TECHIE: Teaching Engineering Concepts through Haptic, Interactive Experiences

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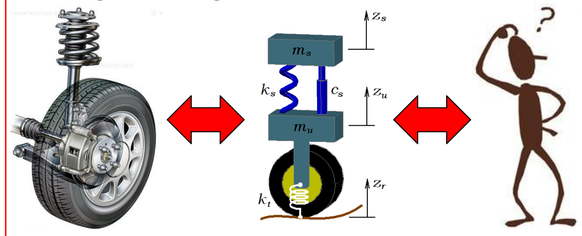
Introduction

- Limited time and resources make hands-on learning experiences difficult

BUT…

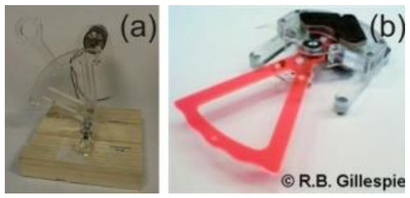
- Physical interactions are imperative to intuitive understanding of "how things work" in mechanical engineering



- **Objective**: Uncover the potential of **haptic devices** in enabling these interactive learning experiences

History of Innovation

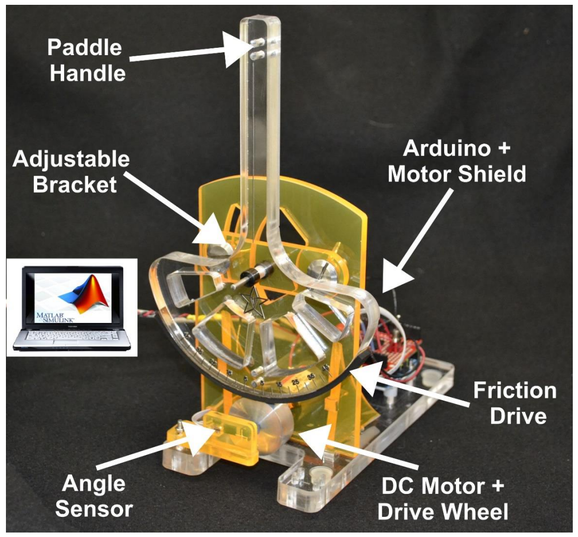
- **Haptics**: Referring to touch
- **Haptic Paddle:** Haptic device that enables students to "feel" simulated objects via force feedback
- Used for teaching dynamics and controls at (a) Stanford/JHU, (b) Michigan, (c) Rice, and (d) Utah



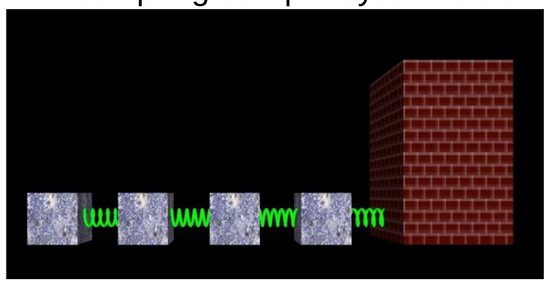
- In education, haptic interfaces can:
  - Provide a single, flexible platform for hands-on examples
  - Promote deep conceptual understanding
  - Enable the inclusion of a variety of learners and learning styles

Learning Activities

- Redesigned haptic paddle hardware and software to lower $$ and enhance classroom ease of use
- Haptic Paddle was used in the System Dynamics course laboratory at Vanderbilt for 5+ years



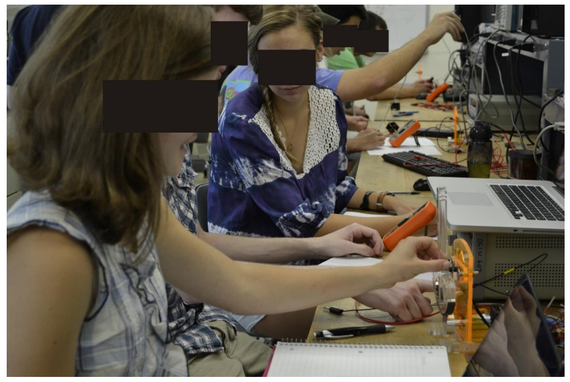
- In lab, students construct, analyze, and interact with the paddle and 3D simulations in real-time
- Students can change and "feel" properties of many systems, like the mass-spring-damper system below:



- Conducted a 3 year conceptual assessment demonstrating significant increases in quiz scores after lab compared to after lecture
- Developed a comprehensive website with online video tutorials and paddle instructions

Execution

- **Goal**: Expand the haptic paddle *in & throughout* a new mechatronics engineering program at SIUE
- **Execution Plan:**
  - Create and integrate haptic paddle curriculum for mechatronics
  - Assess its impacts on the student learning experience



Target Courses that span curriculum:

Intro to Mechatronics	Sensors & Actuators	Micro-controllers
Freshman	Junior	Senior

- Course integration through small group activities and lab experiences

Challenges

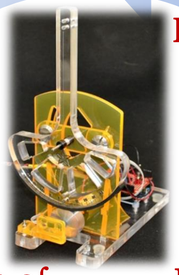
- **Pedagogical**
  - Frameworks/learning theories related to haptics in education
- **Assessment**
  - Developing Concept Inventories for mechatronics that can be disseminated online (e.g. CIHub)
  - Mixed-methods assessments to capture and quantify student learning with the haptic paddle
- **Dissemination**
  - Exploration of online resources for dissemination at the K-16 level

Discussion

- **Impacts of this work include:**

Understanding of the effectiveness of haptic devices in education

Low-cost, flexible teaching platform for STEM



Dissemination of novel learning innovations

Exploration of learning enhancements across age levels & subjects

Insight into how students learn through haptic interactions

Future Work/Grant Ideas

- Role of haptic devices in the changing educational landscape of online and distance learning
- Integration at the K-12 level and with underrepresented populations
- Multi-institutional studies

Acknowledgements

Support for this work was from The MathWorks Inc. Education Curriculum Grant and the National Science Foundation under award #IIS-1054331 and a Graduate Research Fellowship.

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2013 Frontiers of Engineering Education
Irvine, California
October 27-30

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The National Academy of Engineering and
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