EXPOSÉ

A Multi-Robot Platform for Mobil Robots with Multi-Agent Middleware

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Motivation

In robotics today, simple tasks still demand complex solutions. An important development has been the use of Multi-Robot-Systems (MRS) to provide high-level access to robot hardware [4, 3].

Although such platforms provide transparent access to sensors and actuators much difficulty still remains. Typical tasks for a mobile robot require at least some sensors such as a stereo vision camera, a robot arm or even a hand. To interconnect these sensors in software in a meaningful way is not trivial, although device access itself might be simple.

To execute even simple commands such as “grip that trash there”, “open that door” or “find the pink one” can be assumed to be complex tasks. They can be solved either by one or more sophisticated and specially adapted robots, or by multiple, relatively simple, robots that coordinate their activities.

There are important advantages in the latter approach, such as task flexibility, scalability, cost and platform autonomy, which will be substantiated as requirements to this project in the next section.

Goals

This project describes an MRS controlled by a distributed and intelligent Multi-Agent-System (MAS). A stable robot platform serves as the base for high-level services. In the following subsections the requirements will be introduced.

Task Flexibility

The platform shall be able to execute tasks of arbitrary complexity through the management of a dynamic and heterogeneous group of robots.

Scalability

The platform shall perform with an arbitrary number of robots, selected according to robot availability and task requirements. Preparatory work shall be done to facilitate future dynamic addition of extra robots and replacement of malfunctioning robots.

Cost

This work assumes that a group of small, heterogeneous robots is cheaper to maintain in the mid- to long-term than a few, highly specialized ones.

Platform Autonomy

Preparations shall be made with regard to the possible exchange of the MRS and MAS with other potentially better suited systems.

Scenarios

The following three scenarios are partly taken from the MAS Jadex [1]. They demonstrate the basic functionality of the platform and provide a template for other tasks.

Hunter and Prey (an extended Hide and Seek scenario)

Two or more robots look for a hiding robot and try to catch it. The searching robots coordinate their search to increase efficiency.

Cleaner World

Two or more robots collect trash or specially marked objects. The robots coordinate their search to cover the work area efficiently. As an extension, a second task could be to conserve robot battery life. An example implementation is shown in figure 1.

Exploration

In this scenario two or more robots collaborate to explore unknown territory and to build a map.

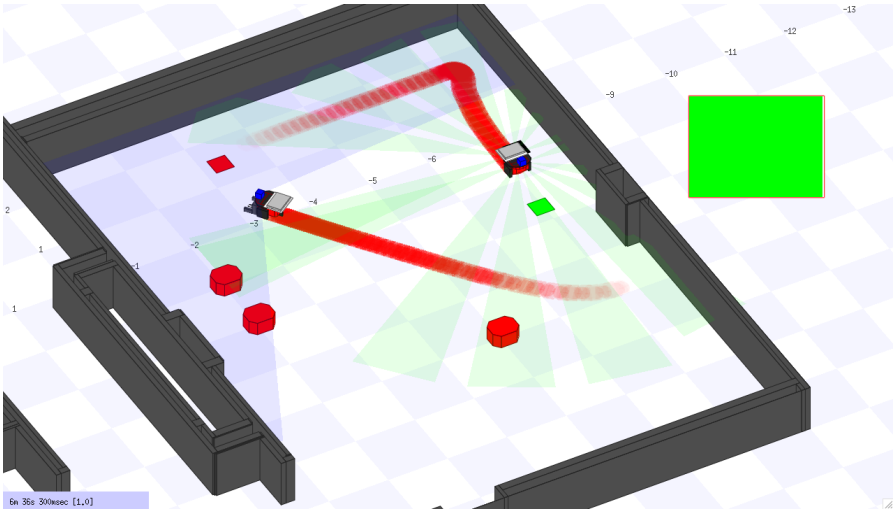

Fig. 1: Two mobile robots and the Cleaner World scenario. The robot on the right is equipped with a camera to look for certain colors and the robot on the left has a gripper to collect objects detected. The picture is taken from the multi-robot simulator included in the MRS Player/Stage [3].

Preliminary Work

In an earlier project [2] the author used the MRS Player/Stage [3]. A Pioneer 2DX robot with on-board sonar, laser and omni-directional camera served as the hardware (as can be seen at Fig. 2).

With a wall-following exploration algorithm and the sonar, laser and camera data its goal was to look for a small pink ball in its environment. Once detected the robot heads towards the ball while continuously tracking it.

The project provided practical experience with a robot platform and with mobile robot hardware that will be relied upon by this work.

Restrictions

This work will combine a high-level MAS with an MRS. Current technologies in MAS and mobile robotics will be used to achieve a high degree of task flexibility.

Some specialized algorithms might be implemented, e.g. for robot control, but mostly out-of-the box drivers and interfaces will be used. An MAS is assumed to provide following features:

- Task description and definition
- Task division and distribution between agents
- Communication via (W)LAN between agents

The robot platform shall provide at least:

- Path planning
- Localization
- Collision avoidance
- Sensor and effector drivers (Laser, Gripper etc.)

Fig. 2: Pioneer robot used in a practical student project. The mounted Laptop runs the control program and communicates via wireless. The (dismounted) laser can be seen on top of the robot and the fixed sonar sensors are visible as circular devices underneath the top board at the front.

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References

[1] Jadex bdi agent system [online]. 2010. Available from: `http://sourceforge.net/projects/jadex/` [cited Wednesday, December 8, 2010].

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[3] Player project [online]. 11 2010. Available from: `http://playerstage.sourceforge.net/` [cited Wednesday, December 8, 2010].

[4] Ros - robot operating system [online]. 9 2010. Available from: `http://www.ros.org/wiki/` [cited Wednesday, December 8, 2010].