Summary of Estimation and Control

This session was comprised of a collection of papers on topics related to either estimation or control or both for one or more mobile robots. In some cases, collaboration with humans is an important element of the work.

The paper by Sujan et. al. addresses the problem of simultaneous localization and mapping using a minimalist and inexpensive sensor suite consisting of a single monocular camera, wheel encoders and contact switches. The system produces a graphical map of the environment where nodes are distinct places extracted from panoramic imagery and the graph is traversed during its own creation using depth first search.

The paper by Danesi et al. also addresses visual SLAM and but it uses a hybrid metric and topological representation. Images again form the nodes in the graph and visual servoing is use to drive from place to place. The technique combines the strengths of both representations in a manner that can be updated simultaneously by multiple robots while providing purely visual solutions to both kidnapping and loop closure.

The paper by Dudek et. al. addresses visual guidance for an amphibious robot. Waypoint acquisition and station keeping behaviors are intended to be used in the target application of visual surveillance of reef environments. The legged vehicle uses its legs as flippers to swim when submerged. The authors discuss the use of visual servoing to follow a moving target. ARTag markers can be used to communicate visually with the robot in order to command specific behaviors. The paper also discusses performance during hovering and other motions.

The paper by Pugh and Martinoli deals with the problem of causing multiple mobile robots to move together in formation. Intuitively this problem requires only relative state information encoding the shape of the formation. The robots used for the work take range and bearing measurements to nearby robots. Three modes of operation are investigated both in simulation and on real robots. Self localizing robots which cannot see each other does not perform as well as those which can measure the relative position of neighbors. The best performance is achieved by communicating the position and heading of the leader throughout the formation.

The paper by Fletcher and Zelinsky investigates the value of driver assistance systems which sense the state of the driver as well as of the road in order to produce a more collaborative interaction. A robotic co-pilot promises the combine the strengths of tireless machines and the flexibility of humans. The authors present a system that looks both inward at the driver and outward at the road. It correlates the driver's gaze, vehicle state, road signs, pedestrians, and lane tracking information to anticipate the driver's needs during periods of fatigue, inattention, and distraction.
As these papers demonstrate, estimation and control remain central aspects of the challenge of constructing useful experimental robotic systems. Whether the problem is to navigate in an unknown environment alone, in cooperation with other robots, or to assist a human in doing so in a collaborative setting, computer vision enables ever more sophisticated solutions to the challenges presented by our increasingly ambitious experimental programs in robotics.