Fault tree analysis (FTA) is used to find and mitigate vulnerabilities in systems based on their constituent components. Methods exist to efficiently find minimal cut sets (MCS), combinations of components whose failure causes the overall system to fail. However, traditional FTA ignores the physical location of the components. Components in close proximity to each other could be defeated by a single event with a radius of effect, such as an explosion or fire. Events such as the Deepwater Horizon explosion and subsequent oil spill demonstrate the potentially devastating risk posed by such spatial dependencies. This motivates the search for techniques to identify this type of vulnerability. Adding physical locations to the fault tree structure can help identify possible points of failure in the overall system caused by localized disasters. Since existing FTA methods cannot address these concerns, using this information requires extending existing solution methods or developing entirely new ones.

Using a set of benchmark fault trees derived from Lâ€”systems, three approaches to finding these vulnerabilities were explored in this research.

â€¢ The control method executes traditional FTA software to find minimal cut sets (MCS), then extends this approach by searching for clusters in the resulting MCS to find minimal cut volumes (MCV).

â€¢ The next method starts by searching for clusters of components in the three dimensional space, then evaluates combinations of clusters to find MCV that defeat the system.

â€¢ The last method uses an evolutionary algorithm to search the space directly by selecting center points, then using the radius of the smallest sphere(s) as the fitness value for identifying MCV.

Results generated using each method are presented. The performance of the methods are compared to the control method and their utilities evaluated accordingly.

Major: Modeling and Simulation

Educational Career:
Bachelor's of Physics, BS, 1986, University of Arizona
Master's of Computer Science, MS, 1992, Johns Hopkins University

Committee in Charge:
R. Paul Wiegand, Chair, Computer Science
Ronald F. DeMara, Computer Architecture Laboratory
Annie S. Wu, Evolutionary Computation Laboratory
Ziâ€”Xia Song, Department of Mathematics

Approved for distribution by R. Paul Wiegand, Committee Chair, on March 15, 2018.

The public is welcome to attend.