Leadership Protocol for S-Nets

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Abstract

*Smart Sensor Networks are collections of non-mobile devices (*S-elements*) which can compute, communicate and sense the environment; they must be able to create local groups of devices (*S-cliques*). We propose here a protocol to solve the leadership problem for* S-Nets*. We sketch the correctness of this protocol in terms of an asynchronous network model.*

1. Introduction

At one extreme, mobile robots can be provided with a wealth of on-board sensing, communication and computational resources [1, 2]; at the other extreme, robots with fewer on-board resources can perform their tasks in the context of a large number of stationary devices distributed throughout the task environment [3]. We call the latter approach the *Smart Sensor Network*, or the *S-Net*. We have performed simulation experiments using software (C and Matlab), and the performance of robot tasks with and without the presence of an *S-Net* (i.e., a set of distributed sensor devices) has been evaluated in terms of various measures. See [4, 5] for a more detailed account.

This approach can be exploited widely and across several scales of application; e.g., fire fighting robots. If mobile robots are used to fight forest fires, there may be several hot spots to extinguish or control. If sensor devices can be distributed in the environment, then their values and gradients can be used to direct the behavior of fire fighting robots and to transport fire extinguishing materials from a depot to the closest fire source. During this movement to and from the fire, collision avoidance algorithms can be employed. Sometimes coordinated activities are necessary and communication models are also important.

In our previous work, we provided models for various components of the study: (1) mobile robots with on-board sensors, (2) communication, (3) the *S-Net* (includes computation, sensing and communication), and (4) the simulation environment. We have developed algorithms in the simulation environment for the *S-Net* which perform cooperative computation and provide global information about the environment. Local and global frames are defined and created. A method for the production of global patterns using reaction-diffusion equations has been described and its relation to multi-robot cooperation demonstrated. In addition, we have shown how to compute shortest paths in the *S-Net* using level set techniques [7].

The results of our simulation experiments help us better understand the benefits and drawbacks of the *S-Net*. We have shown that for behaviors of one mobile robot going to a temperature source, and multiple mobile robots surrounding a temperature source, in the ideal situation (which means no noise), the *S-Net* takes more time and distance. But when noise is added in, which is more realistic, the *S-Net* system is more robust than the non-*S-Net* system. For the task of multiple mobile robots going back and forth to a temperature source, there are thresholds above which the *S-Net* system out-performs the non-*S-Net* system.