Motion planning of two stacker cranes in a large-scale automated storage/retrieval system

We propose a method for reducing the computational time of motion planning of warehouse equipped with two stacker cranes (Fig.1). There is a former research studied the motion planning of an automated storage/retrieval system with two independent stacker cranes. While the loading efficiency of the algorithm it proposed was satisfying, calculating the feasible trajectory requires a significant amount of time, which does not satisfy the requirement of industry. In other words, the load to be transported is assigned randomly, so we cannot do trajectory calculation beforehand. For employment in an actual industrial warehouse, we must reduce the calculation time of the automated storage/retrieval system.

There are two reasons which make the calculation time longer. For not colliding with other crane, we have to do collision verification for each trajectory candidate. Those works will take much calculation time, especially for large-scale warehouse.

For a specific start position and target position, there are infinite trajectory candidates. To find an efficient and safety one from those candidates will also take much calculation time.

To solve these problems, first, we devise a new algorithm for collision verification which uses information of position and velocity of cranes to get a time span (free step) for not doing collision check in order to reduce the calculation time of a collision check. By using free step, we can do collision check only when the time collision may happen, thus we can reduce the calculation time.(Fig. 2).

Second, we propose a method for faster selection of a trajectory with a higher probability of avoidance from a quantity of trajectory candidates. We use the information of position and of cranes to speculate a feasible trajectory.

In the simulation, we assigned 200 tasks randomly of the simulation environment of 256rays 128levels. The simulation result is much better than the former research. While the maximum trajectory calculation time in this simulation is 13.33s, the maximum trajectory calculation time in this simulation is 0.03s. Furthermore, the working time in a former study and that in the proposed method are almost identical. Therefore, we can understand that the proposed method is useful here.

Key word: Warehouse, motion planning

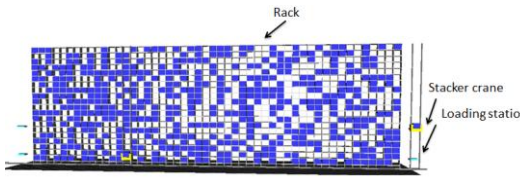

Fig. 1 Automated storage/retrieval system with two stacker cranes

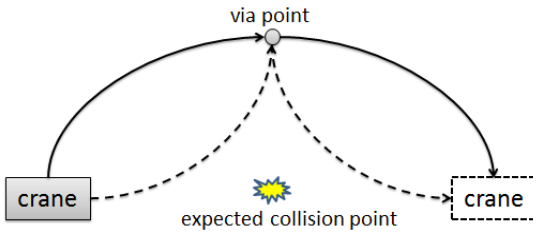

Fig. 2 Derivation of the order of collision verification in a detour avoidance trajectory