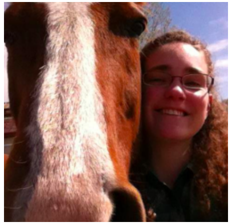


PESES

post earthquake structural evaluation system

Final Presentation

The Problem

Safety risk to building inspectors & first responders

Cost of inspections

Cost of building downtime

Resources spread thin: thousands of buildings could be damaged with few engineers to inspect

Current System

Engineers check building by building to determine which structures are safe to enter.

Buildings are tagged as red, yellow, or green.

The USGS has attempted to develop a sensor network for large structures, but this has not been implemented on a large scale.

So what will PESES do?

Use networked accelerometers to monitor building deformations during an earthquake.

Enable engineers and first responders to know the risk of each inspection, and avoid unsafe structures.

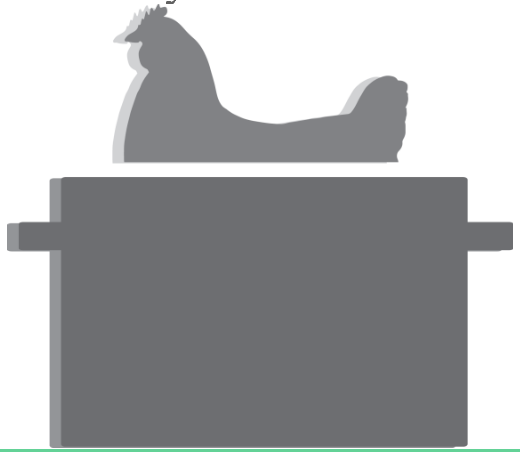
Give communities the information to recover more quickly after earthquakes.

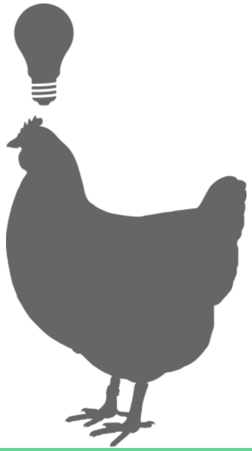
Our Vision

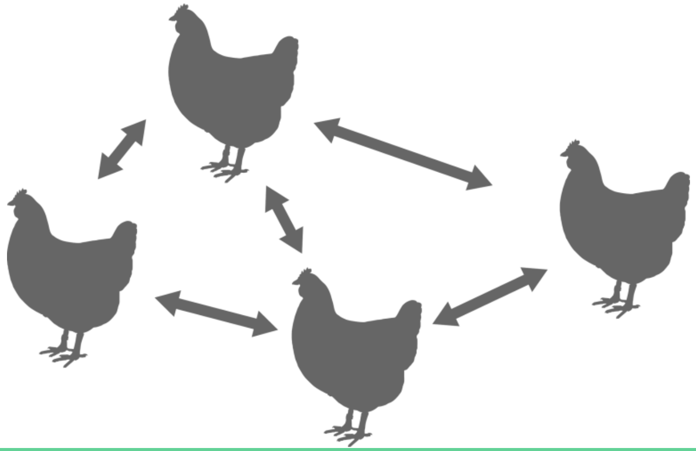
“A Chicken in Every Pot” → easily installed and affordable

