Problem Statement

Real-world environments are plagued with uncertainties, such as faulty sensors, and sporadic network connectivity often caused by environmental factors, including bad weather, and unplanned intrusions (Girardin & Nova, 2005). These conditions can adversely affect the decision-making process, and even add to the user's cognitive load (Zuk & Carpendale, 2006).

Applications with high levels of certainty can positively affect user impressions by displaying the uncertainty (Lim & Dey, 2011). However, adding uncertainty visualizations to a crowded visual canvas can adversely affect a user's cognitive load (Antifakos, Schwaninger, & Schiele, 2004).

The literature has not provided a proven theory for effective uncertainty visualization (Lapinski, 2009) and the effects of uncertainty visualization on reasoning during periods of high cognitive load.

Research Questions

1. Does adaptive uncertainty visualization improve the system operator’s level of performance in completing assigned tasks? Performance will be measured by reaction time, and error rate.
2. Does adaptive uncertainty visualization reduce the system operator’s mental load? Mental load will be measured by the operator's performance on the secondary task.
3. Does adaptive uncertainty visualization reduce the system operator’s level of mental effort? Mental effort will be measured by a subjective survey.
4. Can the adaptive uncertainty visualization be calibrated to reduce cognitive load that stems from uncertainty without increasing the system operator’s overall cognitive load?

Research Objective

Identify how adaptive uncertainty visualization can decrease cognitive load arising from uncertainty more than visualization increases cognitive load arising from complex user interfaces. By mitigating the increase in cognitive load due to uncertainty, uncertainty visualization techniques can reduce the user’s overall cognitive load.

Research Methodology

- Design a computer simulation that reproduces the effects of uncertainty and high workload (Garrabrants, 2009)
- Conduct studies using two conditions: with and without uncertainty visualization (the independent variable)
- Study sample size using 24 knowledge workers (12 male and 12 female)
- Quantitatively measure the subject’s response time and error rate using primary and secondary tasks (de Jong, 2009)
- Qualitatively measure user satisfaction with a questionnaire

Project Status

1. Dissertation committee formed: Dr. Maxine Cohen, Dr. Sumitra Mukherjee, Dr. William Garrabrants
2. Dissertation research proposal approved
3. Currently piloting software simulation

Pilot Findings

- Reduced simulation from four monitors to one due to subject reports of feeling overwhelmed by four monitors
- Added an animated “busy” indicator during simulated outages to retain the subject’s attention
- A training round is useful for immersing the subject in the simulation
- Simulation should have high fidelity (closely matches a real-world situation) to increase subject’s buy-in

Reference List


