Chapter 27
Path Planning in a Mobile Robot

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ABSTRACT

This chapter presents the development and implementation of three approaches that contribute to solving the mobile robot path planning problems in dynamic and static environments. The algorithms include some items regarding the implementation of on-line and off-line situations in an environment with static and mobile obstacles. A first technique involves the use of genetic algorithms where a fitness function and the emulation of the natural evolution are used to find a free-collision path. The second and third techniques consider the use of potential fields for path planning using two different ways. Brief descriptions of the techniques and experimental setup used to test the algorithms are also included. Finally, the results applying the algorithms using different obstacle configurations are presented and discussed.

INTRODUCTION

Robotics is an area with vast prospects for industrial development that in a relatively short time could allow companies to improve production techniques, quality, and precision in many different processes.

For some years now, mobile robots have been introduced into various productive areas. This interaction has increased the need to provide autonomy to robots, which can interact beyond static environments. A basic example of this interaction is cleaning robots that currently are sold for domestic tasks and Automatic Guided Vehicles (AGV) which are often used in industrial applications.

Increasingly, robots must interact in environments where workspaces are not static, meaning that robots must have the tools to adequately perform their required tasks despite changes that can occur in cases where planned trajectories represent part of the solution.

Path planning has been approached in different applications, including robotic manipulators, mobile robots, and underwater robots, among others. Similarly, different methodologies have been developed for both static and dynamic environments, which use different sensors for local and global planning of the workspace, as will be shown in the brief section review.

DOI: 10.4018/978-1-5225-8060-7.ch027

This chapter presents the development and implementation of three approaches for path planning. These are defined for working in a static workspace, but also can be applied to dynamic workspaces by updating the information of the position of all elements (obstacles and mobile robot). Specifically, in this case, an artificial vision system based on color algorithms is used for updating the position. The first technique involves the use of genetic algorithms which use a fitness function and the emulation of natural evolution to find the best trajectory; the results obtained are in function of the number of generations defined by the user. The second and third techniques include the use of potential fields as path planning method by means of two approaches; these algorithms define specific weights to the workspace for each element (obstacles and mobile robot) and compute a free path based on the potentials defined for the workspace. The chapter also includes a brief introduction to path planning and a brief state of the art that is focused on the methodologies presented. Additionally, each one of these techniques was proven in a physical system that consisted of a 1.50 m x 2.40 m wooden platform, an artificial vision system, two mobile robots, and some fixed obstacles. The results obtained are included.

BRIEF REVIEW ON PATH PLANNING

Research in path planning is an area of great interest in robotics because of the versatility it gives a robot to perform its work with reliability and autonomy. The domain of this ability gives the robot the option of avoiding collisions and obtaining different free collision paths for it to move in a workspace based on the user-defined criteria.

Currently, a large numbers of robots are equipped with sensors that allow them to obtain information from the environment. These sensors can provide global or local information to detect obstacles, which allows calculating free-collision paths using some planning strategies to move the robot step-by-step or to define a complete path in a workspace (Tibaduiza, 2008).

For more than 30 years, mobile robot autonomy has been one of the main motivations for developing path-planning strategies to provide the necessary tools for moving the robots through different environments and under difficult conditions. Below are some jobs mobile robots perform on a regular basis.

Lozano (1983) presents an approach for computing constraints on the position of an object due to the presence of obstacles. The algorithms presented allow persons to characterize the position and orientation of objects as a single point in a Configuration Space when the objects and obstacles are polygons or polyhedral.

Thorpe and Matthies (1984) propose a method called Path Relaxation which combines characteristics of grid search and potential fields. It works in two steps: a global grid search that finds a rough path, followed by a local relaxation step that adjusts to each node on the path to lower the overall path cost. The same year, Lumelsky and Stepanov (1984) describe one approach based on the continuous processing of incoming local information of the environment. A continuous computational model for the environment and vehicle operation is presented. Information about the environment (the scene) is assumed to be incomplete except that at any moment, the vehicle knows the coordinates of its target as well as its own coordinates. The vehicle is presented as a point; obstacles can be of any shape, with continuous borderline and finite size. Byung and Kang (1984) also present a method for minimum-time path planning in joint space subject to realistic constraints by testing the methodology in a Unimation PUMA 600 manipulator robot.