ELECTRICAL & COMPUTER ENGINEERING **RESEARCH SEMINAR** **Spring 2018**

Collaborative All-Weather Sensing for Automated Vehicles

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Friday, April 20, 2018, 2:00pm – 2:50pm, Location: BB 3.03.24

Abstract

Future Vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) connectivity will permit vehicles to relay their positions and velocities to each other with millisecond latency, enabling tight coordinated platooning and efficient intersection management. More ambitiously, broadband V2V and V2I enabled by 5G wireless networks will permit vehicles to share unprocessed or lightly-processed sensor data, allowing ad-hoc networks of vehicles and infrastructure to function as a single sensing organism. The risk of collisions, especially with pedestrians and cyclists---notoriously unpredictable and much harder to sense reliably than vehicles---will be significantly reduced as vehicles and infrastructure collaborate to build a blind-spot-free model of their surroundings. Such collaborative sensing and traffic coordination requires vehicles to know and share their own position. How accurately? The proposed DSRC basic safety message, a first step in V2V coordination, does not yet define a position accuracy requirement, effectively accepting whatever accuracy a standard GNSS receiver can provide. But automated intersection management, tight-formation platooning, and unified processing of sensor data---all involving vehicles of different makes who may not share a common map---will be greatly facilitated by globally-referenced positioning with sub-30-cm accuracy. Poor weather also motivates high-accuracy absolute positioning. Every current high-profile automated vehicle initiative depends crucially on lidar or cameras for fine-grained relative positioning within a local map. But these sensing modalities perform poorly in low-visibility conditions such as a snowy whiteout, dense fog, or heavy rain. Moreover, high-definition 3D maps created with lidar and camera data, maps that have proven crucial to recent progress in reliable vehicle automation, can be rendered dangerously obsolete by a single snowstorm. What sensor combinations will enable automated vehicles to reliably operate despite heavy rain, snow, fog, and dark of night? This talk will focus on reliable collaborative mapping and localization despite poor weather, dense urban environments, and even adversarial sensor deception.

Biography

Todd E. Humphreys is an associate professor in the department of Aerospace Engineering and Engineering Mechanics at the University of Texas at Austin, Director of the UT Radionavigation Laboratory and associate director of the UT SAVES center, which works at the intersection of sensing, communication, and data analytics for automated vehicles. He received a B.S. and M.S. in Electrical and Computer Engineering from Utah State University and a Ph.D. in Aerospace Engineering from Cornell University. He specializes in the application of optimal detection and estimation techniques to problems in satellite navigation, automated systems, and signal processing. His recent focus has been on secure perception for automated systems, including navigation, timing, and collision avoidance, and on centimeter-accurate location for the mass market. Dr. Humphreys received the University of Texas Regeants' Outstanding Teaching Award in 2012, the National Science Foundation CAREER Award in 2015, and the Institute of Navigation Thurlow Award in 2015.