Robotics and Autonomous Systems 75 (2016) 119–128

Contents lists available at ScienceDirect

Robotics and Autonomous Systems

journal homepage: www.elsevier.com/locate/robot

An algorithm for multi-robot collision-free navigation based on shortest distance

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HIGHLIGHTS

- A new algorithm for collision-free multi-robot navigation is introduced.
- The new algorithm is based on shortest distance algorithm.
- It is particularly efficient and easy to implement.
- Comparison with previously discussed algorithms on different standard scenarios is presented.

ARTICLE INFO

Article history:
Received 21 March 2015
Received in revised form
15 October 2015
Accepted 23 October 2015
Available online 31 October 2015

Keywords:
Navigation
Multi-robots
Collision avoidance

ABSTRACT

This paper presents a new approach for multi-robot navigation in dynamic environments, called the shortest distance algorithm. This approach uses both the current position and orientation of other robots to compute the collision free trajectory. The algorithm suggested in this paper is based on the concept of reciprocal orientation that guarantees smooth trajectories and collision free paths. All the robots move either in a straight line or in a circular arc using the Bresenham algorithms. The current approach is tested on three simulation scenarios.

1. Introduction

This paper addresses the problem of motion planning of multiple mobile robots in dynamic environments. This problem, arising in the presence of mobile obstacles or multi-robot systems, is more difficult than the static problem, that is, the case arising when obstacles are fixed, since it requires the real-time solution of the path planning [1]. In fact, when multiple mobile robots share the same environment, collisions among them must be taken into account. Collision avoidance may be achieved by using a centralized approach to plan the trajectories of all the robots [2,3] or by planning each trajectory separately and using a centralized approach to coordinate these paths [4,5]. However, kinematic constraints are not taken into account in most of the centralized approaches. Only the earliest methods for path planning that use car like robots deal with kinematic constraints [6]. Such car like models are controlled to forward motions with a fixed speed and limited turning radius and modified by adding a reverse gear [7]. Their control is farther extended considering variable speed in any direction [8,9].

In this paper, we develop an approach for collision-free navigation of multiple robots with differential drive kinematics. Groups of coordinated differential-drive robots may be used for environmental monitoring, and rescue applications [10]. Hence, it is important to develop methods to investigate smooth and collision-free paths for these kinds of robots. Smooth trajectories are not guaranteed in most of the earlier methods and the investigation of collision-free paths is limited to single robots moving amongst dynamic obstacles.

Many works in robotics have addressed the problem of collision-free navigation of a robot in dynamic environments with moving obstacles [11–13]. Most approaches rely on the prediction of future locations of obstacles by extrapolating their current velocities, and let the robot avoid collisions accordingly. However, such approaches do not suffice when the robot encounters other robots, because treating the other robots as moving obstacles

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http://dx.doi.org/10.1016/j.robot.2015.10.010
0921-8890/