“Your Chicken is Smart” → maintains its own memory and activates autonomously

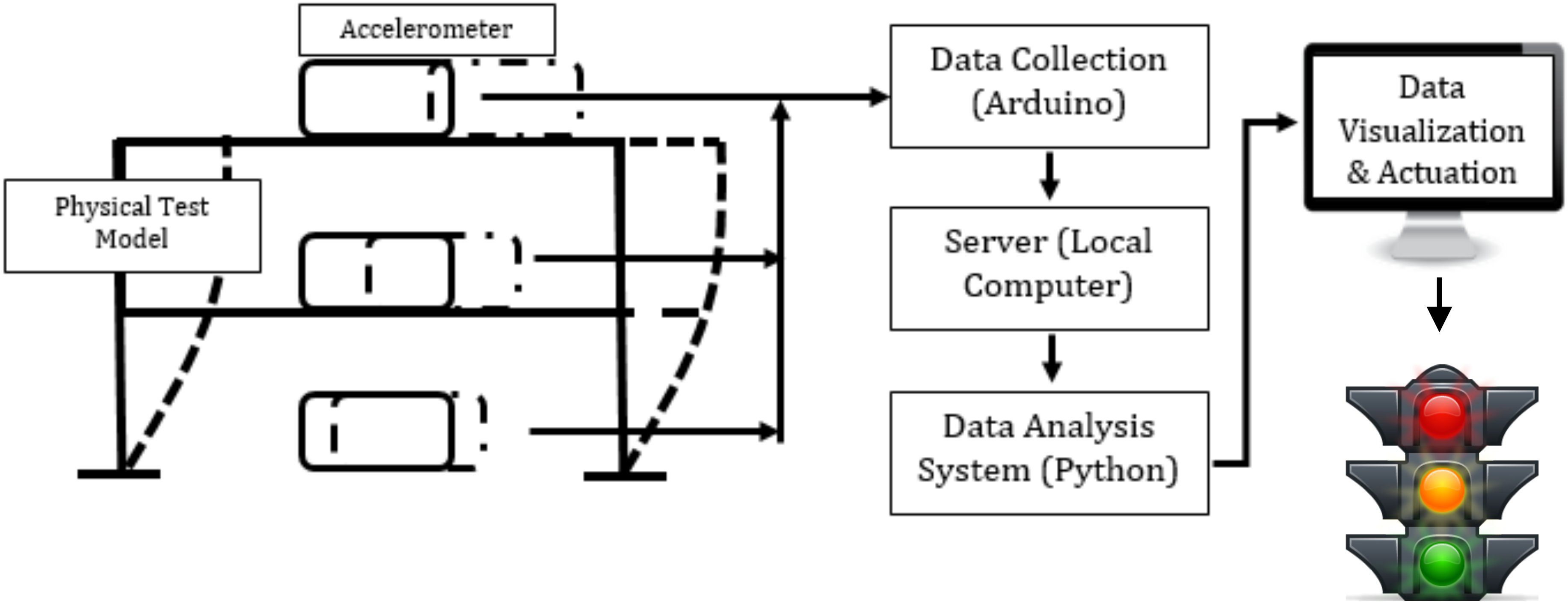
“Your Chicken Can Network” → the potential to establish a web of sensors across a community







How It Works

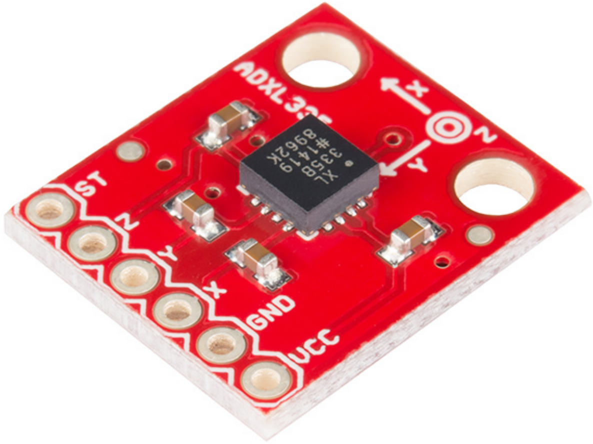

Accelerometer
Physical Test Model
Data Collection (Arduino)
Server (Local Computer)
Data Analysis System (Python)
Data Visualization & Actuation

