EDITORIAL – SENSORS IN CONSTRUCTION AND INFRASTRUCTURE MANAGEMENT

PUBLISHED: April 2008

GUEST EDITORS: Burcu Akinci and Chimay Anumba

Dr. Burcu Akinci, Associate Professor
Civil and Environmental Eng. Department
Carnegie Mellon University
Pittsburgh, PA 15213
email: bakinci@cmu.edu

Dr. Chimay Anumba, Professor and Head
Department of Architectural Engineering
The Pennsylvania State University
University Park, PA 16802
email: anumba@engr.psu.edu

EDITORIAL

Construction project managers and infrastructure managers can benefit from utilizing a variety of sensors and wireless communication technologies on construction sites. Sensors are becoming an important item in construction project managers' and infrastructure managers' toolboxes. These sensors target getting relevant information about products that are being constructed, processes and equipment that are being utilized in constructing these products, and monitoring the as-is condition of an infrastructure throughout its service life. The nature of sensing can vary from embedded sensing that assesses some material characteristics of a product, to spatial sensing and imaging technologies that assess both the quality of products being constructed and the safety of processes being utilized during construction. Through the utilization of a wide array of sensors, both infrastructure components and processes of managing the construction and operations of those components can become intelligent, and as a result, project and infrastructure managers can have better situation awareness and can make more informed decisions.

A variety of sensors is already being utilized on job sites and on infrastructure systems and it is expected that this trend is going to continue. Job sites and infrastructure systems are going to become more intelligent as sensing and wireless communication technologies get to be deployed ubiquitously. This special issue provides an opportunity to exchange ideas and research results to date in the area of sensing in construction and infrastructure management. It has brought together perspectives and research results obtained from usage of different types of sensors to streamline a variety of different decisions throughout the life-cycles of facilities and infrastructure.

A group of research projects, published in this special issue, target utilization of different sensing technologies to streamline construction processes. Bosche and Haas discuss an approach for automated retrieval of three-dimensional CAD objects from point clouds collected via 3D imaging technologies. Their approach specifically focuses on supporting Quality Assurance/Quality Control (QA/QC) processes on construction sites. The results obtained in this research are promising in being able to automatically detect different structural elements and perform some QA/QC analyses using 3D imaging technologies.

Again, within the construction quality control area, Zhu and Brilakis discuss an automated approach that leverages imaging techniques for detecting and quantifying air pockets in architectural concrete. This study specifically targets two kinds of detection failures: (1) failure to detect small air pockets, and (2) failure to represent big air pockets. The developed approach involves a hierarchical way, referred to as image pyramid, to search for air pockets of different sizes in a given image. The results show high precision rate in detecting air pockets without sacrificing recall.

Targeting safety problems on construction sites, Teizer describes 3D range imaging camera sensing as a way for active safety monitoring and mitigation of hazardous situations. Teizer overviews different optical range sensing technologies and specifically discusses the working principles of 3D range imaging technology. Background subtraction is one of the key issues that need to be addressed when identifying objects of interests and their movements using this technology. Teizer describes a set of algorithms that will help in identifying and tracking objects of interests in 3D range images.

Again, in the construction safety management area, Chi et al. focus on the development of a framework for crash avoidance during the operation of heavy equipment. This framework consists of four major components: (1) Data acquisition done through a high-frame-rate range sensor, (2) Real-time 3D spatial modeling to represent the 3D environment based on the data collected. (3) Object tracking to identify and track objects of interest, (4) 3D Path planning, to identify an optimized operation path for heavy equipment. Several experiments conducted in a lab setting demonstrated the viability of this approach in managing heavy equipment on job sites.

Finally, in the construction domain, Kiziltas et al describe technological assessment and process implications of several field data capture technologies. These field technologies include radio frequency identification (RFID), laser scanning, and embedded sensing technologies. The results from several case studies highlight some strengths and limitations of these technologies and corresponding data acquisition and processing practices for construction and facility management.

In the infrastructure management area, Dziadak et al. describe an approach for locating buried assets in a 3D space using Radio Frequency Identification (RFID) technology. This approach involves incorporation of a depth function to assess how deep a specific asset is. Free air lab tests highlight the importance of creating signal shells and the range information for RFID tags utilized. The initial results from the field tests demonstrate the possibility of detecting depth using RFID, but also highlight future work that needs to be done to have a fully-functional and robust approach.

Targeting the water industry, Moustafa et al focus on identifying and minimizing the negative impact of bad sensors. The impact of acting on data collected from bad sensors and as a result, closing a portion of a water treatment facility is costly. Reliabile sensor data is essential for effective decision-making. The results from two case studies show the need for augmenting the data collected from embedded sensors with the ones collected from remote sensors to increase the reliability of the sensor data.

In streamlining urban disaster response, Tsai et al. discuss a black-box system for buildings. The goal of having such a system is to provide reliable and accurate information about a building to emergency responders over a mobile adhoc network. Such information is critical for fast and effective response during emergencies. The main components and features of such a system are building information database, disaster-survivability, redundancy, communication and security. After providing an overall architecture of the black-box system, the authors specifically discuss the survivability tests done on the initial design. High temperature, static crush pressure, and free drop tests demonstrate that the initial design of the blackbox system can survive under these situations.