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Title

SEI1: Sensor Networks for Real Time Monitoring State of Health of Buildings

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Authors

Monica Kohler
Paul Davis
Igor Stubailo
et al.

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Sensor Networks for Real Time Monitoring of the State of Health of Buildings
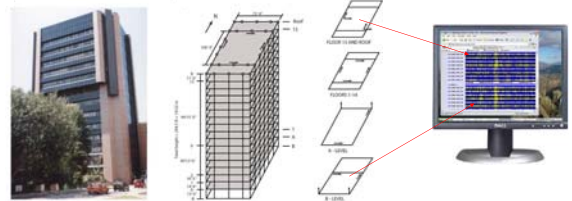
Monica Kohler, Paul Davis, Igor Stubailo, John Wallace, Derek Skolnik   (UCLA)
Ramesh Govindan (USC), Case Bradford (Caltech)
Seismology Group – http://www.cens.ucla.edu/Project-Descriptions/Seismology/index.html

Introduction: Network architecture development for structural monitoring and model verification

Key questions that CENS technology is enabling us to answer using the Factor building seismic network.

- How can we **architect wireless sensor networks** for in-situ structural damage detection and localization?
- How can we **identify useful seismic signal** in high-noise portions of structural data?
- How can we use dense structural data to **verify predictive models** of building motions due to earthquakes?
- How can we automate the **identification of significant events in large volumes of high-sample-rate data** recorded and experienced by structure?

17-story moment steel frame UCLA Factor building, locations of accelerometer sensors within building, and real-time monitoring system.

Wireless monitoring of structures

Experimental Platforms

Seismic test structure (left) and scaled building model (right).
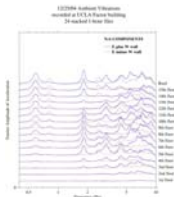
Algorithm development to do real-time processing of large volumes of data

- We have developed and prototyped a system called NetSHM on which structural engineers can develop **in-situ damage detection and localization algorithms**.
- We are also currently implementing an **event collection system** called Wisden on NetSHM.
- Our main challenges are coming up with a programmable software platform for these applications, dealing with highly complex computations, and the high sampling rates that the applications require.
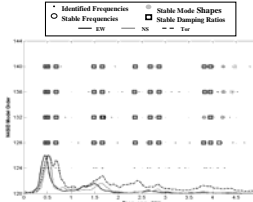
Monitoring and numerical modeling of Factor building motions

Methods for signal identification in complex, and/or higher-noise portions of data

- **Stacking and median filtering are used** to distinguish high-frequency translational (solid lines in figure) from torsional modes (dashed lines).
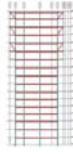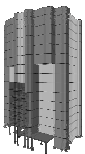

- A numerical algorithm is employed to identify the structural frequencies, damping ratios, and mode shapes. Stability plots distinguish the structural modes from superfluous modes.
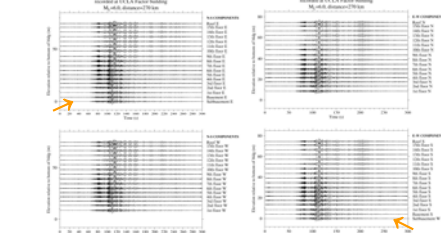

- A borehole seismo-meter was installed nearby to distin-guish bedrock motions from building motions and to remove soil amplification effects.
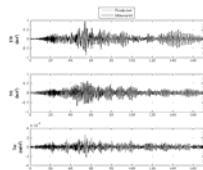

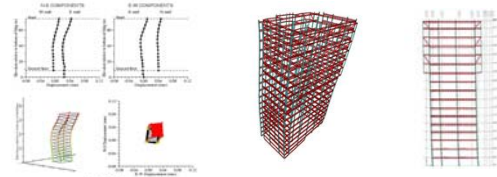### Dynamic analysis and model verification

1. Our **finite-element structural modeling** uses physical object based structural design (e.g., columns, moment-frame beams, slabs, walls, beam-column intersections).

3. The natural frequencies and mode shapes identified from data are used to **verify and update the 3-D finite-element model** to achieve better agreement between the computed and identified modal properties.

2. **Dynamic linear analysis** is performed with multiple base and ground acceleration excitation from real-earthquake data recorded at Factor.

4. **Animations of observations** (circles in figure) from earthquake data **and simulations** (right) are further used to verify the model and to obtain time- and spatially-dependent dynamic properties. The updated model serves as a baseline linear elastic model of the building.