Hardware

Sparkfun Triple Axis Accelerometer

- size of a quarter
- $ 16
- Accurate to within .01 g

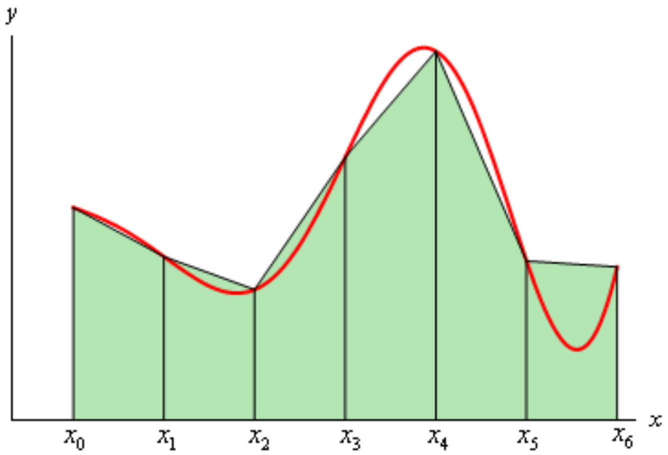
Small, cheap, and accurate

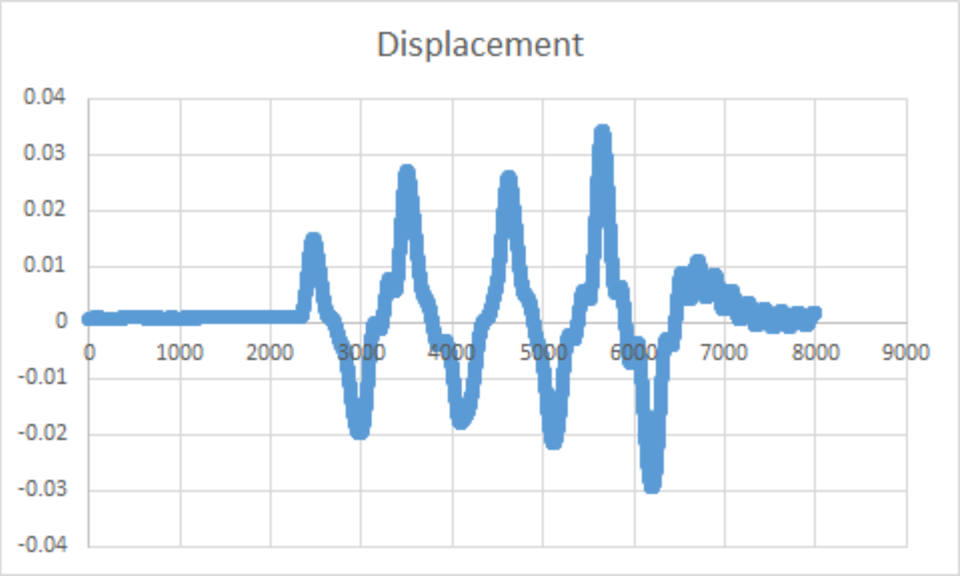


Finding Displacements

Double integral of the acceleration readings using trapezoidal method

