Motion Planning of Mobile Manipulator for Multiple Tasks
(Dr. R. Chiba, Prof. J. Ota and Prof. T. Arai)

Recently, a flexible manufacturing system using a mobile manipulator (Fig.1) is gradually generalized as one of the effective product system in factories. The mobile manipulator circulates in a factory for handlings of items. Therefore, the mobile manipulator moves, stops, handles items repeatedly. In this research, we propose the motion planning method for autonomous mobile manipulator in a factory.

For this purpose, there are two problems to be solved as follows: 1) To plan the positions for the handlings in order to minimize the number of those. 2) To generate the short paths for the circulation. The former problem is based on the needs to explore the stop-positions in which the manipulator can handle two or more items because of the errors in stopping. The latter is based on the needs that paths should have continuous curvature because of non-holonomic constraints.

To solve these problems, we propose the methods as follows: In problem 1), we make manipulability templates including the errors of stopping (Fig.2), and the problem is defined as Least Set Partitioning Problem (LSPP) to which the Set Partitioning Problem (SPP) is modified and a branch and bound method is applied to the problem. In 2), we propose a path expression method consisting of line segments, circular and clothoid arcs considering the continuity and the maximum of the curvature and propose a visibility graph-like method to set the nodes for obstacle avoidances (Fig.3). With these two methods, the effective motion planning is realized (Fig.4).

Keywords: Mobile manipulator, navigation, non-holonomic constraint, Manipulability

References
1) Tomomi Kito, Jun Ota, Rie Katsuki, Takahisa Mizuta, Tamio Arai, Tsuyoshi Ueyama, Tsuyoshi Nishiyama: "Smooth Path Plannnig by Using Visibility Graph-like Method," Proc. 2003 IEEE Int. Conf. Robotics and Automation, pp. 3770-3775, 2003.
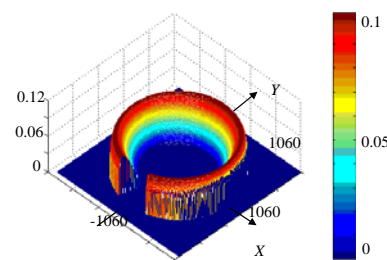

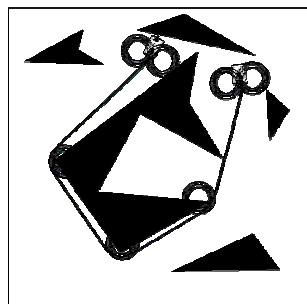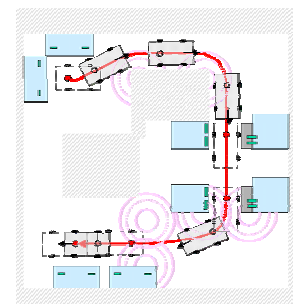Fig. 1   Mobile manipulator

Fig. 2 Manipulability template

Fig. 3 Genelated pathes with proposed method

Fig. 4 Planning positions and pathes