



University of Michigan Provost's Teaching Innovation Prize

2013 WINNER



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Feeling Is Believing: Haptic Feedback Links Math and Intuition

Innovation Description

Students may be capable of manipulating mathematical models of physical systems in the abstract, yet lack intuitive understanding of how changes in system variables will manifest physically. The Cigar Box is a tool that makes the same behavior that is being described mathematically accessible to students' haptic senses of touch and motion. It turns code into virtual environments that can be touched and manipulated, much like the real world objects to which they refer. Best of all, model parameters can be changed on the fly as students interactively explore dynamic systems.

Pedagogically speaking, this teaching innovation addresses challenges that may be found in any discipline. The instructor identified a gap in the experiences of current student cohorts, who tend to be far more familiar with clicking a computer mouse than tinkering directly with mechanical objects. The Cigar Box provides an alternative (and far more flexible) means of acquiring mechanical experience and intuition.

Additionally, the relatively inexpensive Cigar Boxes make it feasible for students to perform laboratory experiments while topics are being covered in lectures. Students can thus connect theoretical and practical understandings immediately, instead of waiting for a consolidated lab course that serves multiple courses.

Student Comments

"I can personally attest to the power of [the Cigar Box project] to give an intuitive representation of frequency response. ...seeing it in operation helped the reality of what was occurring during a frequency response test to 'click' with me. It gave me a more innate feel for what was occurring that allowed me to identify everyday systems that exhibit a similar behavior."

The Cigar Box's MATLAB compatibility with Arduino "allow[ed] me to develop plotting and tracking algorithms for the nervous signals that we were reading from the rats that we were working with."

"From helping us visualize the effects of the individual components of PID (Proportional-Integral-Derivative) control to helping plot Bode plots, the Cigar Boxes turned dry chalkboard content into fun projects."

"My group designed a program that lets [Cigar Box] users feel the force feedback of a ball bouncing between a ceiling and a floor."

"The project expo at the end of the class was thoroughly enjoyable as we got a chance to explore the variety of projects done by the different groups in the class."

Examples of Teaching Innovation



The red, motorized fader knobs allow students to feel and explore mechanical behaviors that change as they vary system parameters by turning the potentiometer knobs.



Inside the box are 3 switches, 3 rotary knobs, and 2 motorized faders. An Arduino microprocessor can be connected to a computer program like MATLAB, allowing simultaneous visual display of the virtual environment on a computer screen.