$$x = \iint a\,dt$$

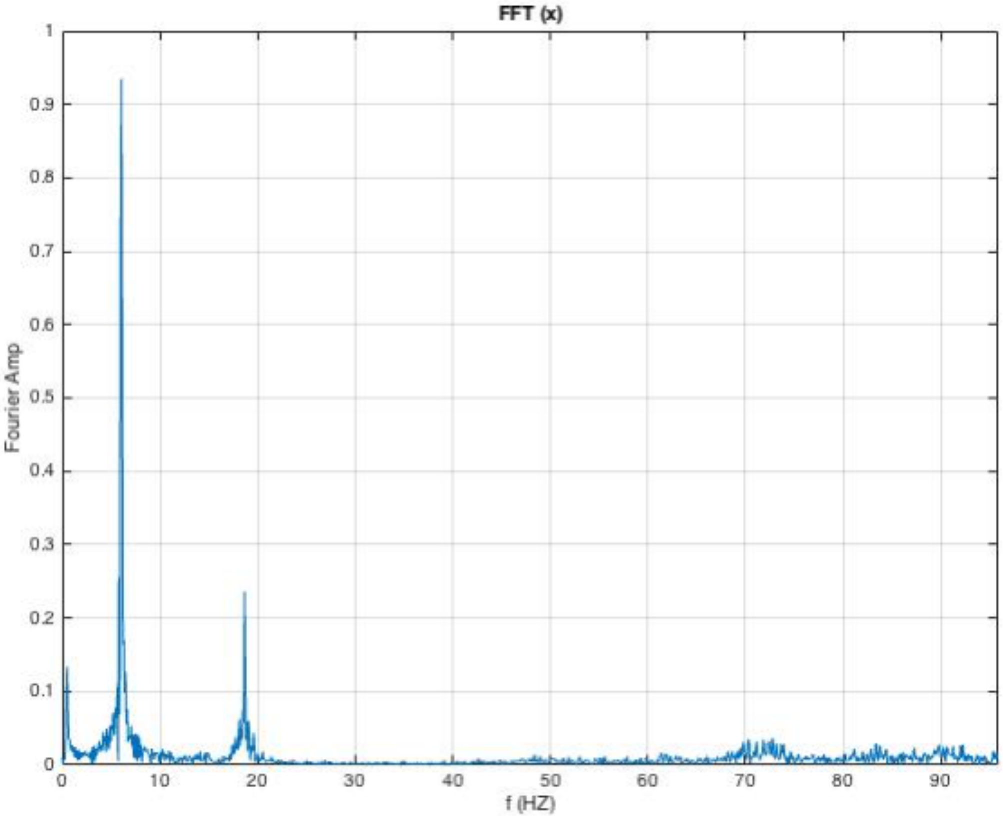




Filtering the Data

Bandpass Butterworth Filter

Isolate structural response and eliminate low and high frequency noise



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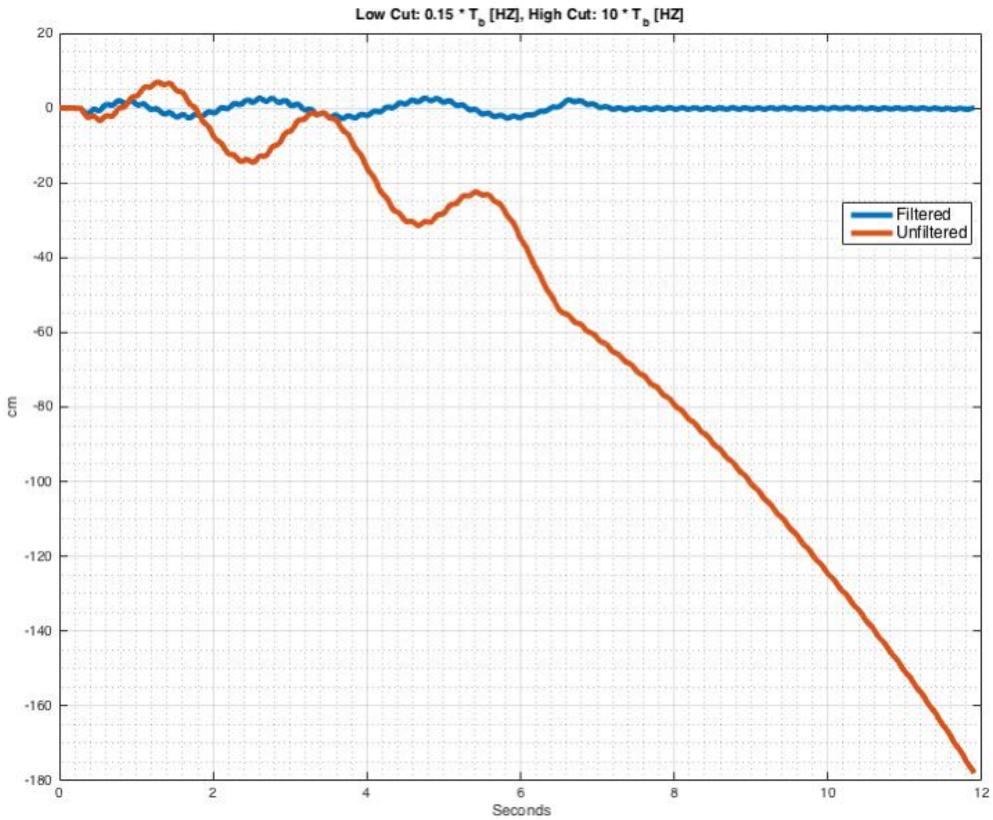

