Information Fusion Research Simulates Disasters to Manage Emergency Response

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Improving how decision-makers respond in the minutes and hours that follow the first reports of a natural disaster like the recent tsunami or a manmade incident, such as a chemical accident or a terrorist attack, is the focus of a research project at the University at Buffalo's Center for Multisource Information Fusion.

"Responders immediately begin knitting together a picture that makes sense of what is happening based on the flow of reports they receive from the field," said Peter Scott, Ph.D., associate professor of computer science and engineering in the UB School of Engineering and Applied Sciences and principal investigator on the project.

"Our goal is to take the typically chaotic flow of reports of variable quality and heterogeneous origin received from the field in the period immediately after the disaster and transform it into useful information for decision-makers and emergency responders to act upon," he said.

The system is undergoing beta testing, Scott said, and should be completed and available for use within one year.

The project, funded with a $2.5 million grant from the Air Force Office of Scientific Research, consists of theoretical research on information fusion coupled with design of a large-scale simulation of a disaster modeled after the 1994 Northridge earthquake in California.

The goal is to produce response-system design guidelines, applicable to both natural disasters, such as earthquakes, tsunamis and wildfires, and to manmade incidents, such as chemical accidents and terrorist attacks, and test them in the simulated-disaster environment.

The software Scott and his colleagues are developing is driven by data collected by the Federal Emergency Management Administration during the Northridge earthquake and similar earthquakes regarding characteristics of that disaster, such as building and roadway damage, and how they correlated to casualties.

"Using our software, we create realistic simulations of earthquakes in the San Fernando Valley of differing characteristics, such as the depth of the quake, the location of the epicenter and its proximity to population centers," explained Scott. "Based on those parameters, the simulation determines the number of casualties created as an immediate consequence of the primary shake and their geographical distribution."

The computer program also simulates and "fuses" reports typically received from observers such as policemen and civilians, who may be providing redundant or contradictory information.

"Our simulation takes these reports and assigns probabilities of error and uncertainty to the information they contain based on known reliability data and then fuses the information into a unified, coherent 'situation assessment' to help emergency responders and decision-makers make the best, most timely decisions that they can," Scott said.

One of the critical goals of the project and one that is a chief concern for the Air Force, he added, is discovery, in the midst of a primary incident, of an unpredicted and unexpected secondary event that can occur as a result of the initial disaster.

"Psychological testing shows that a responder can too quickly lock into the idea, 'OK, I'm responding to trauma casualties caused by an earthquake,' and it's difficult for them to then consider other issues," he said.

In the recent tsunami, he said, those secondary incidents might include ruptured gas mains, environmental contamination or widespread cholera. After an earthquake, the collapse of a highway bridge might cause a tanker truck full of chlorine to fall and rupture, spreading a toxic plume and causing a spike in respiratory casualties.

According to Scott, the information fusion process begins linking reports and considering secondary causes, as soon as the first two reports of casualties or damage are received.

"Our program is designed to suggest likely scenarios and to provide confidence measures associated with each of those scenarios," he said.

The software will provide those scenarios and measurements within minutes or seconds after the first reports are received.

"If the situation assessment is not keeping pace with the unfolding needs of the emergency responders and decision makers, then it's not useful," he said.

Scott's co-investigators on the project from the UB Department of Industrial Engineering include Rajan Batta; Ph.D., Li Lin, Ph.D.; and James Llinas, Ph.D., all professors, and Ann Bisantz, Ph.D., associate professor. Thenkurussi Kesavadas, Ph.D., associate professor in the UB Department of Mechanical and Aerospace Engineering, also is a co-investigator. Eight graduate students also work on the project.

Jim Scandale of the CMIF Lab is software manager and the group is supported by collaborators from the Systems Engineering Department of the University of Virginia at Charlottesville and the Department of Computer Science of the University of Arkansas at Little Rock.

Source: University at Buffalo