DISTRIBUTED SECURE STATE ESTIMATION WITH THE TURTLEBOT PLATFORM

by

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Contents

List of Tables

List of Figures

List of Acronyms

UKF Unscented Kalman Filter. 1

List of Terms

Distributed Filter Another name for the Discrete Filter. *see* Discrete Filter

Self Filter Another name for the Continuous Filter. *see* Continuous Filter

Distributed Secure State Estimation with the TurtleBot Platform

Abstract

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Mobile robot localization is one of the fundamental problems of robotics. Without the ability to localize itself in the world, a mobile robot is almost useless. As mobile robotic systems become more present, the need for reliable and cheap state estimation systems has grown. The increasing coverage of wireless networks and density of network cyber-physical systems has lead to an opportunity for distributed systems coordinated between multiple agents. This thesis examines the feasibility of a distributed state estimation system using Kalman filters, and its resilience to erroneous or compromised sensor measurements. This system is implemented on the TurtleBot platform using the Robot Operating System, and performance is evaluated with the Gazebo simulator.

Chapter 1

Introduction

1.1 Mobile Robot Localization

Robotic navigation can be divided into three questions: "Where am I?", "Where am I going?", and "How should I get there?" [1]. The first of these questions, "Where am I?" is the problem of localization. This second and third are problems of goal-setting and path-planning. All three are complex issues, but the focus of this thesis will be on localization. Determining where a robot is in reference to its surroundings is a fundamental precursor to all other robotic motion problems.

The main idea behind localization is combining sensor measurements that assess the state of the robot with measurements that represent the state of the surroundings [2]. There are numerous methods for doing this, and new methods and improvements on existing methods are constantly appearing. Most of these methods vary in their chosen estimator and how they filter out inherent noise in the measurements. This thesis will explore some of the existing methods, but the chosen method is the Unscented Kalman Filter (UKF) [3].

How these sensor measurements used for localization are obtained is equally as important as the type of estimator used for localizing the robot. Adding more sensors into the state estimate will generally increase the accuracy. The typical approach has been to add more sensors onto an individual robot in order to increase the accuracy of its location estimate. However this thesis explores a distributed system for sharing information between different robots and examines the possible increase in accuracy that this can bring.

1.2 Robotic Security

1.3 Problem Statement

Now, I specify the exact localization problem that this thesis addresses. Our system contains the following assumptions and constraints.

1. M independent mobile robots operating in a planar environment.
2. Wireless communication abilities between all robots in the environment.
3. No known map of environment, but GPS for localization in a world frame is available.
4. Localization must be able to seamlessly transition between operating with and without pose estimates from other robots.
5. Minimize complexity and added computations to Extended Kalman Filters used for localization.

Bibliography

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