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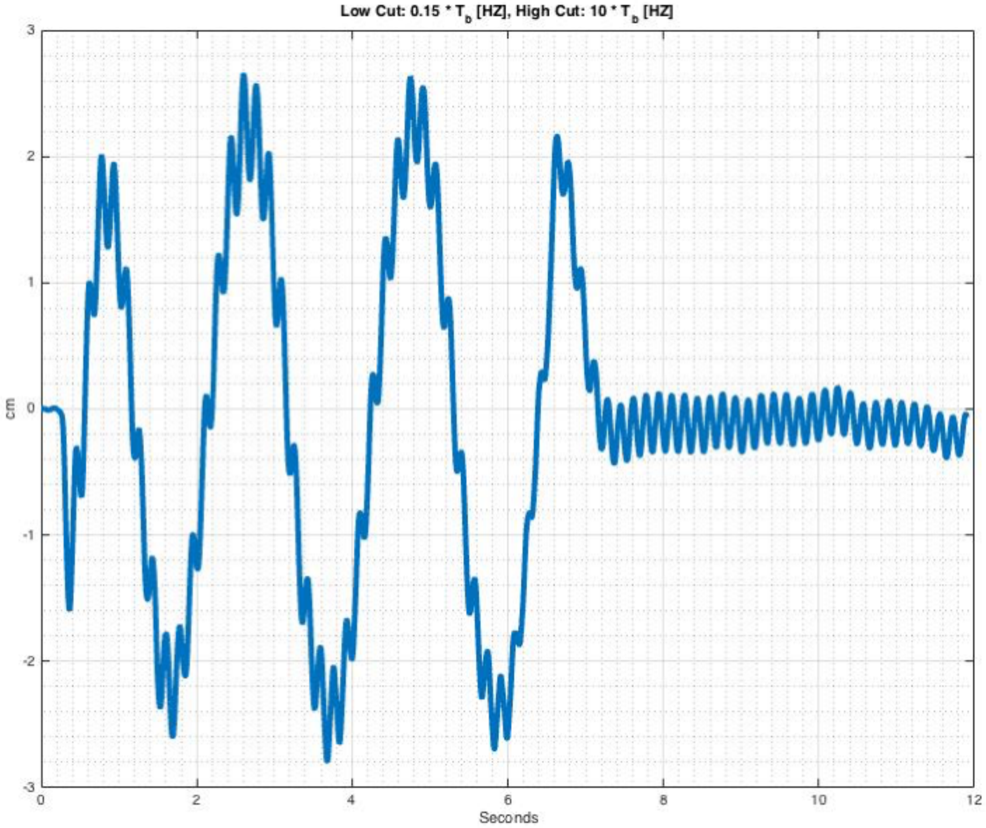
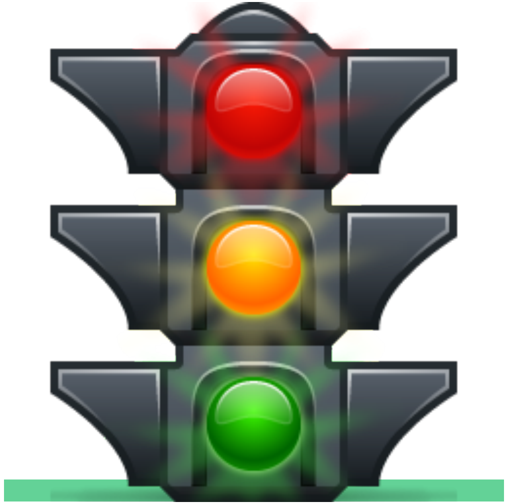


Actuation

After an earthquake, the building has a green, yellow, or red light showing its safety level. These will be displayed in standard locations, such as exits, stairwells, and other access points.



