IAS intelligent autonomous systems

MAP EXPLORATION WITH AN AIRROBOT

ASSIGNMENT FOR THE PROJECT
'DESIGN AND ORGANIZATION OF AUTONOMOUS SYSTEMS'

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INTRODUCTION

This document describes the extension of the mapping system of a team of rescue robots, which are competing in the Virtual Rescue league of RoboCup. Until now, the rescue robots were all ground based. This year the team may be expanded with an AirRobot (see Figure1). The advantage of non-ground based robot is the high viewpoint, which makes it possible to get an overview of the situation. The disadvantage of such robot is the limited payload, which reduces the sensor suite to a minimum.

Figure 1: The AirRobot is a four-rotor electrical helicopter with flight stabilization control produced by AirRobot Co. Left a real robot, right a simulated version.

To be able to do mapping for the ground robots from this platform, two problems have to be solved. Firstly the location of the robot has to be known with sufficient accuracy. Secondly the robot should be able to distinguish free space from obstacles. The first problem is partly solved with the on-board GPS. The second problem has to be solved with the on-board camera. No other sensors are available. To create a solution for the second problem is the central task of the assignment.

To distinguish free space from obstacles, the AirRobot needs a probabilistic model (for instance color or texture based) to do the filtering. This model will be very depended on the environment, and should be learned on the spot. The training data will be supplied by the ground robots, which have both a camera and a range scanner on board.

The AirRobot and the ground robots have to cooperatively explore a maze (see Figure 2). The ground robots will start exploring, avoiding obstacles with their range sensors. During this initial exploration a local map is produced, with marks both obstacles and free space. The AirRobot will compare this local map with its current view, and learns in this way the distinguishing features (color or texture). From its high viewpoint, the AirRobot can start searching in the neighborhood for areas that have the same features as the free space found by the ground robots. In this way the map can be extended fast, which will allow the ground robots to traverse the maze more swiftly, because dead-ends in the maze can be detected before the ground robots reach the T-junction.

Figure 2: Overview of the maze in the RoboCup Rescue Virtual Robot competition 2006 environment.

TASKS TO PERFORM

The following tasks need to be performed. The team has to decide how these tasks are going to be divided. A planning with global task assignments and detailed ticket distribution needs to be developed in the first week. The progress and modification of this planning will be discussed during a meeting each week.

- Read the relevant publications about the Virtual Rescue competition [1].
- Read the section about Computer Vision Terrain analysis of the article [2]
- Get sufficient machines to install and test the software, based on the planning and task assignments.
- Install all required software, like Unreal Tournament and USARsim[1].
- Download the software of the UvA Team[2].
- Install and test the existing code by exploring the maze with ground robot
- Investigate what needs to be modified the current architecture to extend the team with an AirRobot
- Design a plan how these modifications can be in small steps, and how these modifications can be tested independently.
- Keep a logbook of the modifications and tests applied to the system.
- Setup a structure for the report and make each team member contribute to this report, based on the agreed planning.
- If possible, get your algorithm running. If previous tests proof that it is impossible, design a demonstration that shows convincible the maximum capabilities of your algorithm.

[1] http://sourceforge.net/projects/usarsim
[2] svn://info.science.uva.nl/scratch/svn/Roboresc/edu/

SUGGESTED READING

The following documentation, available in the library and on the web, is suggested reading before the project starts:

[1] S. Thrun *et al.*, 'Stanley: the robot that won the DARPA Grand Challenge', Journal of Field Robotics 23 (9), pp. 661-692, September 2006.

[2] Stephen Balakirsky, Stefano Carpin, Alexander Kleiner, Michael Lewis, Arnoud Visser, Jijun Wang and Vittorio Amos Ziparo, "Towards heterogeneous robot teams for disaster mitigation: Results and Performance Metrics from RoboCup Rescue", Journal of Field Robotics, volume 24(11-12):pp. 943-967, November 2007.