Improving Energy Efficiency Through Exploratory Sub-Metering of Cory Hall

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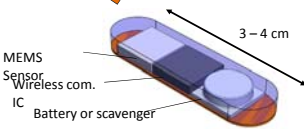
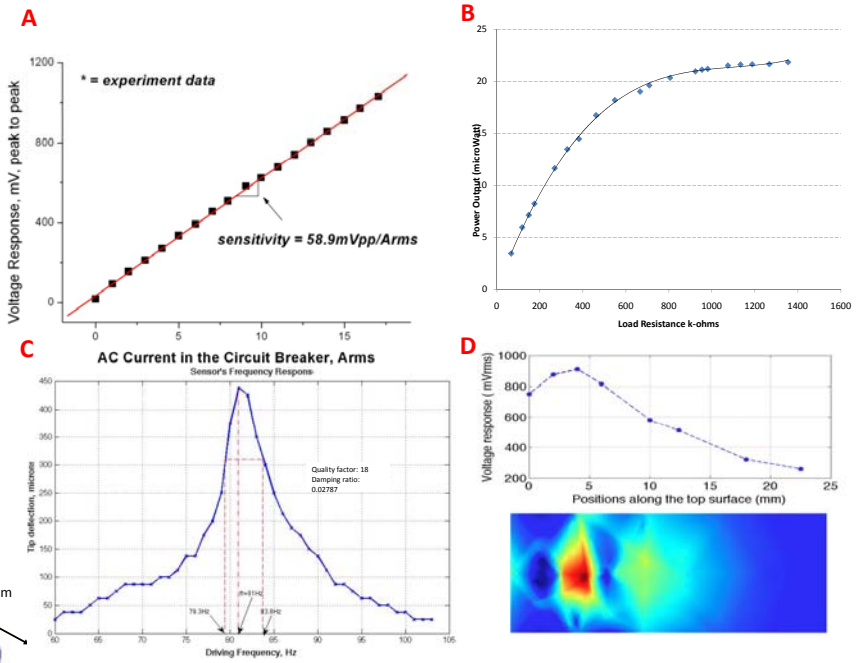
Vision

- Use Cory Hall as a test bed for wirelessly enabled passive proximity Berkeley MEMS sensors for AC current, voltage and power
- With additional commercially available equipment, such as TI motes, permit automated monitoring of the heavy electrical loads to aid in improving efficiency of electric energy usage in Cory Hall

(above) Meso-scale magnetic/piezoelectric current sensors (as suggested by orange reflective tapes) can be simply attached to fronts of *in situ* commercial breakers



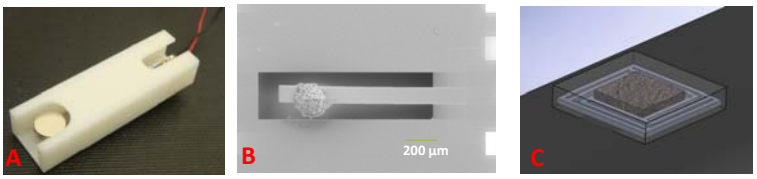
Characterization:



(above) A : Linear response at 60 Hz (f_r=81Hz); B: Energy scavenging performance (meso-scale device) 20μW; C: Sensor's frequency response; D: Measurement and FEM modeling (COMSOL) reveal location where magnetic field due to breaker current is maximum

Research Questions

- Can Berkeley MEMS electrical sensors be used in retrofitting an existing building such as Cory Hall (built in 1953) as well as being used in residences and commercial buildings? With additional commercially available equipment, can we utilize the automated monitoring of the heavy electrical loads to aid in improving efficiency of electric energy usage in Cory Hall?
- Can energy scavenging by using miniature coupling devices placed near energized conductors supply sufficient energy to power microprocessors and radio chips for processing and transfer of electrical variable data to control equipment?
  - Note: The Cory Microlab uses computerized tools to monitor pressures, temperatures, liquid levels and valve settings, but no electric power quality monitoring is done there.
- To what extent can MEMS current sensors permit using existing circuit breakers as centralized monitoring locations for widely distributed circuits?



(above) A : Meso-scale piezoelectric/magnetic current sensor (length = 2 inches). B: MEMS-scale version of current sensor. C: Proposed MEMS-scale energy scavenger (see also Poster 96)

Future Work

- Test the devices above (A – meso-scale piezoelectric/magnetic current sensor; B – MEMS-scale current sensor; C – proposed MEMS-scale energy scavenger) to determine sensitivity, linearity, and transient response.
- Construct and test the sealed energy-scavenging module shown opposite to determine its suitability for powering wireless units from ambient AC magnetic and/or electric fields.
  - Note: experiments with earlier designs have shown ability to scavenge 11 *milliwatts* from proximity to wire carrying 50 A (see poster 96)
- Fabricate and characterize "hardened" sensors in retrofit locations such as Cory Hall's basement power entry point and in circuit breaker boxes (where can monitor widely distributed circuits), and compare monitoring success and projected cost with those obtained with standard commercial sensing systems.
- Study sensor designs for capturing and reporting features such as power-line transients and load signatures.

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