Is structure needed for omnidirectional visual homing?

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I. Introduction

In omnidirectional visual homing implementations, one can choose between two main approaches. The first, inspired by the work of Cartwright and Collett, uses only the bearing (azimuth) angles of corresponding landmarks as input and does not use range or structure. Their proposed algorithm consists of the construction of a home vector, computed as the average of landmark displacement vectors.

An other approach in visual homing, relies on the estimation of the structure of the environment, represented in a 2D or 3D map. In this map, both present location and target location are estimated which enables the computation of a homing vector.

In this paper, we compare one method of each kind. As input data, we find image correspondences using a combination of *fast wide baseline matching* and *KLT* tracking.

II. Solving the image correspondence problem

Because the initial and target images are taken relatively far from each other, initial correspondences are established using recently developed fast wide baseline matching algorithms. We use the combination of two different kinds of these features, namely a rotation reduced and color enhanced form of David Lowe's *SIFT features*, and the *invariant column segments* we developed in previous work. Fig. 1 shows the matching results on a pair of omnidirectional images.

While driving towards the target, an image sequence is recorded in which the formerly identified features are tracked using the well-known KLT tracker.

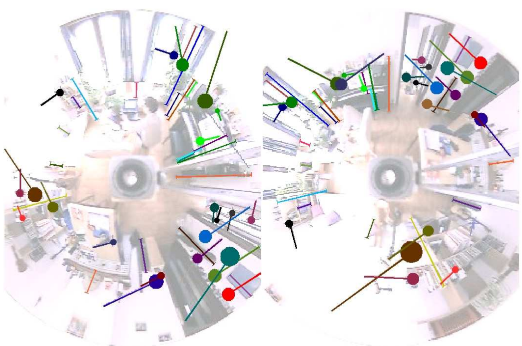

Fig. 1. A pair of omnidirectional images, superimposed with color-coded corresponding column segments (radial lines) and SIFT features (circles with tail).

III. Structure-less homing method

In the wealth of algorithms derived from the snapshot model of Cartwright and Collet, we chose the implementation of Argyros *et al*. At each time instant, a homing vector is computed based on bearing angle measurements of corresponding landmarks in present and goal position. Unfortunately, this method showed not generally applicable because it assumes an isotropic landmark distribution.

IV. Homing method with structure estimation

Unlike the former method, the method we propose in this section builds a local map describing the structure of the environment. After initialization of the feature correspondences, the algorithm computes a robust estimate of the homing vector and drafts a local map, containing the feature world positions. Later, during the movement, as feature measurements are coming in, the map is refined using a EKF scheme. Concurrently, the position of the present image is computed. The position of the target images is updated by a second EKF algorithm. This enables the computation of a homing vector each time instant.

V. Experimental results

We have done extensive tests of the two described methods for visual homing in a natural environment, using a modified electric wheel chair as test platform. As seen in the images, no special visual features were added to the natural scene. First, a target image was taken at a certain position (left in fig. 2). Then, the wheel chair was placed at a distance of 1 to 2 metres from this target and the homing procedure is performed. A typical result for the trajectories is shown superimposed in fig. 2.

We can conclude that our structure-computing method yields a better homing path, although the structure-less method computes less precessing power.

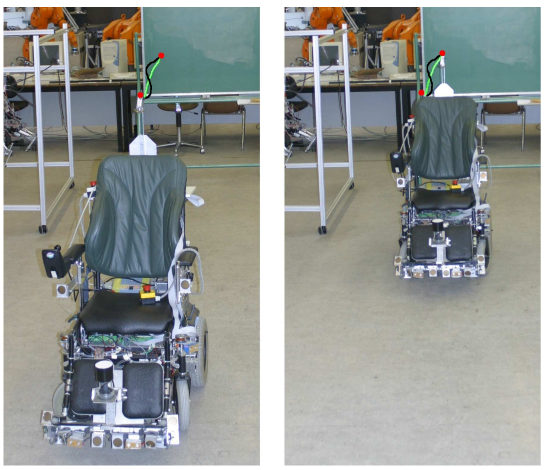

Fig. 2. Target position (left) and start position (right) of the wheel chair, with superimposed projected motion (black: without structure, light green: using structure).