UNIVERSITY OF SOUTH FLORIDA

Major Research Area Paper Presentation

Learning State-Dependent, Sensor Measurement for Simultaneous Localization and Mapping
by

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For the Ph.D. degree in Computer Science and Engineering

A robot typically relies on sensor measurements to infer its state and the state of its environment. Unfortunately, sensor measurements are noisy, and the amount of noise can vary with state. The literature provides a collection of methods that estimate and adapt measurement noise over time. However, many methods do not assume that measurement noise is stochastic, or they do not estimate sensor measurement bias and noise based on state. This research proposes a novel method called state-dependent, sensor measurement models (SDSMMs). This method: 1) learns to estimate measurement probability density functions directly from sensor measurements and 2) stochastically estimates an expected measurement (which includes measurement bias) and a measurement noise, both of which are conditioned upon the states of a robot and its environment. This paper discusses how to learn an SDSMM, describes how to use it with the Extended Kalman Filter (EKF), and uses SDSMMs to solve an EKF localization problem using a real robot dataset. The localization results showed that at least one of the proposed methods outperformed a standard EKF in all 15 cases for 2D position error and 10 of the 15 cases for 1D orientation error. On average, these results had a mean improvement of 39% for position and 15% for orientation.
This presentation also discusses current and future works. The current work proposes novel techniques for learning state-dependent, sensor measurement models with limited sensor measurements and ground truth data. The future work will describe how SDSMMs will help a drone navigate safely below a tree canopy.

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