

# Modern Singular Robotics: Simultaneous Localization and Mapping

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## Introduction

In the field of robotics, the ability to map out an area is a key factor in autonomous exploration and task execution. Many researchers study a directly relevant field, simultaneous localization and mapping (SLAM) because it is valuable to be able to map an environment without prior knowledge of the area. I present a brief overview of research activities before performing our literature survey, and then identify two of the issues that arise in SLAM; uncertainty and complexity. I conclude with my contribution to the networking research lab.

## Background

Previous to conducting my literature survey on single robot SLAM, our lab worked on several paths of research over time. First, we experimented with motes, which are useful, small, wirelessly connected computers with limited processing power, but strength in numbers. Next we approached a more complex robotic system called the iRobot Create, for a smaller scale networking project. The goal of our project with the Creates was to create an ad hoc network between the robots that enabled them to coordinate multi-robot oriented tasks such as cleaning a hospital, which was Brandon's idea. We ran into a few difficulties that are described in the beginning of the Research Section. We eventually felt it necessary to conduct individual literature surveys to tackle the specific challenges associated with the aforementioned project idea.

## Research

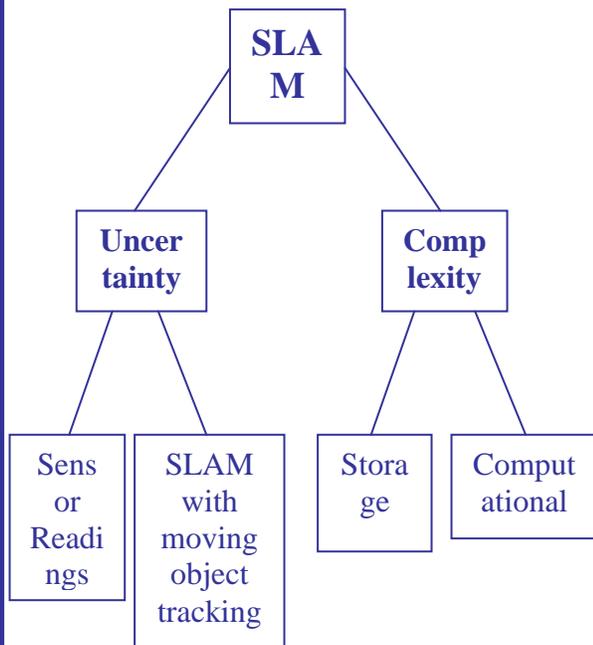
Talk about what you did in an outline:

- Mote experimenting
  - Performed simple programs
  - Attempted networking
  - Moved on to try out the iRobot Create, a more complex but harder to network and mobile robot.
- iRobot Create experimenting
  - Used command module
  - Achieved music and driving
  - Gumstix stack was required for networking and advanced programming
- Kermit era
  - Connection program for connecting to Gumstix via serial port
  - Would not work on Windows or Mac platforms
  - Eventually acquired Linux laptops
- Player and Gumstix era
  - Player is an abstract robot interface
  - Attempted to cross-compile server for the Gumstix
  - Achieved cross compilation, but ran into software library problems
- Survey
  - An essential part to any research is performing a literature survey
  - Selected single robot mapping as an avenue to focus my survey on
  - Selected SLAM as a specific focus, because SLAM would benefit our project goal of networked hospital cleaning

## Impact

Talk about what you got in an outline:

- Found two categories for SLAM
  - Uncertainty
    - Sensors a fundamental source of uncertainty because they are not perfect
    - Solutions:
      - Sensor fusion
      - Multiple maps to tackle moving object challenge
  - Complexity
    - Computers are limited by their hardware
    - Categories of focus:
      - Storage
      - Computational
    - Both categories intertwined, but can separately be optimized



Above is taxonomy of survey organization. Each section is discussed with two separate approaches totaling 8 main papers surveyed.

## Conclusions

Talk about what you learned in an outline:

- The complexity involved in multiple map approaches to dynamic environments is useful in its accuracy and real-time implementation.
- However, the ideal for hospital cleaning robots is a group of small, sensing and computational power limited robots
- Optimizations such as FastSLAM 2.0 using a Least Squares approach can be used for networked iRobot Create because of the linear complexity
- As computational technology evolves, 3D dynamic SLAM may become a viable option for smaller robots, space and power efficient robots.

## Future Work

Next in line for research would be to learn multi-robot autonomous exploration techniques that are appropriate for our goal of wirelessly networked hospital cleaning robots. The idea of a dynamic SLAM with linear complexity and implemented through multiple robot cooperation is the goal of future work in the networking research lab.