

Automated Rough Terrain Navigation

MSc Project Description

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Fig. 1. A real Kenaf robot and its simulated counterpart.

Background

Recent advances in robotics and computer science mean that it is now possible to use teams of robots for many real-world applications. One very important application is robotic search-and-rescue. Robots are highly suitable for search-and-rescue tasks since they may be deployed in dangerous and toxic environments without putting human responders at risk.

While much effort is going into development of more robust and mobile robot platforms, it is also necessary to develop advanced methods for multi-robot coordination and practical user interfaces for humans to control the robots.

The Oxford University Computing Laboratory is currently cooperating with the University of Amsterdam to develop a simulated multi-robot search-and-rescue team. This team integrates advanced techniques from a variety of fields such as mapping, localization, exploration, communication, navigation and human-robot interface design.

All simulation work is performed using the USARSim framework. Based on a commercial game engine, this simulator uses state of the art techniques for simulating physics and rendering graphics. It is fully configurable, allowing for independent development of simulated robot models, sensors and environments.

Project Description

Simulation research such as ours must proceed in step with hardware development and engineering research. As more robust and mobile robot sensors and models become available, control interfaces for these must be developed and incorporated into the already existing framework.

Currently most of our research involves exploration by simulated P2AT robots. While these are very useful for implementation and evaluation of various exploration algorithms, they are unlikely to ever be useful in real search and rescue scenarios, due to a lack of mobility. A more advanced rescue robot, the *Kenaf*, has been developed in Japan that uses four flippers and tracked motion. A corresponding model of this robot has been developed for the simulator.

Control of a robot with as many actuators as the *Kenaf* is difficult for a human and requires training and expertise. For example, navigating the *Kenaf* over a single cubic obstacle requires approximately 9 separate manipulations of the flippers.

It would be of great interest to develop a control interface to this simulated robot that automates straightforward motions. In other words, rather than an operator having to control the robot's every movement, it would be easier to provide goal points for the robot. These would then be reached by the robot autonomously, adjusting its movements on its own to overcome obstacles as efficiently as possible. A very interesting extension would be to use machine learning techniques to help the robot learn motions.

Tasks

- Read relevant publications about the USARSim simulation environment
- Install the USARSim simulator and the most recent Amsterdam-Oxford code release
- Learn how to control the simulated *Kenaf*
- Develop autonomous behaviours for the *Kenaf*, possibly using machine learning techniques
- Design a control interface to the robot
- Test extensively
- Incorporate this interface into the existing team

Required Background and Related MSc Courses

A background in software development, probability and geometry is helpful. The MSc courses most relevant to this project are:

- Object Oriented Programming I & II
- Object Oriented Design
- Intelligent Systems I & II
- Machine Learning

Also, the Engineering department's course on "Mobile Robotics" may be of interest.

Supervision and Acknowledgement

Dr. Stephen Cameron will act as supervisor for this project. Help with software and some general background will be provided by Julian de Hoog.

The current simulated search and rescue team was developed mainly at the University of Amsterdam by Arnoud Visser and Bayu Slamet. Further contributions are listed on the team website.

Recommended Readings and Links

- The USARSim simulation framework.
Download on SourceForge.
S. Carpin, M. Lewis, J. Wang, S. Balakirsky, C. Scrapper (2007). USARSim: a robot simulator for research and education. Proceedings of the 2007 IEEE Conference on Robotics and Automation. [PDF]
- Three videos of the Kenaf on YouTube.
Short intro to the robot (0:10)
DigInfo video (2:36)
The Kenaf at RoboCup 2008 (0:59)
- One of the labs where the Kenaf is built and developed.
Tadokoro Laboratory, Tohoku University
- A semi-autonomous control approach by the same group.
Kazunori Ohno, Shouich Morimura, Satoshi Tadokoro, Eiji Koyanagi and Tomoaki Yoshida, "Semi-autonomous Control of 6-DOF Crawler Robot Having Flippers for Getting Over Unknown-Steps," Proceedings of the 2007 IEEE/RSJ International Conference on Intelligent Robots and Systems, pp.2559-2560, 2007 [PDF]
- 2008 Team Description of the Joint Rescue Forces, Amsterdam and Oxford's RoboCup team.
A. Visser, T. Schmits, Steven Roebert and Julian de Hoog, "Amsterdam Oxford Joint Rescue Forces - Team Description Paper - Virtual Robot competition - Rescue Simulation League - RoboCup 2008", Proceedings CD of the 12th RoboCup Symposium, Suzhou, China, July 2008 [PDF]