Robotic exploration: new heuristic backtracking algorithm, performance evaluation and complexity metric

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Abstract

Mobile robots have been used to explore novel environments and build useful maps for navigation. Although sensor-based random tree techniques have been used extensively for exploration, they are not efficient for time-critical applications since the robot may visit the same place more than once during backtracking. In this paper, a novel, simple yet effective heuristic backtracking algorithm is proposed to reduce the exploration time and distance travelled. The new algorithm is based on the selection of the most informative node to approach during backtracking. A new environmental complexity metric is developed to evaluate the exploration complexity of different structured environments and thus enable a fair comparison between exploration techniques. An evaluation index is also developed to encapsulate the total performance of an exploration technique in a single number for the comparison of techniques. The developed backtracking algorithm is tested through computer simulations for several structured environments to verify its effectiveness using the developed complexity metric and the evaluation index. The results confirmed significant performance improvement using the proposed algorithm. The new evaluation index is also shown to be representative of the performance and to facilitate comparisons. Keywords Robot exploration, sensor-based random tree technique, backtracking, complexity metric, evaluation index

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