**The Center for Control, Dynamical Systems, and Computation**
**University of California at Santa Barbara**
**Presents**

# Stable and Efficient Tracking of Multiple Dynamic Obstacles Under Large Viewpoint Changes


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## Abstract:

Despite the successful application of target tracking algorithms in long-range and even high-dynamics tracking scenarios, field robots tasked with the similar goal of detecting and tracking moving obstacles still rely on ad hoc feature extraction algorithms and error-prone best-fit matching schemes to track obstacles through multiple frames of sensor data. Though such schemes enable real-time processing on field robots with limited computational budgets, they often introduce significant biases and estimation artifacts through lossy feature extraction steps taken at the level of raw sensor data. Unfortunately, the estimation artifacts induced by these steps are most catastrophic in scenarios of critical interest to robotic path planning: when obstacles occupy a significant portion of, or move rapidly across, the robot's field of view. The sensor noise that lies at the root of these estimation artifacts suggests the application of Bayesian techniques to eliminate ad hoc feature extraction in favor of robust, probabilistic target tracking. To that end, this talk presents the LocalMap tracking algorithm: a computationally feasible, real-time solution to the joint estimation problem of data assignment and dynamic obstacle tracking from a potentially moving robotic platform. The algorithm utilizes a Bayesian factorization to separate the joint estimation problem into 1) a data assignment problem solved via particle filter, and 2) a multiple dynamic obstacle tracking problem solved by efficient parametric filters developed specifically for tracking full-size vehicles in a dense traffic environment. The algorithm is validated in controlled experiments with full-size robotic vehicles, and on data collected at the 2007 DARPA Urban Challenge, where it was used in real-time. This talk will also discuss the LocalMap tracking algorithm in the context of the present, past, and future of obstacle detection and tracking in dynamic environments on fielded, real-time robotic systems. Of particular interest is the widespread trend toward the use of ad hoc data processing algorithms in real-time systems, which often have deleterious effects on overall system performance when left unmodeled and unmonitored. The LocalMap addresses these shortcomings in a Bayesian framework through the use of dynamics models that capture new sources of uncertainty, and stable sensor measurements that are suitable for real-time estimation techniques. The techniques employed in the LocalMap are some of the first to rigorously address the fundamental difficulty of interfacing ad hoc and theoretical algorithms in fielded, real-time systems- a difficulty that must ultimately be overcome before full-size robots see widespread use in future transportation systems.


**About the Speaker:** Isaac Miller obtained his Ph.D. in Mechanical Engineering at Cornell University in 2008, with a minor in Computer Science. He received his M.S. in Mechanical Engineering from Cornell University in 2006 and his B.S. in Mechanical Engineering from Caltech in 2003. Isaac's research interests include robotic perception and planning in the context of Bayesian estimation and probabilistic representation, sensor fusion and Bayesian estimation, attitude and position estimation, real-time algorithmic implementation for robotic field deployment, controls, and dynamic modeling and simulation. Isaac's past work includes design and implementation of localization and perception algorithms for Cornell University's 2007 DARPA Urban Challenge robot and 2005 DARPA Grand Challenge robot.