# Collaborative Multi-Robot Localization
# Senior Research Project Proposal

**John Sweeney (sweeney@andrew.cmu.edu)**
**Advisor: Tucker Balch (trb@cs.cmu.edu)**

## Introduction

One of the most challenging and important problems facing the designer of an autonomous robot is how the robot will determine its location. Recently, several algorithms have been suggested for successfully localizing a robot in a land-marked environment based on sensor readings. This project will focus on the less understood problem of collaborative multi-robot localization, that is, multiple robots working together to determine their position in the environment. Multiple robots working collaboratively allows the observations of one robot to aid others in their own localization, which can very useful especially in situations where not all robots have the same kind of sensors.

Some the methods for single robot localization include a sample-based Monte Carlo Localization (MCL) method, and a Grid-Based Bayesian approach. In this project, we will be comparing the performance of the MCL method and the Grid-Based method in their relative effectiveness when applied to the multi-robot domain. We will also be examining the effectiveness of the collaborative localization algorithms in situations with greater than two robots, which has not yet been studied.

## Background

A significant amount has been published about single robot localization in recent times, illustrating the importance of the problem. Monte Carlo Localization and Grid-Based Bayesian Localization are two methods which have been used successfully to localize a robot in a land-marked environment. The research to date on cooperative multi-robot localization is more sparse, with the main focus being on adapting single robot localization methods, specifically MCL, to the multi-robot domain. For this project, we will be researching the existing methods for multi and single robot localization, and then we will determine the best way to compare the differing algorithms.

## Research

For this project, we intend to first implement and refine the localization methods in simulation using the TeamBots environment, and based on those results we will implement the algorithms in real robots. We plan on concluding the simulation in the first semester and the real-world experiments in the second semester. In each case we will be examining the performance of the localization in a system with more than two robots. We will also be studying how the systems' effectiveness change as the number of robots increases. This can be measured in a number of ways, including the amount of error between the robots belief of its position and its actual position, the amount of time it takes the robot to localize itself, and the amount to which other robots helped the robot to localize itself. The intended contribution of this project is to give a better understanding of the performance of different methods to cooperatively localize multiple robots.

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