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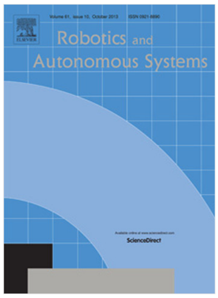

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Humanoid Navigation using a Visual Memory with Obstacle Avoidance☆

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Abstract

We present a complete humanoid navigation scheme based on a topological map known as visual memory (VM), which is composed by a set of key images acquired offline by means of a supervised teaching phase (human-guided). Our autonomous navigation scheme integrates the humanoid localization in the VM, a visual path planner and a path follower with obstacle avoidance. We propose a pure vision-based localization algorithm that takes advantage of the topological structure of the VM to find the key image that best fits the current image in terms of common visual information. In addition, the visual path planner benefits obstacle-free paths. The VM is updated when a new obstacle is detected with an RGB-D camera mounted on the humanoid's head. The visual path following and obstacle avoidance problems are formulated in a unified sensor-based framework in which, a hierarchy of tasks is defined, and the transitions of consecutive and hierarchical tasks are performed smoothly to avoid instability of the humanoid. An extensive experimental evaluation using the NAO platform shows the good performance of the navigation scheme.

Keywords: Visual navigation, humanoid robots, visual memory, obstacle avoidance

1. INTRODUCTION

One of the main objectives to be reached by a humanoid is to mimic human navigation strategies. An important feature of the human brain is the ability to visually memorize key scenes of previously visited places for facilitating a subsequent navigation in the same place [1]. The idea of using a sequence of key images for robot navigation was early introduced in [2], where the visual memory (VM) was called view-sequenced route representation. A VM is a topological map that represents an environment by a set of key images [3, 4], which are typically organized as a directed graph where each node is a key image and the edges provide information of a relation between key images. Once this representation of the environment is known, the problems of robot localization, path planning and autonomous navigation can be solved.

Visual servo control schemes are built upon the sensor-based control approach, taking advantage of the rich information of images acquired by a vision system to command the

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