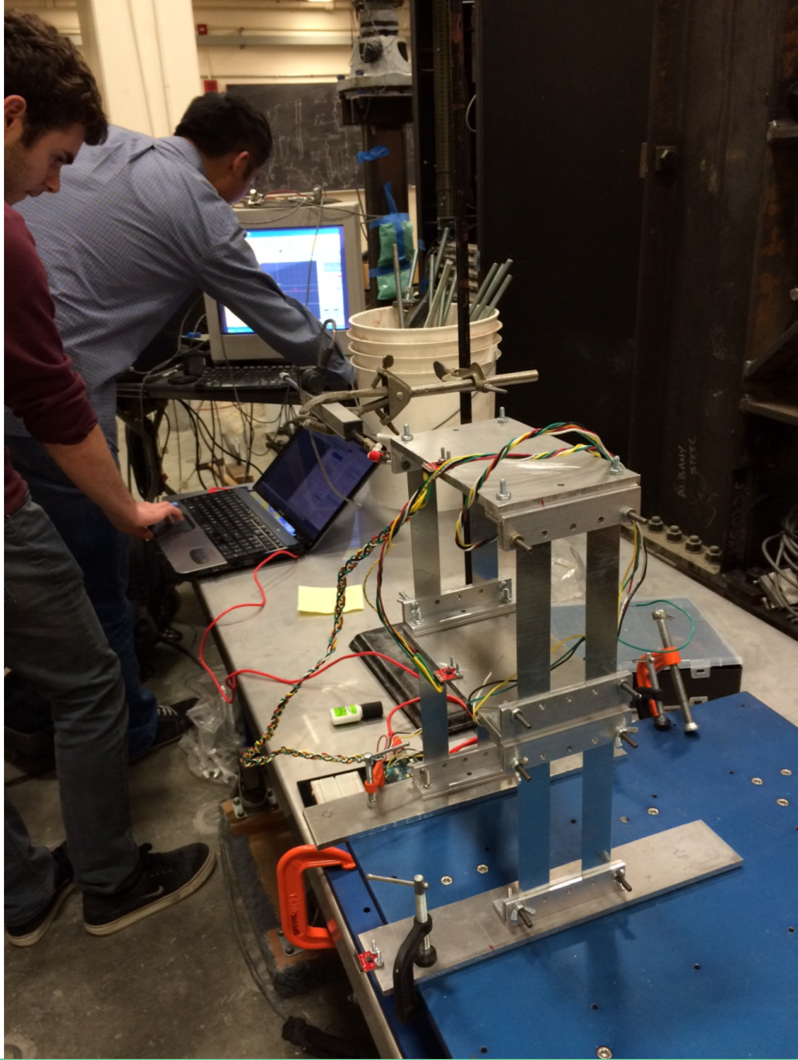
Testing

Test structure meant to simulate a simple structure, with two degrees of freedom

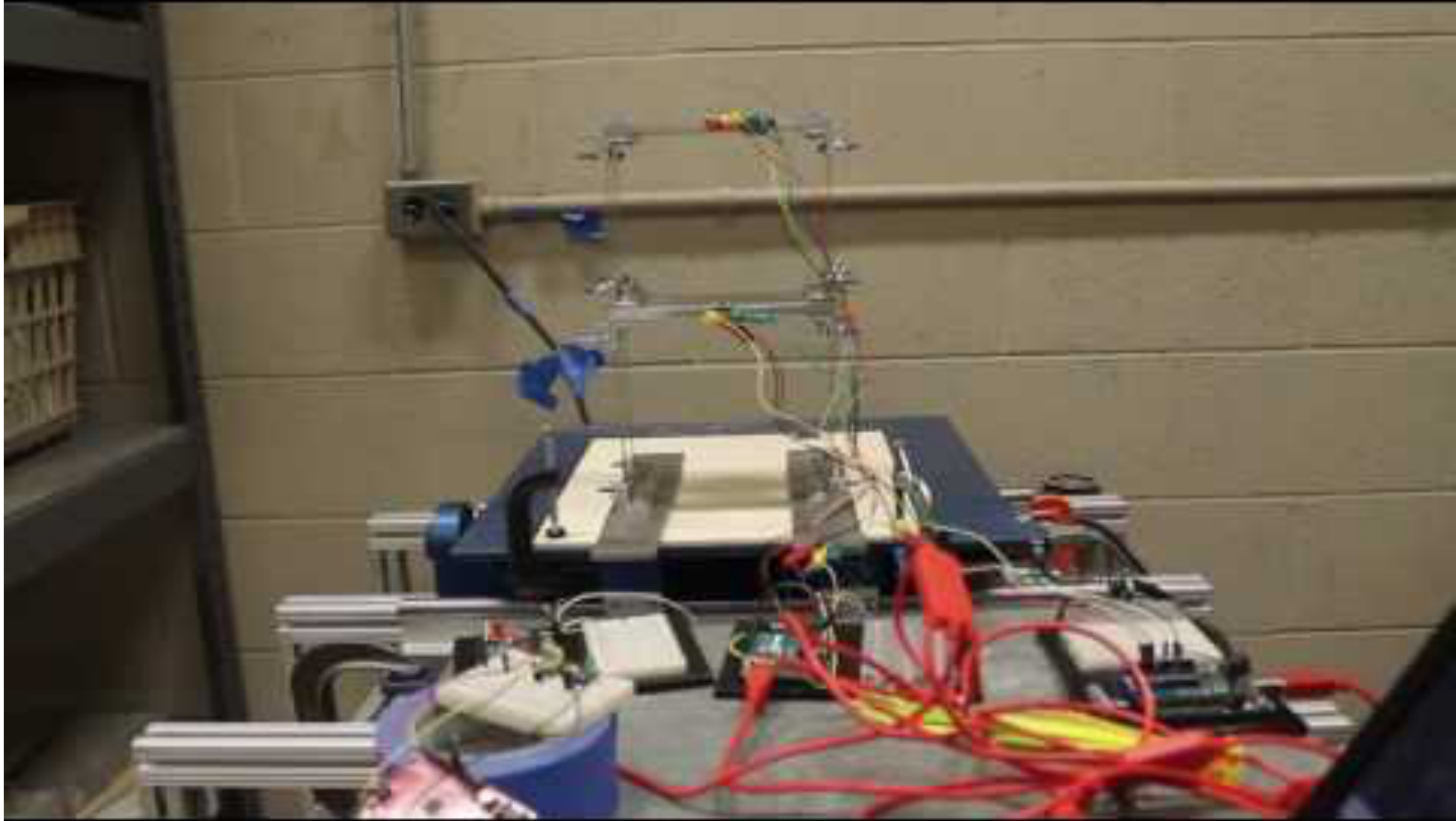
Connections and foundations are all fixed.

