

Computer Vision for Autonomous Mobile Robots

Dissertation

zur

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Preface

When starting my thesis and my work in the Middle Size league of RoboCup, I always intended to use RoboCup as an example domain for methods that should later work somewhere else. I am glad that I was able to find an algorithm that was very useful for our soccer robots, but which will also be of great use for other systems. The algorithm is able to efficiently track large homogeneous regions in image sequences.

My second aim was to try to use shape information for robot localization and navigation. Here, I developed a method that is specialized to the RoboCup scenario in that it tries to recognize a palette of features in the very specific RoboCup field lines. However, the way in which detection is performed can be transferred to other scenarios.

It has always been difficult to achieve the balance between a reliable, working system in practice and the aim for inventing new methods. Often, simple methods work better in practice. In the end, I am glad that it was not a balancing act but rather a convergence of the two aspects. All the methods that are proposed in the thesis were used in our final six robots participating at the world championships in Lisbon 2004, where we placed fourth.

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Abstract

This thesis has been written in conjunction to our engagement in the Midsized league of RoboCup where autonomous mobile robots play soccer. In particular, it is about the computer vision system of the robots, which supplies the necessary visual information.

The main contribution is a new image processing technique that allows efficient tracking of large regions. The method yields the precise shape of the regions and it is a base for several other methods, which are described in this thesis.

They comprise a new localization method enabling the robots to determine their precise position by perceiving the white field lines. In particular, they are able to perform real-time recognition of a whole palette of features, including the center circle, T-junctions and corners. If a situation occurs where no feature can be recognized, another new method, the "MATRIX-method", is applied. It uses a pre-computed force field to match the perceived field lines to the corresponding lines in a model.

Overall localization is then performed in a three-level fusion process, which precisely takes into account the different time delays in the system. The approach has been demonstrated to work, playing over 10 games at the world-championship 2004 in Lisbon where the system achieved fourth place.

Although the system was conceived for participation in RoboCup, especially the region tracking method will be of great use for many other applications.

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