

MOTION PLANNING AND OBSTACLE AVOIDANCE FOR MOBILE ROBOTS IN HIGHLY CLUTTERED DYNAMIC ENVIRONMENTS

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Abstract

After a quarter century of mobile robot research, applications of this fascinating technology appear in real-world settings. Some require operation in environments that are densely cluttered with moving obstacles. Public mass exhibitions or conventions are examples of such challenging environments. This dissertation addresses the navigational challenges that arise in settings where mobile robots move among people and possibly need to directly interact with humans who are not used to dealing with technical details. Two important aspects are solved: Reliable reactive obstacle avoidance to guarantee safe operation, and smooth path planning that allows to dynamically adapt environment information to the motion of surrounding persons and objects.

Given the existing body of research results in the field of obstacle avoidance and path planning, which is reviewed in this context, particular attention is paid to integration aspects for leveraging advantages while compensating drawbacks of various methods. In particular, grid-based wavefront propagation (NF1 and fast marching level set methods), dynamic path representation (bubble band concept), and high-fidelity execution (dynamic window approach) are combined in novel ways. Experiments demonstrate the robustness of the obstacle avoidance and path planning systems.

Zusammenfassung

Nach einem Vierteljahrhundert der Forschung erscheinen nun immer konkreter werdende Anwendungen der mobilen Robotik. Einige davon bedeuten Einsätze in Umgebungen, die dicht besiedelt sind mit bewegten Objekten. Die vorliegende Arbeit behandelt die Herausforderungen, die an das Navigationssystem des Roboters gestellt werden, wenn dieser in Menschenmengen zurechtkommen muss. Als Beispiele können Massenausstellungen oder Konferenzen herangezogen werden. Möglicherweise sind die Menschen, mit denen der Roboter interagiert, nicht bewandt im Umgang mit detailliertem technischen Wissen, und diesem Umstand wird Rechnung getragen. Für zwei ausschlaggebende Aspekte werden Lösungen präsentiert: Zuverlässiges und sicheres Ausweichen von Hindernissen; sowie eine flüssige Wegplanung, die sich der verfügbaren Information über die teilweise bewegten Hindernisse dynamisch anpasst.

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