- 2 stories
- 1 ft tall

Shake table used to simulate earthquake



Demo



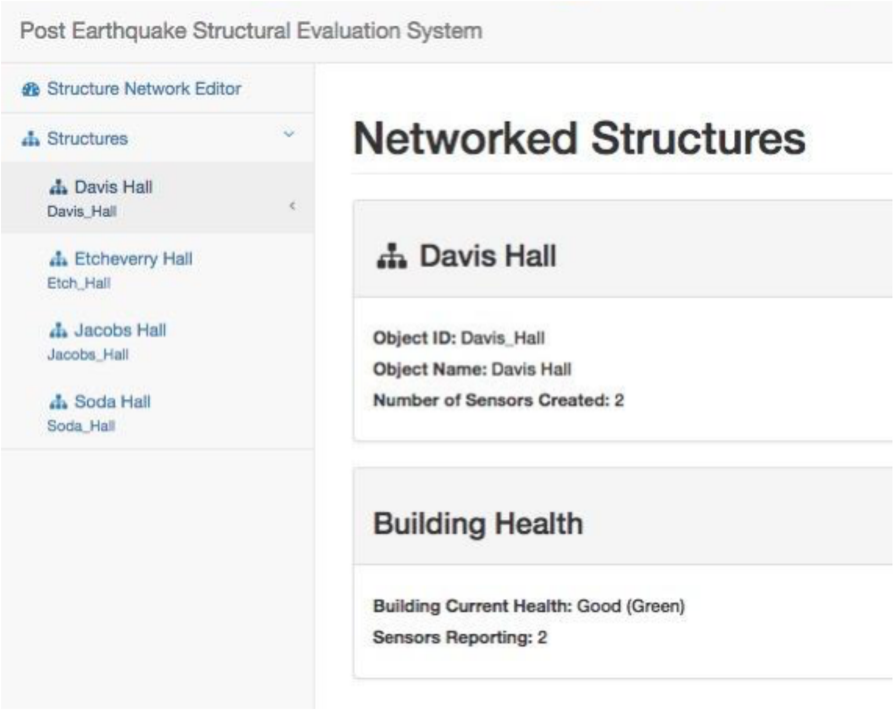
Web Visualization

Three levels of detail for data visualization:

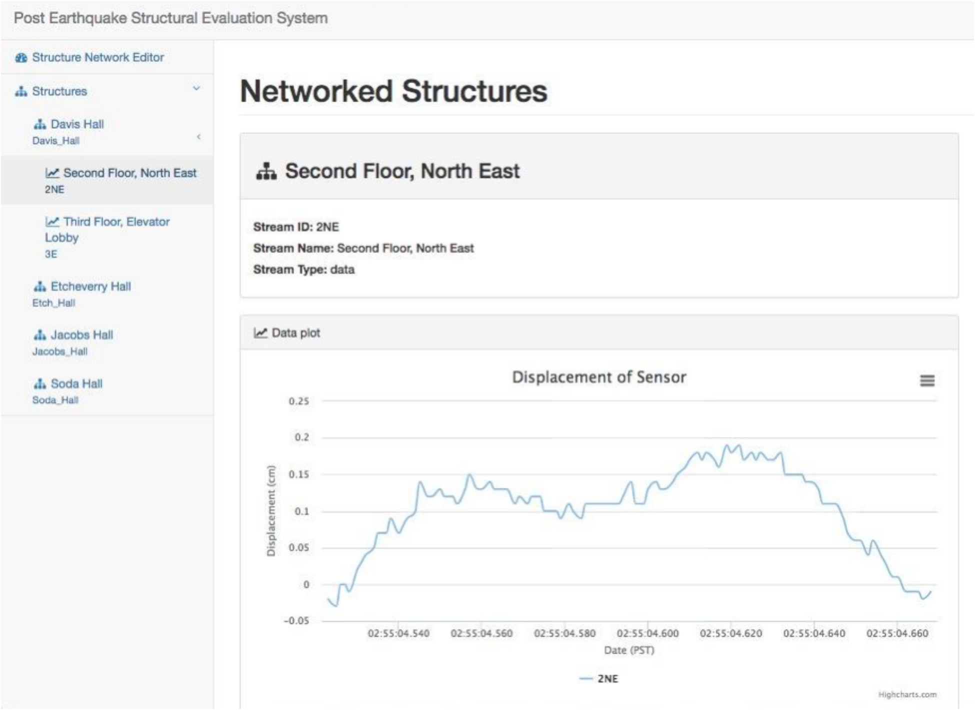
- Network level detail
  - Displays number of buildings networked, and if any of them are flagged as red.
- Structure level detail
  - Displays structure health and status of sensors.
  - Also will display relevant plots, such as floor drift, one of the variables that can be used to evaluate structural safety.
- Sensor Level detail
  - Displays sensor position data, this will allow for users to identify the locations in the structure that might

