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

A CISE-funded Center

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

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. During disasters, traffic blocks, fires, floods, and collapsed structures hamper their movements. Assessing situations is difficult. Too often, loss of communication prevents effective team coordination. DDM-LSDM is an exciting area of work that deals with disaster management for homeland security applications.

This 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.

SSR-RC researchers model disaster management scenarios involving multiple autonomous agents that can sense, act, and make decisions at different time scales using realistic information and communication channels. The work 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. 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 the agent-based DDM-LSDM simulation tool, researchers model large cities with large populations and a variety of emergency responders. They are able to 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 providing a training tool for emergency responders.

> **Economic Impact:** In the opinion of SSR-RC sponsors, this simulation tool facilitates 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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Scout Robot Platform: Urban Search and Rescue

The Scout Robot Platform currently being used by the US Army and several police departments for search and rescue missions.

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 US 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 Complementary Metal Oxide Silicon (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 annually. The Scout is projected to achieve sales of $100 million 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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