Path smoothing for the RRT motion planning algorithm

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We have developed an innovative method of trajectory smoothing for the Rapid-exploring Random Tree (RRT) robotic path-planning algorithm, suitable for real-time applications. Optimal path planning is not suitable for real-time applications since path planning for robotic manipulators is an NP-Hard problem. RRT [1][2] is a sampling based motion-planning algorithm, widely used in robotics because of its efficiency (Figure 1). Due to the nature of random sampling algorithms, the resulting paths are tortuous. Therefore, a phase called path smoothing is required after a possible path is found. The classical smoothing method is a heuristic based on the divide and conquer concept [3], which consists of decomposing the original path and omitting some of its nodes, iteratively, in order to shorten it. We have modified this method by adding two extra split points per each subset instead of a constant split in the middle of the subset, testing a wider set of solutions. Two versions of the RRT algorithm were implemented: Goal-biased [1] (a single tree starting point) and Bi-Directional [2] (two tree starting points), and tested with the two smoothing methods for a simulated 3-linked robot arm within twelve 2D environments that differed in obstacle density. The measures used for comparison reflected both computation time and path quality. Our results indicated that while there were no significant differences in smoothness and length of the resulting paths, the modified path-smoothing method provided shorter computation time, especially for environments with high obstacle density for both RRT algorithms. Additionally, we have adapted the algorithm for a 6-DOF robotic arm in 3D environments, using efficient nearest-neighbor algorithms. Future work will focus on extending the path-planning algorithm for handling multiple potential target poses for a single physical target, followed by an extension for a multiple physical targets, all suitable for environments with a high obstacle density such as the agricultural environment.

References:


Acknowledgement: Supported by the European Commission in the 7th Framework Programme (CROPS GA no 246252).