Autonomous Navigation in Unstructured Environments

Hugh Durrant-Whyte
ARC Centre of Excellence for Autonomous Systems
Australian Centre for Field Robotics (ACFR), J04
University of Sydney, NSW 2006
hugh@cas.edu.au

Some of the most challenging applications for robotics lie outdoors in harsh and unstructured environments. These include land applications such as mining, construction and agriculture, maritime applications such as search and rescue, sub-sea mining, and environment monitoring, and in air applications such as mineral exploration, meteorology and defence. Autonomous navigation of robotic vehicles in unstructured environments is probably the single most important problem in enabling commercial exploitation of robotics in these applications.

This presentation will describe the current state-of-the-art in autonomous navigation for field robotics: The advent of reliable GPS and low-cost inertial sensing has had a substantial impact on navigation in many outdoor applications. Integrated GPS/INS systems of sufficient integrity and of a price appropriate for automation now allow high-speed precision navigation of autonomous vehicles in land and air applications. However, in many situations, GPS is of limited value and terrain-aided navigation using exteroperceptive sensors is required. The huge progress that has been made in simultaneous localisation and map building (SLAM) in the past five years has had a major impact on what is now achievable in terrain-aided navigation. In particular, Kalman-filter based SLAM methods have now been demonstrated in a number of high-speed long-range land and air applications. New methods employing full Bayesian SLAM techniques have addressed structured terrain navigation problems in applications such as sub-sea mapping and land-vehicle operations. There is promise that such methods will also aid in the general area of map-building for motion planning and control. The maturity of many navigation methods, together with our knowledge of appropriate systems engineering, now suggests that we are on the eve of many new and exciting field automation opportunities.