Robotic Sensor Networks: Principles and Practice

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Abstract— We summarize the activities and organization of the workshop entitled *Robotic Sensor Networks: Principles and Practice* which took place on Saturday, June 30, 2007 at the Georgia Institute of Technology as part of *Robotics Science and Systems 2007*.

Sensor network research has risen to prominence in recent years. *RSS 2007* featured a one-day focused workshop on *robotic* sensor networks, namely sensor networks which incorporate robotic mobility or articulation. Such systems include, e.g., a networked multi-robot group, a network of immobile computing and sensing nodes and mobile robot(s), a network of immobile nodes each with computing and actuated sensing (allowing e.g., each node to change the direction in which a sensor is pointed). The design of such systems raises algorithmic and theoretical challenges as well as challenges associated with the practicalities of of conducting real deployments. This workshop brought together people interested in the algorithmic aspects, mathematical and statistical foundations, and experimentalists who have fielded robotic sensor networks in the context of specific applications.

The workshop was structured as a mix of short technical (though relatively informal) presentations and discussion panels. There were three technical sessions, each followed by a panel discussion. The first technical session (5 talks) was about algorithmic issues in sensor selection, placement, deployment, and belief propagation. The second and third sessions (5 talks each) were on applications of robotic sensor networks. The average attendance at the workshop was approximately 35, though we estimate that approximately 50 people attended overall over the course of the day.

In Session I, the speakers concentrated on *algorithmic problems* associated with accomplishing certain sensing tasks. The talk by Isler outlined an approach to networked motion planning, sensor planning and topology management in the context of a network composed of robots equipped with cameras. Bullo's talk focused on routing problems for autonomous vehicles, boundary estimation for robotic sensor networks, and an algorithm for sensor placement and control in the context of placing asynchronous guards in art galleries. Poduri's talk gave a theoretical bound on the rate of convergence of a coalescence algorithm in robotic sensor networks, while Jenkins discussed inference problems in robotic sensor networks as instances of multi-robot belief propagation. Berman concluded the session with a discussion of her work on the analysis and synthesis of bio-inspired controllers for swarm robotic systems.

In sessions II and III, the speakers focused on *implementations and applications* of robotic sensor networks. Three of the five talks in Session II dealt with applications to the aquatic environment, while three of the five talks in Session III were focused on multi-robot systems. Three of the five talks in Session III were also about environmental monitoring.

Bayazit opened Session II with an interesting talk on roadmap-based navigation strategies with an application to route finding in dynamic environments such as those affected by a wildfire. Kansal followed this with a distributed optimization approach to the coordination of networked cameras, thus exploiting low-complexity motion for large sensing gains. Sukhatme's talk was on mapping and exploration using an aquatic sensor network posed as a sampling design problem. Deshpande followed this with a discussion of how to exploit natural (passive) mobility in water bodies. Paley concluded the session with an inspirational talk showing results in cooperative control of an AUV network for ocean sampling with experiments performed at-sea.

In Session III, the first three speakers focused on multi-robot applications: Stachniss on cooperative multi-robot exploration, Hsieh on multi-robot behaviors for the perimeter surveillance problem, and Singh on human-assisted robotic teams for environmental monitoring. Song and Stealey continued the environmental monitoring theme: Song with a discussion of his work on creating a collaborative observatory for natural environments and Stealey with a discussion of infrastructure-supported mobile systems.

The workshop led to an interesting exchange of ideas, and an informal survey of the participants indicates that they enjoyed the experience. Further, judging by the number of speakers interested in participating, and the significant number of non-speaker attendees, we believe the workshop was timely and useful. For a complete speaker list, and titles of the various presentations, please visit the *RSS 2007* website.