3-Dimensional Mapping

MSc Project Description

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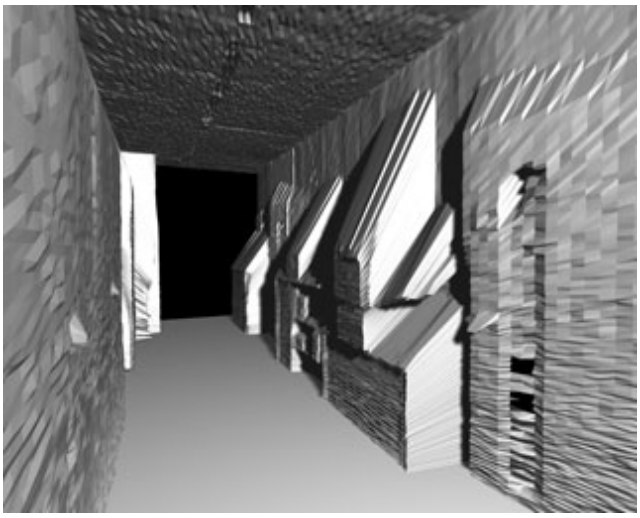

Fig. 1. A rendered view of a corridor based on robotic 3D data.
Credit: Autonomous Systems Lab, Swiss Federal Institute of Technology.

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

As the robots explore an environment they create a map of what they have sensed. These maps are used to coordinate the exploration process, either autonomously or by a human operator. Precise maps are very important and prevent robots from colliding with obstacles (or victims). Currently the robots use a laser range scanner to create a 2-dimensional map. Image feedback from a camera can be used by human operators to detect and avoid obstacles.

It would be of great interest to develop a 3-dimensional mapping system. 3-Dimensional laser range scanners are not yet common but it is possible to use a 2-D laser scanner for this purpose with the addition of a mount and a servo-motor. The main goals of this project would be to develop a simulated model of such a modified 2-D laser range scanner, to validate its performance in simulation, and if time permits to use the acquired data for creation of 3D maps.

Tasks

- Read relevant publications about the USARSim simulation environment
- Develop an understanding and awareness of current 3D mapping techniques
- Install the USARSim simulator and the most recent Amsterdam-Oxford code release
- Learn how to manipulate the simulator
- Build a simulated model of a laser range scanner on a mount with a servo
- Test the model extensively
- Use the acquired data from the simulated 3D scanner to estimate the traversability of the environment

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]
- An excellent survey of robotic mapping, though several years old now.
  S. Thrun. Robotic mapping: A survey. In G. Lakemeyer and B. Nebel, editors, Exploring Artificial Intelligence in the New Millenium. Morgan Kaufmann, 2002. [PDF]
- A successful 3D mapping approach that uses a 2D laser range scanner on a mount with a servo.
  H. Surmann, A. Nuchter, and J. Hertzberg, An autonomous mobile robot with a 3D laser range finder for 3D exploration and digitalization of indoor environments, Robotics and Autonomous Systems, vol. 45, pp. 181198, 2003. [PDF]
- An approach at Oxford's Department of Engineering.
  David M. Cole and Paul M. Newman Using Laser Range Data for 3D SLAM in Outdoor Environments. International Conference on Robotics and Automation, 2006 Florida [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]