## ABSTRACT

A system includes a robot with a robot arm having multiple joints and an end effector to carry a substrate. A processing device is to build, with respect to a joint space for the multiple joints and the end effector, a graph of reachable positions and sub-paths between the reachable positions, wherein the reachable positions and the sub-paths satisfy Cartesian limits within the joint space. The processing device is to determine, by executing a graph optimization algorithm on the graph, multiple paths, each made up of a group of the sub-paths and having one of a shortest distance or a lowest cost between a start point and an end point of the end effector. The processing device is to select a path, of the multiple paths, through the graph that minimizes a move time of the end effector between the start point and the end point.

FIG. 3