Title
Developments on the CENS Structural Health Monitoring Front

Authors
Skolnik, Derek
Lukac, Martin
Naik, Vinayak S
et al.

Publication Date
2007-10-10

Developments on the CENS Structural Health Monitoring Front

D. Skolnik, M. Lukac, V. Naik, W. Kaiser, J. Wallace, and D. Estrin
M. Kohler, I. Stubailo, R. Govindan, and P. Davis

Introduction: Structural Health Monitoring (SHM) Systems

SHM: Process of assessing state of health of instrumented structures from their measurements

Objectives: To improve safety and reliability of infrastructure by *damage detection* and *rapid post-event assessment*

Requirements: Robust DAQ with rapid data processing, suite of sensors, damage detection algorithms


I-35W Bridge Collapse 8/1/2007

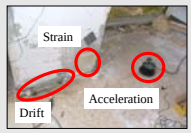
Background: Build on Past CENS Experience

Factor Building

- 72 channel embedded *accelerometer* network
- USGS installed after 1994 Northridge
- CENS upgrades in 2003, 2005

Four Seasons

- nees@UCLA pilot project 2004
- forced vibration testing
- floor accelerations, *interstory displacement*, strain



MASE Deployment

- 100-node array spanning over 500Km
- 50-node multi-hop wireless network
- Collecting data for 2 years
- Challenges include variable *network link quality* and *limited power* while maintaining continuous data transport and operation

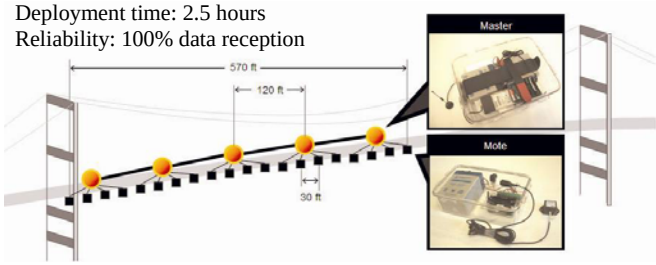
SHM Systems: Development and Implementation

ShakeNet: Portable vibration sensor network for *system identification* and for locating potential damage due to earthquake motions.

- **Multi-tier wireless sensing system**
- **Rapid deployment enables aftershock monitoring**
- **System identification & damage detection**

Vincent Thomas Bridge array deployed for 24 hours

- Mote sensors and stargate backbone
- CENS Tenet multi-tier software
- Deployment time: 2.5 hours
- Reliability: 100% data reception

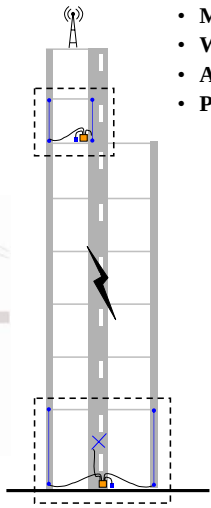


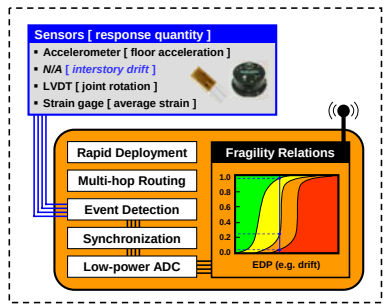
Weld fracture detection

- High frequency
- Preliminary experiment March 8, 2007

SHM of Los Angeles Tall Buildings: A novel SHM system using *tall buildings* in Los Angeles as a testbed.

- **Model-driven deployments**
- **Wireless data acquisition toolbox**
- **A suite of sensors; including a new drift sensor**
- **Probabilistic post-event assessment algorithms**






Accelerometer installed at moment-frame (UCSD)


CENS CDCC box collected vibration data


Cyclical loading

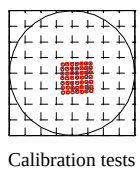

Fracture event

Power

- Building gird not always available (blackouts)
- LEAP2 architecture enables low-power DAQ

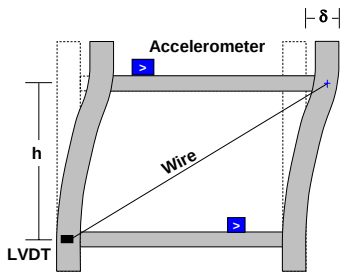
Time Synchronization

- GPS does not work inside buildings
- RBS provides time sync over 802.11


Calibration tests

Measuring interstory drift ($\Delta = \delta / h$)

- Double integration of acceleration
- LVDT w/ spring tensioned wire
- *Laser/Photodiode/Plano convex lens*



Wireless Network

- Minimize interference/reliance with building infrastructure
- Robust to poor link quality and frequent unpredictable disconnections