PLENARY TALK

Autonomous Navigation: Achievements in Complex Environments

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Over the past decade, challenging applications for autonomous robots have been identified, in the areas of servicing crowded, built-up areas, mining, search and rescue operations, underwater exploration and airborne surveillance. Autonomous navigation arguably remains the key enabling issue behind any realistic commercial success in these areas. Consequently, autonomous robotic research has focused on large scale and long term navigation algorithms, sensing technologies, robust sensor data interpretation and map building.

The recent breakthroughs which contribute to the success of outdoor field robotics, and remaining fundamental research issues involved, will be the theme of this presentation. Arguably, the most successful robot navigation algorithms to-date, have been derived from a probabilistic perspective, which takes into account vehicle motion and terrain uncertainty and sensor noise. Over the past decade, an explosion of interest in the estimation of an autonomous robot's location state, and that of its surroundings, known as simultaneous localisation and map building (SLAM), is evident. New algorithms which represent uncertain information based on Random Finite Set (RFS) theory are advancing the progress of a robot's long term navigation abilities. This has been significantly aided by recently affordable sensor technologies, including GPS and inertial measurement units (IMUs) as well as fast and reliable laser range finders.

To demonstrate the state of the art in autonomous navigation, outdoor research experiments will be demonstrated within complex, built environments, with various vehicles, using RADAR, and laser range finders. Finally, research, based on Finite Set Statistics (FISST) will demonstrate new mapping concepts, which estimate the dimensional, as well as spatial, uncertainty in a robot's surroundings. This removes the necessity for fragile data association methods, which formerly caused the failure of many navigation algorithms.

With affordable new hardware, and a wealth of new estimation techniques, autonomous robot technology is entering a new era in which applications within complex environments are becoming achievable.