Simulation-Based Disaster Decision Support System

Shengnan Wu, Larry Shuman, Bopaya Bidanda
Carey Balaban, Matthew Kelley, Ken Sochats
University of Pittsburgh, Pittsburgh, PA, USA

Abstract
Intelligent control systems can assist decision makers in addressing such unanticipated events as disasters. We are developing the Dynamic Discrete Disaster Decision Simulation System (D4S2) for planning improved responses to large-scale disasters. D4S2 integrates agent-based and discrete event simulation, a geographic information system (GIS) and a knowledge-based system into one platform to better assess how various decisions might impact the evolving incident scene. This enables us to model human behavior during large scale emergency incidents, incorporating methodologies from operations research, information sciences and medical sciences into our model. We propose that D4S2 can be used as a sequential decision making tool. As the incident unfolds, decisions such as when and what type of response to dispatch, and what actions should be taken at the scene change. By dividing the incident into phases and simulating the potential result of one phase while it is ongoing, more informed follow-up decisions can be made.

Method
- Dynamic simulation model generation
- Seamless integration of simulation with GIS and decision models
- Integration of agent-based and discrete-event simulation
- Dynamic response rule generation

Motivation
- Increasing need for intelligent control systems to deal with complex events such as disasters
- Both man-made and natural events are stochastic and hard to control
- Infeasible to test response policies and train emergency personnel with actual disaster scenarios

Objective
Provide a circumstance-independent laboratory for testing how the type and scale of the event, situational state and command decisions affect responders’ efficiency and effectiveness in dealing with complex, evolving disasters.

Target Users
- Public safety officials (EMS, fire, police, hazmat, etc.)
- Local, regional, state and Federal planners
- Policy makers
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Development Case
Pittsburgh, Pennsylvania
- Topography
- Hydrology
- Infrastructure
  - Bridges
  - Tunnels
  - Structures

Preliminary Results
Location Simulated: Pittsburgh Convention Center

Break point appears when number of casualties reaches around 330, from there the number of deaths increases exponentially. Additional responses are needed to deal with this level of events.

Research Contributions
- Develop the methodology to combine agent-based model with discrete event simulation
- Implement a dynamic rule-driven simulation system which interfaces with other components including GIS, control system, visualization system, etc.
- Combine AI-based heuristic algorithm with the simulation system to optimize operational rules

Contact:
Prof. Larry Shuman
323 Benedum Hall, Pittsburgh, PA 15261
Phone: +1-412-624-9815
Email: Shuman@pitt.edu