JAMES MCLURKIN
ANNOTATED BIBLIOGRAPHY

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1. **McLurkin, James.** ***Analysis and Implementation of Distributed Algorithms for Multi-Robot Systems.*** **MIT: Thesis Supervisor: Leslie P. Kaelbling, 2008.**

The central theme of this work is that algorithm accuracy, communications bandwidth, and physical robot speed are related. This thesis has three main contributions: First, McLurkin develops a prototypical multi-robot application and computational model, proposes a set of complexity metrics to evaluate distributed algorithm performance on multi-robot systems, and introduces the idea of the robot speed ratio, a dimensionless measure of robot speed relative to message speed in networks that rely on multi-hop communication. Second, he presents a definition of boundaries in multi-robot systems, and develops new distributed algorithms to detect and characterize them. Finally, he defines the problem of dynamic task assignment, and presents four distributed algorithms that solve this problem, each representing a different trade-off between accuracy, running time, and communication resources. This demonstration showcases distributed algorithms for configuration control in multi-robot systems. These algorithms include examples of gradient communication, clustering and dispersion, group motion, and network characterization. The algorithms are demonstrated on a swarm of 15 mobile robots. (James McLurkin and MIT.)

For more information: http://people.csail.mit.edu/jamesm/McLurkin-PhD-MIT-2008.pdf.

2. **McLurkin, James, et al.** ***Speaking Swarmish: Human-Robot Interface Design for Large Swarms of Autonomous Mobile Robots.*** **AAAI Spring Symposium: 2006.**

This paper presents the design philosophy and practical experience with human-robot interfaces to develop, debug, and evaluate distributed algorithms on the 112-robot iRobot Swarm. These human-robot interaction (HRI) techniques fall into three categories: a physical infrastructure to support hands-free operation, utility software for centralized development and debugging, and carefully designed lights, sounds and movement that allow the user to interpret the inner workings of groups of robots without having to look away or use special equipment. The end result is a useable Swarm, with develop-run-debug cycle times approaching that of a simulation. (James McLurkin, MIT, and iRobot Corporation.)

For more information: http://people.csail.mit.edu/jamesm/McLurkinSmithEtAl-SpeakingSwarmish-AAAISS06.pdf.

3. **McLurkin, James, and Daniel Yamins. "Dynamic Task Assignment in Robot Swarms."** ***Proceedings of Robotics: Science and Systems.*** **Cambridge: 2005. 129-136.**

A large group of robots will often be partitioned into subgroups, each subgroup performing a different task. This paper presents four distributed algorithms for assigning swarms of homogenous robots to subgroups to meet a specified global task distribution. Algorithm Random-Choice selects tasks randomly, but runs in constant time. Algorithm Extreme-Comm compiles a complete inventory of all the robots on every robot, runs quickly, but uses a great deal of communication. The Card- Dealer's algorithm assigns tasks to individual robots sequentially, using minimal communications but a great deal of time. The Tree- Recolor algorithm is a compromise between Extreme-Comm and Card-Dealer's, balancing communications use and running time. The three deterministic algorithms drive the system towards the desired assignment of subtasks with high accuracy. (James McLurkin, MIT, and Harvard University.)

For more information:
http://people.csail.mit.edu/jamesm/McLurkin_Yamins_DynamicTaskAssignment_RSS2005.pdf.

4. **McLurkin, James, and Jennifer Smith. *Distributed Algorithms for Dispersion in Indoor Environments using a Swarm of Autonomous Mobile Robots.* Distributed Autonomous Robotic Systems Conference: 2004**

McLurkin describes a set of distributed algorithms used to disperse a large group of autonomous mobile robots efficiently throughout an indoor environment. Only local inter-robot communication and processing is used. Ad-hoc communications network topologies formed by gradient floods spread messages and guide robot motion. Special attention has been given to doors, hallways, and other constrictions. The network maintains a route to chargers to allow self-charging. (James McLurkin, MIT, and iRobot Corporation.)

