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Research Project Highlight

High-Performance Computing Based Distributed Multi-Layered City-Scale Transportation Network Tool

Project # NCTRSO

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Research Team

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Start-End Dates:

1/1/2018-12/31/2018

Abstract

The goal of this project is to utilize a graph-parallel distributed agent-based model (ABM) to quantify the performance of transportation network and water pipeline network at city scale under different ground motion scenarios. The objectives are to quantify the performance of these infrastructure networks using a high-fidelity microscale model and to develop a unified network model capable of simulating the interactions between the above two networks under different ground-motion scenarios. The developed graph-parallel distributed computing tool is capable of simulating city-scale infrastructure networks with hundred-thousand links and millions of agents traversing close to real time. The purpose of the ABM tool is to capture the complex city-scale response from individual agent behaviors. Macro-scale events such as earthquakes influence the weights of the edges on a graph network (e.g., reduced road capacity/road closures update the weights of the edges/ removal of an edge), which in turn affect the behavior of individual agents, thus changing the response of a city. In this project, pipeline damage scenarios by different ground-motion cases are supplied by EBMUD, and the effect on traffic network is examined. By doing so, the dynamic performance of water pipelines after an earthquake and the assessment and strategy of recovery of the water network is evaluated. This project links to the work of Stanford University, which aims to build and utilize a model that links individual bridges' earthquake-damage-induced traffic capacity loss and restoration with network-level performance over time. The fragility curves and recovery time models for individual bridges subjected to earthquake shaking will be used as inputs to our HPC-based transportation network tool. A series of ABM simulations on traffic networks will be conducted to test scenarios when both bridges and water pipeline networks are affected by an earthquake event.

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Deliverables

An HPC-based distributed ABM tool will be made available under an open-source license. This tool allows visualization of transport network performance at city scale in terms of traffic volume, speed, route closure, and estimated recovery time under different scenarios of infrastructure damage by an earthquake.

Research Impact

The loss of accessibility due to damages/closures of transportation network can greatly affect the rescue and recovery of a city after natural disasters. Transport asset managers need to know the route availability, traffic distribution, reduction in speed, and reconstruction resources required under disaster scenarios so as to evaluate the impacts and plan for disaster relief measures. The ultimate aim of this project is to provide a tool that enables city-scale resilience planning using HPC for infrastructure planners in the Bay Area. The proposed tool can potentially be used for analysis in real time and enables probabilistic analysis through multiple runs for different recovery scenarios after an earthquake. Beyond this proposal, further research could be developed to include more sophisticated models and infrastructure types.

Project Images



City-scale ABM tool – left-Browser-based visualization of journey times on a typical working day at 8AM in London, right-Micro-impact assessment of a bridge closure at mid-night in London

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Macro-micro city-scale modeling concept