Monitoring Structural Health with Sensor Data Fusion

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SYSTEMS

Aging infrastructure is a major problem around the world and monitoring the health of structures, from bridges to dams to buildings, is critical to our modern society. Andrew Smyth, professor in the Department of Civil Engineering and Engineering Mechanics, specializes in structural health monitoring, using the dynamic signature of a structure to determine its condition. This can include assessing a structure's day-to-day performance, locating and quantifying potential areas of damage, or calibrating a model that can be stressed in a computer simulation for a heretofore-unseen loading event.

One of Professor Smyth's recent projects has focused on monitoring vibrations on New York City's Manhattan Bridge. To assess the bridge's performance subsequent to a major retrofitting and strengthening program, and to calibrate a mathematical model of the bridge to predict its performance in the event of a potential seismic event, Smyth and his team placed a variety of different sensors that detected dynamic motions on the bridge over a two-month period. With the recorded data and their newly developed data fusion algorithms—a new technique that combines data from multiple sources— the team was able to identify the dynamic characteristics of Manhattan Bridge.

Smyth has also pioneered the use of differential GPS technology in conjunction with the data fusion technique to obtain highly accurate measures of low-frequency bridge deformations. He continues to develop data fusion algorithms for other civil and mechanical systems that combine information from a network of different kinds of sensors used to measure the dynamic response of a system. He says that, by taking advantage of the various levels of data redundancy, one can get high-fidelity virtual-sensing information that plays to the respective strengths of different types of sensors.

"Basically our work allows us to better understand the condition and performance of the built environment," says Professor Smyth. "This really is our society's most valuable physical asset and the backbone of our way of life. Structural health monitoring allows us to better allocate our resources to maintain and improve our infrastructure, and keep us safe."

In 2008, Smyth was awarded the prestigious Walter L. Huber Civil Engineering Research Prize of the American Society of Civil Engineers. The award recognizes notable achievements by younger faculty members in research related to civil engineering. Professor Smyth was recognized "for fundamental contributions in the highly efficient identification and modeling of nonlinear deteriorating structural dynamics." The selection committee commented that his research is characterized by "thoroughness, novelty, relevance, and intelligent breakthroughs."

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