The Ulm Sparrows 2003

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Abstract. The Ulm Sparrows is a team of researchers, students, and robots competing in the RoboCup middle-size league. This paper describes our research approach, major results achieved so far, and current work.

1 Introduction

The Ulm Sparrows RoboCup team exists since end of 1997. It is a mainly student-driven activity, and serves both as a research as well as a teaching tool. We build and maintain a team of robots for the middle-size league. Initially, the team was active in the simulation league as well, but the team decided to concentrate on MSL after 1999.

2 Approach

Aside of the teaching aspects, the team also has a clear research focus, which is centered around the general theme of *adaptivity and learning in cooperative mulirobot teams*. We are in particular interested in the following issues:

- Developing methods for fast on-site adaptation of various functional methods to on-site playing conditions (*autonomous calibration*, etc.).
- Studying the integration of various learning methods into hybrid methods.
- Studying the interaction of various modules learning simultaneously.
- Autonomy in cooperative, communicating multirobot teams.
- Architectural and middleware support for learning and adaptivity.
- Systematic experimental evaluation of multirobot teams.

We follow a behavior-based approach and tend to view architectural issues more in a bottom-up manner. More information on our approach and its development over the past years can be in past team description papers, which are the the various RoboCup books.

3 Results

The major research results achieved so far are the following:

- The team has designed and built its own Sparrow-99 robot. [1,2]
- Our work on biologically inspired color constancy algorithms has resulted in routines for autonomous vision self-calibration [3].
- In the vision and sensor processing area, we have worked on visual depth estimation, sensor fusion with distance sensors, visual attention and ball tracking, and hierarchical object classification [4,5,6,7].
- A major focus of research was on visual self-localization, where we demonstrated that Monte-Carlo Localization performs well even when feature detection is sparse and sporadic. More recently, we adapted our method to the new environment and developed a method for subsymbolic feature matching of field lines in Hough spaces. [8,4,9,10,11,12,13,14,15]
- Another major achievement facilitated by the team effort is Miro, a CORBA-based middleware for robots [16,17,18,19,1,2,20]. It includes facilities for
  - event-based communication,
  - group communication,
  - flexible logging of data and tools for replaying them for testing and experimental evaluation, and
  - various visualization tools.

Results have been published in several journal articles, conference papers, and book contributions. See the References Section for a selected list.

4 Current Work

As our team is perceived as a long-term research effort, we continuously pursue the previously mentioned research issues and constantly improve our methods and results. Some current work includes:

- Based on an improved and robust implementation of our color classification and segmentation methods, we are now tackling robust object tracking methods based on particle filters.
- We have developed a framework called BAP for hierarchical specification of behavior, which consists of behaviors and arbiters, action patterns, and policies. Rigorous formalization of this framework is underway, and will complete some papers currently in preparation.
- After a lot of necessary preliminary work, which included the integration of a locally developed neural network language, EpsiloNN, into Miro, we are now able to apply various learning methods for learning behaviors.
- Arbitration can be a very tough problem in behavior-based apporaches. A new approach to the specification and arbitration of behavior output promises to resolve a few of these problems.
- In our work related to investigating spatiotemporal representations and reasoning methods we are looking into adaptive spatial positioning algorithms.
- We have started to intensively investigate representational issues for situation classification and playbooks.

Acknowledgment

The work of Hans Utz and Gerd Mayer is supported by project *Adaptivity and Learning in Teams of Cooperating Mobile Robots* within DFG SPP-1125. The Ulm Sparrows team thanks the University of Ulm, the Faculty of Computer Science, MFG Medien- and Filmgesellschaft Baden-Württemberg, and several industrial sponsors for their support. Details on team support can be found on our web site at `www.sparrows.uni-ulm.de`.

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