Safety, Security and Rescue Research Center (SSR-RC)

A CISE-funded Center

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Scout Robot Platform: Urban Search and Rescue

The development of large-scale robot teams has been prohibitive for a number of reasons. The complexity of such systems has been hard to simulate, especially in the case of a many to one relationship between a marsupial robot and the robots it can deploy. Additionally, the construction of physical systems can be expensive to implement and maintain. However, there is a number of scenarios in which large scale distributed teams are advantageous such as urban search and rescue, biological or chemical release monitoring, or distributed surveillance and reconnaissance. Distributed robot teams are often able to leverage the power, computational, and locomotive capabilities of a larger system to transport, coordinate, and control miniature robots which may carry more specialized capabilities into areas that are spatially restrictive. Research at the Safety, Security, Rescue Research Center has resulted in the development of the Scout Robot Platform currently being used by the U.S. Army and several police departments for search and rescue missions. The above robot has a cylindrical shape that allows it to be deployed by launching it from an appropriate barreled device. Once deployed, these robots move using a unique combination of locomotion types. Each Scout is provided with a sensor suite, which may vary with the Scout's mission. Scouts may contain some combination of a CMOS camera, a passive infrared sensor, a microphone, and other sensors.

Economic Impact: The Scout Project has resulted in a start-up (ReconRobotics Inc.) that has sales of more than 20 million USD annually and employs 35 people. The Scout is projected to achieve sales of 100 million USD in sales within a few years. More than 4,000 robots have been deployed worldwide by the US Army and Navy, the FBI and various police forces in more than 50 countries.

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Plume Tracking with a Reconfigurable Computing Platform

Robotic teams are envisioned to assist or even replace humans in search and rescue operations such as when dealing with a chemical leaks. The objective researchers at the Safety, Security and Rescue Research Center (SSR-RC) is to develop algorithms and reconfigurable hardware that will allow distributed groups of robots to search an area and determine the source, type and quantity of dangerous gases released in the atmosphere due to an accident or malicious act. In order for robots to achieve this goal, they must be able to determine their position, create detailed representations of the area they search, and coordinate in their distributed detection and estimation task. Additionally, robots must deal with mobility issues when navigating in unstructured environments or need to climb stairs. To this end, the center has designed adaptive sensing algorithms that allow robots to determine the optimal locations where they need to move in order to receive the most informative measurements for the detected chemical. Additionally, stair-climbing estimation and control algorithms have been implemented that allow safe and precise navigation inside buildings. These dynamic re-configurable processes allow re-tasking of hardware and software resources, thus making adaptations to varying operating conditions possible.

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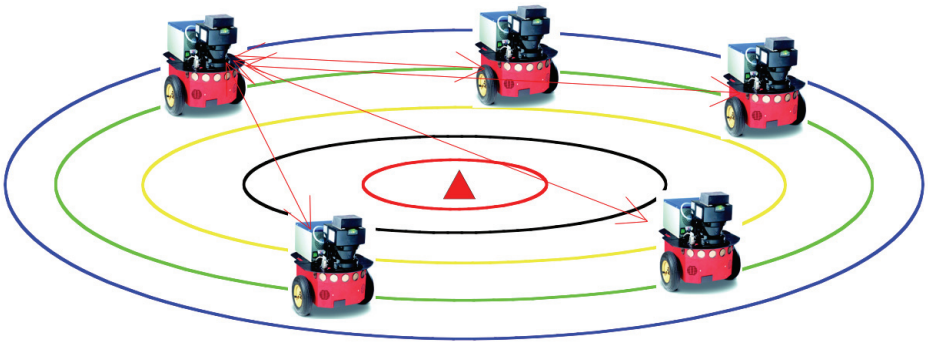
Robot team searching for the source of a gas leak.



Distributed Decision Making for Large Scale Disaster Management (DDM-LSDM)

DDM-LSDM is an exciting area of work that deals with disaster management for homeland security applications. Disaster management is becoming increasingly complex, due to uncertainty, limitations in resources, difficulty of coordination among teams, the existence of multiple and at times conflicting objectives, the need to adapt continuously to changing situations, and the scale of the operations. We model disaster management with multiple autonomous agents that can sense, act, and make decisions at different time

scales using the available information and communication channels. The project builds on a simulation tool developed by the Robocup Rescue Project after the 1995 Kobe earthquake. The tool simulates civilians, traffic blocks, fires, and building collapse. Police, emergency and fire agents need to rescue civilians and extinguish fires before the civilians die and the fires spread. Traffic blocks hamper their movements, noisy sensors make assessing the situation hard, loss of communications prevents effective team coordination. We focus on the decision processes and communication needs of the agents, addressing specifically the need to rapidly adapt to changing situations. We study: 1) distributed decision making algorithms that make the best use of available information, and; 2) multi-agent systems approaches to manage interactions and cooperation among large numbers of individual agents and teams of agents.

Using this agent-based simulation tool we can model large cities with many people and emergency responders, and study how each decision made by each agent affects the global outcome of the disaster. The simulation tool works on real maps of real cities, giving the decision makers ways of assessing how well their emergency plans will work under different circumstances and provide a training tool for emergency responders.

> **Economic Impact:** In the opinion of SSR-RC sponsors, when completed this simulation tool will be capable of facilitating disaster management operations by providing emergency responders and citizens with a tool that can be used not only to train emergency workers, but more importantly to better understand how disasters can affect them, to locate escape routes and to become better prepared when a disaster strikes. The long-term plan is to connect the simulator with software systems such as Eden (Emergency Development Environment), an open software system for rapid deployment humanitarian response management (from the Sahana Software Foundation), so that the information used by the simulator can be updated with real-time data provided by citizens in the affected areas.

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