Robust Artificial Landmark Recognition Using Polar Histograms

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Abstract. New results on our artificial landmark recognition approach are presented, as well as new experiments in order to demonstrate the robustness of our method. The objective of our work is the localization and recognition of artificial landmarks to help in the navigation of a mobile robot. Recognition is based on interpretation of histograms obtained from polar coordinates of the landmark symbol. Experiments prove that our approach is fast and robust even if the database has an high number of landmarks to compare with.

1 Introduction

Robot navigation is a research field where a great variety of different mechanisms are being studied in order to achieve an interesting goal: having a physical autonomous agent capable of navigating without any human interaction, just interpreting the surrounding environment. Information exchange with this environment leans on several types of sensors, like sonar, laser range sensors, and so on.

Vision based navigation systems can achieve a high degree of flexibility, allowing the robot to take complex decisions. Some of these systems are based on landmark recognition; however, papers explaining this kind of systems (like, for example, [1]) focus more on the system description or on the use of environmental characteristics as landmarks (natural landmarks) rather than explaining the recognition process. Our research deals with the landmark recognition process from another point of view. We present our landmark localization and recognition approach itself, without considering a concrete robot system where this process could be included, so it could be included in other kind of systems.

The use of landmarks with roadsign symbols has been chosen so in a future this method could be applied to the problem of the recognition of this kind of signals. It is possible to find several papers talking about the roadsign recognition problem ([2],[3],[4]), but they explain more complex techniques that the one we present here. The objective has been to find an efficient and robust recognition method. Although the papers about roadsign detection mentioned before show us some ways of solving this problem, our method is simpler and give us better results.

This paper is divided in the following sections: in section 2 we define polar histograms, in section 3 we explain how to compare different polar histograms,

C. Bento, A. Cardoso, and G. Dias (Eds.): EPIA 2005, LNAI 3808, pp. 455–461, 2005.

in section 4 the complete approach to localize and recognize artificial landmarks is shown, and finally, in section 5, some experimental results are shown.

2 Polar Histograms

Polar histograms are introduced as a way of comparing symbols, without being affected by little changes in shape, orientation and displacement (scale variations are solved in the localization part of our system, which is explained above). These polar histograms are created from polar coordinates of symbols. Some works have proven that using polar coordinates allows an efficient and low computational cost two dimensional irregular shape comparison, invariant to displacement and rotation (on the plane of the image, no 3D rotations) [5].

The first step to build a polar histogram from a symbol is to have a binary image containing that symbol. This image is represented by means of cartesian coordinates, and it must be transformed into a polar coordinates image, using the gravitational center of the symbol as pole and a polar axis which origin is this pole (some examples are shown in Figure 1). Using the equations (1) and (2) we can know which cartesian pair (x, y) corresponds to each polar pair (ρ, θ). This translation can be done in two ways: calculating the polar coordinates for each cartesian pair in the original image, or calculating the cartesian coordinates corresponding to each polar pair in the destination image. This second method is more efficient and faster, avoiding gaps to be present in the resulting polar image.

$$x = \rho \cdot cos(\theta) \tag{1}$$

$$y = \rho \cdot sin(\theta) \tag{2}$$

Finally, from the polar image, we can obtain a histogram that represents the original symbol. In the polar image, the distance ρ increases with each column; so, all the pixels in the same column are at the same distance from the symbol's gravitational center in the original image. If we add all the pixels with value 1 in each column in the polar image, we generate a histogram that indicates us for all the distances from the gravitational center of the symbol, how many pixels

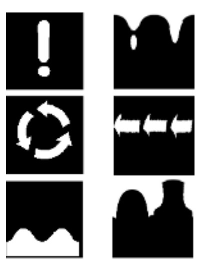

Fig. 1. Some examples of symbols represented in cartesian coordinates (left) and the same symbols represented in polar coordinates (right), using the gravitational center as a pole