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Jerome Lynch is an Associate Professor of Civil and Environmental Engineering at the University of Michigan; he is also holds a courtesy faculty appointment with the Department of Electrical Engineering and Computer Science. Dr. Lynch completed his graduate studies at Stanford University where he received his PhD in Civil and Environmental Engineering in 2002, MS in Civil and Environmental Engineering in 1998, and MS in Electrical Engineering in 2003. Prior to attending Stanford, Dr. Lynch received his BE in Civil and Environmental Engineering from the Cooper Union in New York City. His current research interests are in the areas of wireless structural monitoring, feedback control systems, and damage detection algorithms. Specifically, Dr. Lynch's work aims towards addressing challenging problems associated with the health of aging infrastructure systems and the performance of infrastructure during and after natural hazard events. Some of Dr. Lynch's more current research has been focused on the design of nanoengineered materials for smart structure applications including carbon nanotube-based thin film wireless sensors for structural health monitoring. Dr. Lynch was recently awarded the 2005 Office of Naval Research Young Investigator Award, 2007 University of Michigan Henry Russel Award, 2008 College of Engineering (University of Michigan) 1938E Award, 2009 NSF CAREER Award and the 2010 Rackham Distinguished Faculty Award. He was also featured by Popular Science magazine in their 2009 "Brilliant 10" annual issue.

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Opportunities for Sensing and Actuation Technologies for the Mitigation of Mega-Disasters

Recent natural disasters including the Indian Ocean Tsunami (2004), Hurricane Katrina (2005), Sichuan Earthquake (2008) and Typhoon Morakot (2009) have all elevated the public's awareness in the vulnerability of large urban areas (*i.e.*, megacities) to natural hazards. The degree of physical destruction, the spatial impact of the events, and the lingering social and economic issues that result has led many to term theses events as "mega-disasters". Three factors make the occurrence of mega-disasters more likely in the future: 1) population growth in already dense urban centers; 2) poor construction quality of infrastructure systems in developing nations; and 3) deterioration of aging infrastructure in developed nations. Clearly, multidisciplinary solutions are direly needed to mitigate the effects of mega-disasters.

The safety of the civil infrastructure systems that society depends upon for its prosperity can be dramatically enhanced through the ubiquitous adoption of sensing and actuation technologies. The recent technological advancements in the information technology domain have resulted in many new sensing modalities that can be used to address the risk posed by natural hazards. The same wireless networks that provide users the convenience of untethered access to the internet can also be used to cost-effectively collect data from sensors installed throughout the natural and built environments. In particular, networks of wireless sensors can be used to monitor the environment (e.g., weather conditions, environmental loadings imposed on structures) as well as the physical behavior of infrastructure systems. The placement of dense networks of sensors will result in large sets of data that can lead to data-driven decision making. Data derived from dense wireless sensor networks installed throughout urban environments can also lead to improvements in understanding the loads imposed on infrastructure, assessment of their vulnerabilities to natural hazard scenarios, and real-time assessment of their conditions after a natural hazard event.

Another advancement of the information technology era is the cell phone; cell phones offer the convenience of anytime, anywhere access to telephony service. The recent generation of “smart” cell phones also illustrates the utility of sophisticated software applications that store personal information (*e.g.,* contacts, calendar) on the phone, utilize sensors embedded in the phone (*e.g.,* GPS positioning on maps) and offer internet-enabled tools such as email and texting. With 4 billion cell phones in use globally, they are capable of being used as a powerful regional data-collection network. Currently, these data-collection networks are only starting to be recognized as a tool for sensing society. Non-profit InSTEDD (Innovative Support to Emergencies, Diseases and Disasters) and for-profit Sense Networks both are exploring means of collecting (passively and actively) data and information from cell phone users to assist emergency response efforts to pandemics and natural calamities such as earthquakes. For example, cell phones can serve as a basis for determining the number, location and state of structural inhabitants following a natural hazard event. Other mobile phone sensor modalities including sound, picture and video open additional data types that could contribute to first responder’s post-event decision making. While comparatively little research has been conducted on the use of cell phones, their ubiquitous availability renders them a potentially powerful, yet untapped data source.

The aforementioned advances in sensing and telemetry technology now make it possible to install dense sensor networks (potentially millions of sensors) throughout an urban region. However, an important question to ask is, “what does one do with all of the data that can be created by these ubiquitous sensing environments?” Unfortunately, the tools necessary for data interrogation have not kept pace with the rapid development of the sensing and telemetry technologies that make the data possible. With current data management approaches proving difficult to scale to such large data sets, new research aimed at using data mining, machine learning, and pattern classification methods for identifying subtle changes in data are direly needed. Scalable cyberinfrastructure solutions will need to be created that can manage large flows of data, store data, and to autonomously convert data into information of value to decision makers that are involved in natural hazard event planning and response.