Wireless Battery-Free Sensing Technology and a Data-Driven Approach for Smart Autonomous Monitoring System

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Abstract

Wireless sensing technology for structural responses and post-processing methods to analyze and predict structural behaviors are essential elements in the smart structural system. In this presentation, two innovative methods are proposed: 1) battery-free sensing technology to achieve wireless strain measurement and 2) data-driven methodology using a machine learning (ML) algorithm.

Recently developed wireless sensors in Structural Health Monitoring (SHM) system have reduced instrumentation time and system cost. However, current wireless sensing devices usually have limited operating time and lifespan in that the devices rely on an external power source, such as batteries. To address this issue, wireless battery-free sensing technology is proposed in this presentation. Since the battery-free sensor transfers mechanical responses on structural surfaces to an electromagnetic signal, a mechanics-electromagnetics coupled simulation approach is investigated to evaluate and improve sensing performance. Extensive experiments are then conducted to validate the performance of the proposed battery-free sensor.

A data-driven method estimates and predicts structural behavior by using strain-gage sensors for collecting physical data and an ML algorithm for analyzing data pattern of strain. Capitalizing on recent technological advances, this study proposes a framework for an autonomous monitoring system that can be used in both the field and the office. As a validation of the data-driven method, a scaffold is constructed and four strain gages are installed to each column. The strain patterns from each scaffolding column are key indices for estimating the structural condition of a scaffold. Then, an FEM model is built to accurately describe the structural behavior of the scaffold by a model updating technique that investigates data from the FEM simulation to precisely reflect on real structural responses under given loading cases. Finally, the ML algorithm is implemented to the proposed framework that enables to distinguish categorized scaffolds' structural conditions (i.e., safe, over-loading, over-turning, and uneven-settled conditions).

Date: **Thursday, March 22nd, 2018. 12:30 to 1:30PM**

Location: **University of Hawaii at Manoa, Holmes Hall Room 244**
Parking Available at the UH Lower Campus Structure ($5.00 for the day).

Speaker Bio

Dr. Chunhee Cho is Post-Doctoral Scholar in the Department of Civil and Environmental Engineering and Construction at the University of Nevada, Las Vegas. His research interests include passive (battery-free) wireless sensing technology and data-driven methods to estimate and predict structural behavior. He received the B.S. degree in the Department of Architectural Engineering at Konkuk University Korea in 2003, the M.S. degree in structure engineering from the Seoul National University Korea in 2009, the M.S. degree in electrical and computer engineering, and the Ph.D. degree in Civil and Environmental Engineering from the Georgia Institute of Technology, GA in 2016. In addition, he had worked at the Republic of Korea Marine Corps as an engineering officer (First Lieutenant) from 2003 to 2006. He was with Hyundai Architects & Engineering Associates as a Structure Engineer from 2009 to 2010. Dr. Cho is an expert in Structural Health Monitoring research area where he has published more than 30 peer-reviewed journal papers and conference proceedings and has a few patents related to his research. Last year, he received the best paper award from ASCE computing in civil engineering conference for his outstanding contribution to the engineering research.