Compact Design of a Redundant Manipulator System under a Task Completion Time Constraint

Ideally, manipulator systems must occupy minimal space to achieve a high density of work cells over a given area (spatial requirement) and be high-speed for high productivity (temporal requirement). Satisfying these two requirements is complicated due to conflicting constraints such as collision and motion time. In this study, a redundant manipulator system consisting of a 6-DOF manipulator and a 1-DOF rotating table is designed to be compact . A new *compactness* measure is proposed that considers the manipulator swept volume, which is crucial because the manipulator has a small footprint but can occupy a substantial space due to its large workspace (Fig.1). As a solution, a motion coordination based on the swept volume called spatial motion coordination (SMC) is proposed and is integrated with the base placement optimization and goal rearrangement (Fig. 2). In the proposed method, the task completion time is also minimized to a desired value, $t_{desired}$, to ensure that the system throughput is achieved. Therefore, SMC is evaluated under various $t_{desired}$ values and is compared with a motion coordination based on the task completion time called temporal motion coordination (TMC). The reduction in the system size is about 28% on the average by using the proposed method compared to a method using only goal rearrangement and motion coordination (Fig. 3). It is also found that the applicability of SMC and TMC depends on the $t_{desired}$ values (Fig. 4).

Keywords: Multiple-goal task realization, manipulator optimization.

References

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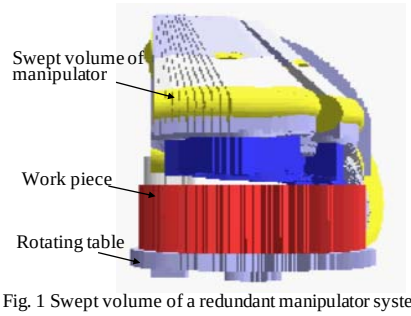

Fig. 1 Swept volume of a redundant manipulator system

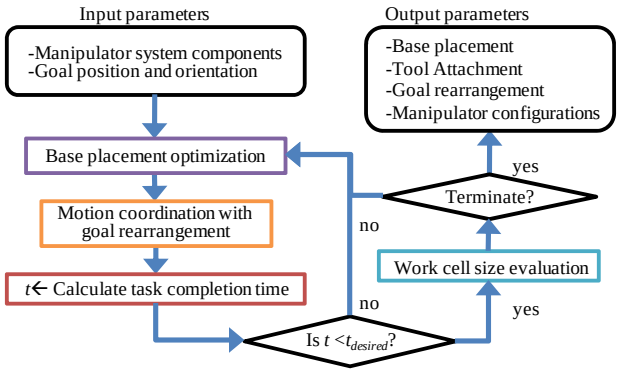

Fig. 2 Proposed method

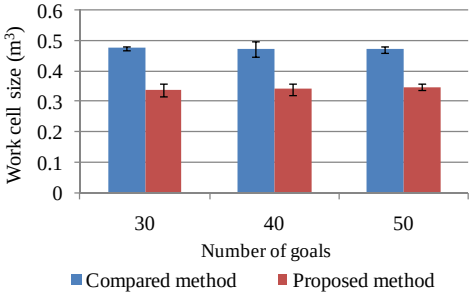

Fig. 3 Average work cell size derived by the compared and proposed methods.

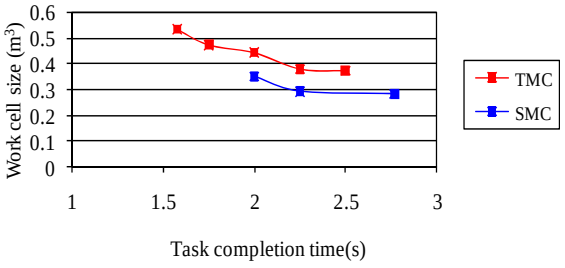

Fig. 4 Performance of SMC and TMC under various $t_{desired}$ settings