



Centibots: SRI International's 100 Robots Project

Robots for Autonomous Urban Surveillance

Scientists at **SRI International's Artificial Intelligence Center** are developing Centibots, a system of mobile, coordinated robots that can autonomously and effectively explore, map, and survey the interior of unknown building structures. When complete, Centibots will mark a milestone in robotics, representing the largest collection (more than 100), to date, of coordinated autonomous mobile robots.

Centibots can work together as a team, while adapting to changing circumstances. They can cope with unexpected events and deal with the uncertainty inherent in sensing and acting on the physical world.

Each Linux-based robot is capable of self-localization within a map. Some Centibots are specialized for particular tasks such as searching for a particular type of object or tracking intruders.

Centibots can communicate with each other and with a central base station under conditions in which power or bandwidth may be limited, connectivity may be intermittent, and stealth may be necessary.

Centibots improve upon current robot architectures, which rely on large, power-hungry subsystems for mobility, communication, and control, and are limited to only individual or small teams of robots.

Reducing the Risk to Human Life

Centibots were designed to augment the situational awareness of human teams – such as crisis response teams -- in situations that could pose a threat to people. Centibots could be deployed to serve as an advanced surveillance team for urban missions in which a first set of mapping robots survey an area of interest, then build and share a distributed map as well as highlight hazards, human intruders, and hiding places. A second wave of tracking robots are then deployed in an optimal way, configuring themselves to effectively sense intruders and share information among themselves and a command center.



The Centibots use the VIA EPIA Mini-ITX Mainboard.



A team of Centibots ready for action



One of the Linux-based Centibots

Making it Work

To overcome the significant challenges associated with the realization of such large-scale robot teams, SRI has developed a distributed robot architecture in which collective behavior is uniquely adaptive, fault-tolerant, and capable. The Centibots system encompasses the following innovative elements:

- A collaborative, multi-level architecture, adaptive to new tasks and team organizations and also scalable to very large teams. Centibots can adapt to new localization and communication goals as well as recover from disabled team members
- Optimal distributed map-building and deployment of Centibots for tracking based on novel distributed spatial reasoning techniques. Centibots can reconnoiter a set of buildings faster, more reliably, and more comprehensively than an individual or small set of robots
- Open agent system integration of problem-specific computational modules including a variety of onboard sensor suites
- Large-scale, fault-tolerant communication based on SRI's packet-hop mobile ad-hoc network technology
- A robot team interface and monitoring subsystem that supports robot tasking, requires minimal supervision and provides robot-level attribute-of-interest updating and tracking, as well as task- and team-level goal tracking
- Analyzable and predictable behavior through systematic experiments with well-defined evaluation metrics

DARPA's Software for Distributed Robotics Program

SRI International's Centibots project is funded by the Department of Defense Advanced Research Projects Agency (DARPA) through the Software for Distributed Robotics Program. SRI leads a team that includes Stanford University, the University of Washington, and ActivMedia Robotics to design and implement a computational framework for the coordination of large robot teams, consisting of at least 100 small, resource-limited mobile robots on an indoor reconnaissance task.

For more information about the Centibots, visit www.ai.sri.com/centibots.

About SRI International

Silicon Valley-based SRI International is one of the world's leading independent research and technology development organizations. Founded in 1946 as Stanford Research Institute, SRI has been meeting the strategic needs of government and commercial clients for more than 55 years.

SRI's Artificial Intelligence Center (www.ai.sri.com) is a pioneer and major contributor to the development of computer capabilities for intelligent behavior in complex situations. The Center's objectives are to understand the computational principles underlying intelligence in humans and machines and to develop methods for building computer-based systems to solve problems, to communicate with people, and to perceive and interact with the physical world.



SRI International
333 Ravenswood Ave.
Menlo Park, CA 94025
www.sri.com

Inquiry Line: (650) 859-4771
or inquiry.line@sri.com