For more information: http://people.csail.mit.edu/jamesm/McLurkin-Smith-Directed-Dispersion-DARS04.pdf.

5. **McLurkin, James. *Stupid Robot Tricks: A Behavior-Based Distributed Algorithm Library for Programming Swarms of Robots.* MIT: Thesis Supervisor: Leslie P. Kaelbling, 2004**

This work presents a set of communication techniques and a library of behaviors useful for programming large groups, or swarms, of robots to work together. The gradient-flood communications algorithms presented are resilient to the constantly changing network topology of the Swarm. They provide real-time information that is used to communicate data and to guide robots around the physical environment. Special attention is paid to ensure orderly removal of messages. Decomposing swarm actions into individual behaviors is a daunting task. Complex and subtle local interactions among individuals produce global behaviors, sometimes unexpectedly so. The behavior library presented provides group behavior "building blocks" that interact in predictable manner and can be combined to build complex applications. The underlying distributed algorithms are scaleable, robust, and self-stabilizing. The library of behaviors is designed with an eye towards practical applications, such as exploration, searching, and coordinated motion. All algorithms have been developed and tested on a swarm of 100 physical robots. Data is presented on algorithm correctness and efficiency. (James McLurkin.)

For more information: http://people.csail.mit.edu/jamesm/McLurkin-SM-MIT-2004(72dpi).pdf.

6. **McLurkin, James. *Algorithms for Distributed Sensor Networks*. University of California, Berkeley: Thesis Supervisor: Professor Kristofer S.J. Pister, 1999.**

This work develops algorithms that allow: the group to establish robust spatial patterns of messages; the group to develop a communications network by dividing tasks among themselves; each mote to determine its position in physical space based on their location in the network topology; each mote to determine if it is on the boundaries of the network by measuring global constants through local interactions; the group to project the path of a target moving through the network. To verify the algorithms, they have constructed two simulation environments. One is based in software and allows for very rapid proof-of-concept development. The other is a hardware version that still allows rapid development, yet provides all the problems of real hardware for a high fidelity simulation. (James McLurkin.)

For more information: http://people.csail.mit.edu/jamesm/McLurkin-MS-UCB-1999.pdf.

7. **McLurkin, James. *The Ants: A Community of Microrobots*. MIT: Thesis Supervisor: Professor Rodney A. Brooks, 1995.**

As the field of robotics advances, new areas of research are emerging. Two of these new fields are microrobotics and robotic communities. The goal of McLurkin's thesis is to explore both of these areas with an example borrowed from nature -- the ant colony. Ants have evolved into one of the most successful species on earth. Two of the main reasons for this dominance are their small physical size and their community organization. Using real ants as a guide, the robot Ants have been designed with sensors and actuators analogous to their natural counterparts. Their software is written with cooperation in mind, aiming for community behaviors emerging from the interactions of many individuals. Their cubic-inch size produces a robot that is relatively inexpensive and practical to experiment with in a normal-size lab. Natural ants use a multitude of different foraging techniques, many of which involve synergistic cooperation among several individuals. A synergistic interaction is one that produces a group that is greater than the sum of its parts. In this thesis, he has taken the first steps towards constructing a robotic community. (James McLurkin.)

For more information: http://people.csail.mit.edu/jamesm/McLurkin-SB-MIT-1995.pdf.

8. **McLurkin, James, Daniela Rus, and Mac Schwager. "Distributed Coverage Control with Sensory Feedback for Networked Robots." *Proceedings of Robotics: Science and Systems.* Philadelphia: 2006.**

This paper presents a control strategy that allows a group of robots to position themselves to optimize the measurement of sensory information in the environment. Robots use local information to estimate a sensory scalar field. Their estimate is then used to drive the network to a desirable placement configuration using a decentralized control law. They formulate the problem, provide a practical control solution, and present the results of numerical simulations. They then discuss experiments carried out on a swarm of mobile robots. (James McLurkin.)

For more information: http://www.roboticsproceedings.org/rss02/p07.html