Improving emergency evacuation planning with decision-making simulation

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A unique disaster-response planning tool takes real-time human decision-making into account to determine effective law-enforcement strategies during evacuations. A University of Michigan researcher contributed to the development of the tool.

"When a disaster happens, people need to evacuate immediately, and it's difficult to plan for these situations. This new model could help government entities train first responders and determine the best policies to put in place to prepare for emergencies," said Judy Jin, associate professor in the Department of Industrial and Operations Engineering and an author of a paper on the research that will be published in the next edition of the quarterly ACM Transactions on Modeling and Computer Simulation.

The new simulation model is for pedestrian traffic. It can tell emergency planners, for example, how the number of police officers on the scene affects the speed of evacuation, and how the percentage of tourists in a given area can slow down escape.

The model is unique in that it incorporates not just how humans make decisions, but how we plan them. This leads to a more accurate representation of the final decision because it allows the simulated humans to learn from new information they're gathering, Jin said. When evacuating a disaster scene, a person would continually glean new knowledge. They could observe fire, smoke, instructions from police officers and the behavior of the rest of the crowd, for example.

To program the simulation to most accurately model real behavior, the researchers recorded human choices during virtual reality experiments. Six volunteers virtually evacuated from a simulated bomb explosion on the National Mall in Washington, D.C. They each did the exercise three times.

Using this information, the researchers built a model that takes into account how different types of people tend to react in emergencies. Local residents who are familiar with the area are able to find their way out without much help from others or police officers. They escape faster than tourists, for example, who rely on instructions from police or locals, perhaps at every turn.

In order to investigate how increasing the number of police officers or local residents in a given area would affect evacuation times, the researchers ran simulations of 500 people escaping from the National Mall after a bomb explosion. In these simulations, as the number of police officers increased from 10 to 100, the evacuation time of tourists decreased by about 25 percent, or one full minute.

With an increase from 10 to 200 in the number of local residents who would likely serve as leaders in emergency situations, evacuation time decreased by 30 seconds, or 10 percent.

"These results would help officials decide on the optimal number of policy officers in various emergency situations, taking into consideration the percentage of tourists typically present in a city," Jin said.

Jin said the new model could also be applied to traffic management or any situation where humans must make quick decisions under somewhat stressful conditions.

More information: The paper is titled "*An integrated human decision*

making model for evacuation scenarios under a BDI framework," which is co-authored by Jin, doctoral student Seungho Lee and associate professor Young-Jun Son at the University of Arizona.

Provided by University of Michigan