PLACEMENT AND CONNECTIVITY MAINTENANCE ALGORITHMS FOR ROBOTIC SENSOR NETWORKS

By

Onur Tekdas

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Approved:

Prof. Volkan Isler, Thesis Adviser

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ABSTRACT

A sensor network is a network of small devices equipped with sensing, communication and computation capabilities. As sensors are becoming inexpensive, deploying many sensors in a workspace becomes feasible. On the other hand, advancements in wireless communication technologies help mobile robots solve important problems involving collaboration of multiple robots. Multiple robots can communicate with each other with wireless communication to collectively achieve a common task. These advancements in sensor networks and multi-robot systems lead to a hybrid system of sensor networks and multi-robot systems: robotic sensor networks. In this thesis, we consider two algorithmic challenges faced by robotic sensor network systems.

Robots operating in a workspace can localize themselves by querying nodes of a sensor-network deployed in the same workspace. The first part of this thesis addresses the problem of computing the minimum number and placement of sensors so that the localization uncertainty at every point in the workspace is less than a given threshold. We focus on triangulation based state estimation where measurements from two sensors must be combined for an estimate. We present an integer linear programming framework for the general placement problem and an approximation algorithm for a geometric uncertainty measure.

Mobile robots equipped with wireless networking capabilities can act as robotic routers and provide network connectivity to mobile users. Robotic routers provide cost efficient solutions for deployment of a wireless network in a large environment with a limited number of users. In the second part of the thesis, we present motion planning algorithms for robotic routers to maintain the connectivity of a single user to a base station. We consider two motion models for the user. In the first model, the user's motion is known in advance. In the second model, the user moves in an adversarial fashion and tries to break the connectivity. We present optimal motion planning strategies for both models.