Web Visualization examples

Structure



Sensor



Web Visualization limitations

Due to the fact that heroku can only handle 10,000 data points, our prototype is only able to display short shake events.

In order to accurately integrate to position, the sensors must be reading at 1000 Hz, which reach 10,000 data points after 10 seconds. When split among 3 sensors, we aren't able to display date continuously.

We do implement a memory management program to limit the amount of data we push to the server, so only important information is sent to heroku. Non-shaking data is ignored and overwritten before ever being sent to the server.

PESES Impact Potential

Save tens of thousands of man-hours formerly used for Rapid Visual Screening after an earthquake.

Greece 1999: 180,000 buildings damaged, 15-30 minutes/inspection → ~70,000+ man-hours

Christchurch, NZ 2011: 170,000 buildings damaged/destroyed → ~64,000+ man-hours

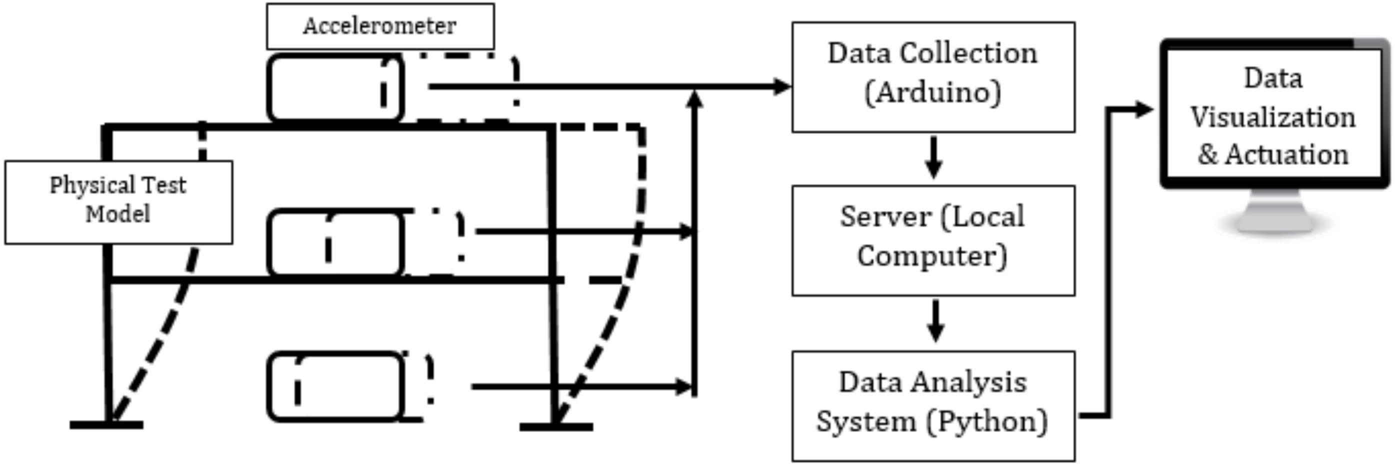
Enhance first-responder and inspector safety.

Reduce building down time.

Efficiently allocate disaster recovery resources

https://www.unicef.org/education/files/VisualEvaluationFEMA_154.pdf
http://link.springer.com/article/10.1007/s40091-016-0118-9
http://www.bbc.com/news/world-asia-35612298

PESES
post earthquake structural evaluation system



Questions?