Information Based Security to Mitigate Threats and Disasters
for Constructed Facilities

Project Summary

Conventional construction practices are governed by stress and cost considerations, and thus unsuitable to mitigate imminent threats. Information technology has empowered civil engineers to initiate live-designs which will alert civic authorities in the face of apprehended natural and manmade disasters. Design specifications are continuously updated using new information according to a Bayesian algorithm hence the paradigm is termed live design.

Over the course of five years, engineers, lawyers and computer scientists will build, deliver and demonstrate the core technology for a live design paradigm. This open environment is amenable to input augmentation and distributed computing. In regular monthly meetings, local and federal authorities will help the team to formulate strategies which will be incorporated into electronic versions of blue prints.

The team will assess safety and security of bridge, airport, tunnel, and water and energy conduit models. More detailed analysis will be carried out for residential and office buildings. In the case study focused on office buildings, design professionals of the team will develop a semantically rich formalized version of New York City building and infrastructure requirements. Economic constraints, construction and architectural design practices as well as legal implications of monitoring and surveillance of private, government and international office buildings will be integrated with the formal specification. The resulting database will guide a computer aided design software to produce baseline drafts, which the architect on the team will animate in three-dimensions. MIT will simulate hazards for all units of the building, such as the rooms, stairways and corridors. They will collect thermo-mechanical stress values from structural calculations, control measurements, security and surveillance data and wireless sensor responses. A live design database will supply a confidence interval to each input. Neighboring sensor data will be statistically combined by Columbia University to detect extreme events from results expressed in the interval arithmetic format. Tight bounds predict credible threats whereas spreads indicate anomalies such as false alarms and noise in the system. Each plausible catastrophe will display optimized rescue and evacuation trajectories on architectural animations, and broadcast voice and text security messages. The legal ramification of human intervention based on such predictions will be assessed by querying another live design database which will be developed by the team's lawyer and a student volunteer who specializes on international laws. CMU will write a markup language and associated applications to facilitate all response input, database functions, and export of results to appropriate media. Based on actual observations and performance of the decision system the confidence intervals, and mean and standard deviations of each signal input will be updated using a Bayesian methodology. A large scale simulation will continuously run to discover yet to be identified fatal combinations.

Research results will be published as design handbooks, university reports, journal and conference papers, and on the internet. The requested budget, which supports domestic university salaries, government rates for the practitioners and minor expenses for sensor fabrication, workshops and publications, will yield life saving security strategies at a fractional cost of a single building.