CPS: Medium: Ant-Like Microrobots – Fast, Small, and Under Control

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CISE

The Institute for Systems Research — Maryland Robotics Center

Objectives

Development of the first wireless network of cooperative mobile autonomous robots at a very small scale.

Current Research Themes

- Sensing and odometry at very small scale
- Miniaturized low-power actuation
- Distributed coordination algoritms subject to time-varying power constraints

Education and outreach

One of the main goals of the project is to expose undergraduate students to the research environment. To this end, there are currently several undergraduate students collaborating with graduate students on various aspects of the project. A new testbed is under development by the students and faculty. It is currently being used to test a miniaturized localization system that has also been used in outreach activities.

Koshland Science Museum on April 16, 2011

Demo at a conference in Brazil (2011)

Locomotion

Thermal Bimorphs

An all-polymer legged robot utilizing a non-cleanroom based fabrication process. The conductive polymer on the legs creates a thermal bimorph to bend the leg.

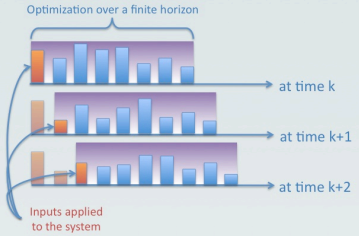
Dielectric Elastomer Actuators

A microfabricated DEA approximately 1 mm long and 100 µm wide. The DEA moves bidirectionally

Dielectric elastomer actuatorsare highly efficient and will eventually provide the legs for our robots. The DEAs are 1 mm long and demonstrated 350 µm of displacement. The fabrication process is identical for all DEA and polymer thermal actuators for use in robot leg development. These actuators have demonstrated approximately 100 µN of force in 100 µm of displacement with device dimensions of 1-2mm on a side.

Analog Receding Horizon Control

In the RHC setting, at each time step an optimization is carried for a finite horizon and the first calculated input is applied to the system. At the next time step, the horizon is updated and the procedure is repeated.



Randomized Approaches

We have discovered new receding horizon strategies that can cope with time-varying constraints and we are currently investigating new efficient control architectures that can be implemented directly in low-power analog hardware. This research involves the development of a new philosophy for control design and analysis rooted on randomized principles to search feasible solutions, associated with dynamic constraints that are imposed to guarantee stability and performance.

Testbed

A testbed has been created in the Cooperative Autonomy Laboratory at the UMD.

Back row: Dr. Nuno Martins, Mike Gateau, Kate Miller, Justin Pearse, Ken Tossel, Chris Perkins
Front row: Eduardo Arvelo, Bavani Balakrisnan, Dr. Sarah Bergbreiter, Dr. Pamela Abshire, Lydia Lei, Dr. Elisabeth Smela, Andy Hammond

Sensing and Odometry

Investigation of a new miniature acoustic localization system. In addition, new algorithms and principles have been proposed and tested.