MECHANICAL ENGINEERING
UNIVERSITY of HAWAI'I at MĀNOA

Doctoral Thesis Seminar and Defense

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CONVERGENT POSE AND TWIST ESTIMATION FOR VELOCITY-DENIED MOBILE ROBOTS BASED ON A CASCADING, DUAL-FRAME, MOTION-TRACKING ESTIMATOR

1:30 pm, 26 November 2019, Holmes Hall 309

Bio: Brennan Yamamoto graduated from the University of Hawaii with a B.S. in mechanical engineering in 2013, and an M.S. in mechanical engineering in 2015, with a focus in energy harvesting from vibration. He is currently a PhD student in the Renewable Energy, Industrial Automation, Precision Engineering (RIP) Laboratory, where his research focus is in the development of maritime unmanned systems for research and industry applications.

Abstract: Advancements in micro-fabrication and micro-electromechanical systems, increased market demand, and economies of scale have lowered the cost for global navigation satellite system (GNSS) and inertial measurement unit (IMU) sensor systems to levels cost-relevant for average consumers. The combination of GNSS+IMU can provide basic robot localization information, but cannot measure linear velocity, which is essential for effective autonomous mobile robot operation. Unfortunately, linear velocity sensors like wheeled odometers, air speed, optical flow, or doppler velocity log sensors are only situationally applicable and/or cost prohibitive for many robot applications; we entitle robots without velocity sensors as “velocity-denied robots”. In this work we propose a state estimation algorithm based on a cascading, dual-frame, motion-tracking estimator that is capable of providing accurate pose (positions) and twist (velocities) estimates for velocity-denied robot platforms, by probabilistically estimating the unobserved velocity state based on the time-varying information extracted from the measured position and acceleration states. Because this state estimator is based on a kinematic, motion-tracking state-transition model, it does not require dynamical information about the robot platform or the forces acting on it. We first demonstrate this state estimator algorithm on simulated mobile robot data and then on real data collected from a GNSS+IMU robot sensor system. We show that this state estimation algorithm consistently maintains a dead-reckoning pose accuracy of <1 m of the post-interpolated pose measurements, and provides a linear velocity accuracy of <±1 m/s.