From Office Equipment to Traffic Management: Xerox's Ambition for Innovation

Xerox Corporation, headquartered in Norwalk, CT, and with a major research center in Webster, NY, is a multimillion dollar global Fortune 500 corporation best known for the invention of the photocopy machine. Over the last 50+ years Xerox's research centers have yielded game-changing technologies like the laser printer, copy machine, computer mouse, the computer graphical user interface (GUI), and Ethernet. One of Xerox's latest ventures is an interest in improving inductive loop detectors (ILDs) for traffic management. Xerox is partnering with researchers at the University at Buffalo to advance their understanding of this technology.

Company: Xerox Corporation
Industry: Business Services and Digital Printing Solutions
Location: Webster, NY
Website: www.xerox.com

THE CHALLENGE

ILDs are increasingly used for vehicle detection to enable efficient traffic management. ILDs consist of conducting loops of wire (coil) embedded in the pavement and connected to detection circuitry. ILDs are typically driven at RF frequencies in a resonant mode and, when ferrous or metallic vehicle components like wheels or axles pass overhead, eddy currents and magnetic fields are generated that couple to the coil and alter its inductance. The change in inductance is detected and registered as a vehicle. A research group led by Dr. Edward Furlani at the University at Buffalo (UB) is working with Xerox scientists based in Webster, NY, to simulate ILD performance under a variety of conditions. Such simulations require large-scale computational models with an extremely fine spatial mesh resolution in order to predict the very small changes in coil inductance that are observed during vehicle motion.

NEXT GENERATION SOLUTIONS

The UB-Xerox collaboration is overcoming modeling challenges by adapting the commercial COMSOL Multiphysics software (www.comsol.com) to solve complex large-scale electromagnetic models using the high performance computing capability of UB's Center for Computational Research (CCR). Specifically, the COMSOL AC/DC module is used to predict

the electromagnetic coupling between embedded sensing coil and moving automobile components, e.g. aluminum wheels and steel belted tires. In addition to developing standalone models, a relatively new tool called COMSOL Application Builder is being employed to perform user friendly parametric analyses of system performance using custom graphic user interfaces. These analyses are known as parameter "sweeps".

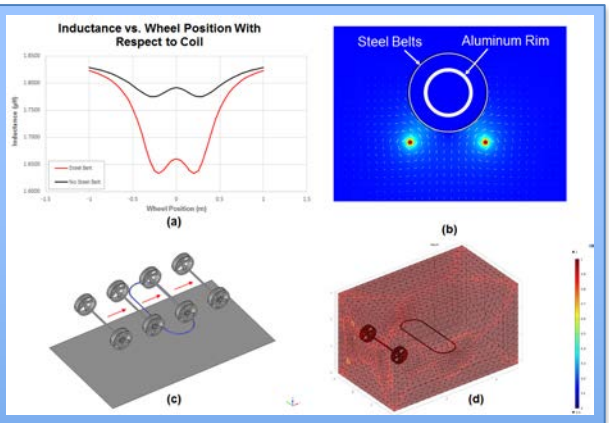
Access to UB's high performance computing (HPC) resources is supported by funding from the Division of Science Technology and Innovation (NYSTAR) of the Empire State Development Corporation (ESD) through its High Performance Computing Consortium (hpc-ny.org) and the New York State Regional Economic Development Council.

ECONOMIC IMPACTS

The Xerox scientists in Webster, NY anticipate leveraging this project towards the development and manufacture of next generation ILD devices. This will spur the creation of **hundreds of new jobs** to design, manufacture, calibrate, test, install, maintain and monitor various ILD systems, both in the laboratory and the real-world. This project could also lead to the placement of UB engineering students in Xerox or other companies with related technology.

RESULTS

A COMSOL analysis performed by Ph.D. candidate Viktor Sukhotskiy is given to the right. This figure shows the predicted change in inductance of an embedded coil as a function of the position of an aluminum wheel with a tire containing steel belts. A typical "sweep" involving 10 different 3D simulations of a vehicle axle moving over a sensor coil would take 40 hours on a traditional desktop computer. This can be reduced to as little as 2.9 hours (14× speedup) using the distributed computing resources provided by UB CCR. In this way, the HPC resources at UB CCR allow Dr. Furlani's group to quickly evaluate the behavior of an induction loop system under various configurations.



Simulation of inductive coil coupling to a moving automobile: (a) effect of steel belts in a moving tire on coil inductance, (b) 2D magnetic field with a steel belted-tire moving above a coil. (c) illustration of vehicle axle motion, (d) 3D computational domain and mesh for simulating vehicle axle detection.

Data generated by the COMSOL-based inductive loop detector simulations is analyzed using UB CCR's remote visualization resources – a combination of high-end graphics hardware and client tunneling software that allows for state-of-the-art visualization applications to run in a hardware accelerated mode. This results in an extremely responsive application that is free from jitter, latency, and buffering. In fact, application performance is often better than a conventional local installation.

Dr. Furlani's research group prepares a simulation. The UB CCR compute cluster is in the background.

"The modeling provided unprecedented detail of inductive loop behavior for automobile detection." -- Peter Paul, Principal Scientist for the Xerox Vehicle Passenger Detection System, Xerox Research Center, Webster, NY

ABOUT HPC^{NY}

Funded by ESD Division of Science, Technology & Innovation, HPC^{NY} is a partnership between NYSERNet, a private not-for-profit corporation created to foster science and education in New York, and three supercomputing centers: the Rensselaer Polytechnic Institute Center for Computational Innovations, Stony Brook University/Brookhaven National Laboratory's New York Center for Computational Sciences, and the University at Buffalo's Center for Computational Research.

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HPC^{NY} provides businesses and research organizations with access to world-class advanced computing expertise through accelerating the engineering and development path of complex, ground-breaking designs to reliable, accurate, innovative product and process performance that can provide a distinct competitive advantage.

ABOUT CCR

The Center for Computational Research (CCR), part of the University at Buffalo (UB), is a leading academic supercomputing facility. CCR maintains a high-performance computing environment, high-end visualization laboratories, and support staff with expertise in computing, visualization, and networking.

The mission of CCR is to (1) enable research and scholarship at UB by providing faculty with access to high-performance computing and visualization resources, (2) provide education, outreach, and training in Western New York, and (3) foster economic development and job creation in Western New York by providing local industry with access to advanced computing resources, including hardware, software and consulting services.

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