CSC466: Artificial Intelligence Two

Candidate Topics for a Research/Programming Project

Ace DeSiena - Jan 2015

Simultaneous Localization and Mapping

I will be studying current algorithms for simultaneous localization and mapping of autonomous robots. SLAM is the problem of concurrently creating a map of the environment based on sensor data, and determining robot pose. I will create a models in Lisp of a robot with variable sensors and movement capabilities as well as an environment for that robot. The environment can be restructured in different way which can present different challenges to the SLAM algorithms. Some sensors may be restructured for varying sensor types and reliability as an optional extension to the project. One or more of the following algorithms will be implemented:

- **Extended Kalman Filter** Earliest and most influential SLAM algorithm. Online, proactive, limited by high dimensionality.
- **Graph SLAM** Solves full slam problem. Offline, lazy.
- **Sparse extended Information Filter** Similar representation to graph slam. Eliminates past poses, but maintains representation of all accumulated knowledge.
- **Fast SLAM** Particle filters for robot pose. Individual extended Kalman filters for each map feature.

Planning and Control using Markov Decision Processes

I will study the use of Markov Decision Processes in creating control policies for autonomous robotics. A control policy is a mapping of best practices and reasonable state spaces. I will create a model of a robot with variable movement capabilities as well as an environment for that robot. The slam problem will be solved by giving the robot privilege to the map information of the environment directly. MDPs and value iteration will be used in both fully observable and partially observable scenarios. Continuous space will be approximated with grid representations. Goals for the robot will be either reaching a goal location or exploring and gathering information.

One of the goals of planning and control is to manage uncertainty. In order to bring goal into the simulation, certain map features with low dimensionality such as whether or not a door is locked, or the color of a sign, will be withheld from the robot until it reaches a state where it can observe the map feature.

The control policy will need to take into account the utility value of various states. This value may or may not be immediately known.