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Mobile Robot Navigation for Moving Obstacles with Unpredictable Direction Changes, Including Humans

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Abstract

In many service applications, mobile robots need to share their work areas with obstacles. Avoiding moving obstacles with unpredictable direction changes, such as humans, is more challenging than avoiding moving obstacles whose motion can be predicted. Precise information on the future moving directions of humans is unobtainable for use in navigation algorithms. Furthermore, humans should be able to pursue their activities unhindered and without worrying about the robots around them. An enhanced virtual force field-based mobile robot navigation algorithm (termed EVFF) is presented for avoiding moving obstacles with unpredictable direction changes. This algorithm may be used with both holonomic and nonholonomic robots. It incorporates improved virtual force functions and an improved method for selecting the sense of the detour force to better avoid moving obstacles. For several challenging obstacle configurations, the EVFF algorithm is compared with five state-of-the-art navigation algorithms for moving obstacles. The navigation system with the new algorithm generated collision-free paths consistently. Methods for solving local minima conditions are proposed. Experimental results are also presented to further verify the avoidance performance of this algorithm.

Keywords

collision avoidance, dynamic obstacles, human-friendly robots, mobile robots, virtual force field

1. Introduction

1.1. Challenges of avoiding humans

In many service applications, mobile robots need to share their work regions with obstacles including humans. Avoiding collisions with humans and obstacles is a fundamental requirement for these robots. The objective of navigation is to plan and control the motion of the robot from its initial position to its goal position while avoiding obstacles. The navigation problem for mobile robots has

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