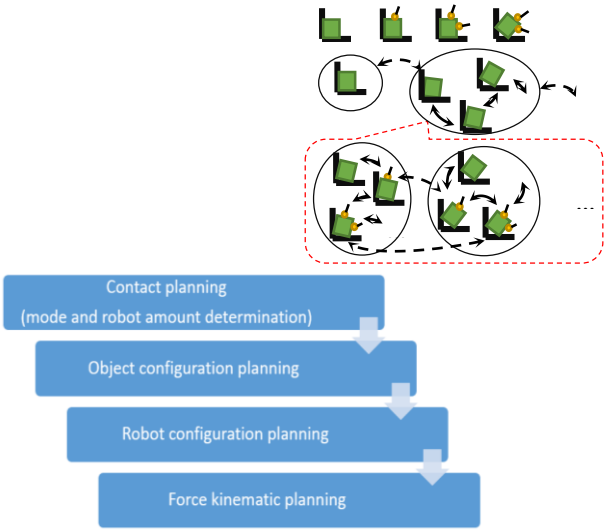

Fig 2. Hierarchical planning of multiple mobile robots.