Using the Wii Remote to Teach Introductory Physics

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Gaming, Learning & Community: From Board Games to Fantasy Baseball

Subverting Games

- content
  - motion
  - light – ray tracing
- technology
  - GPU – graphical processing unit
  - IR – infrared sensors
  - accelerometer – MEMS technology

Wiimote + WiiExperiment and Physics – Methods

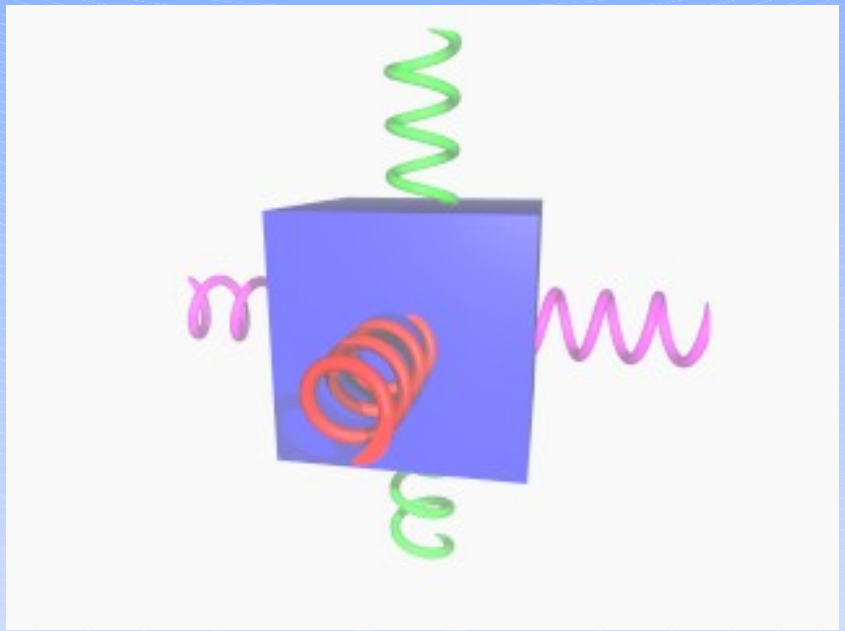
- visual, concrete realization of abstract concepts
  - demonstrations
  - hands-on
- real-world applications
  - in consumer products: games, phones, ...
  - in manufacturing
- use of computation
  - analysis
  - modeling

Two Wiimote Live Demo of WiiExperiment

- What are we seeing?
  - three different directions
  - how to tell it's acceleration and not velocity
  - getting a maximum reading
  - free-fall
- What is going on inside the Wiimote?
  - drop mass on a spring
  - compare spring behavior to Wiimote readings

Inside the Wiimote

- photo from Sparkfun.com

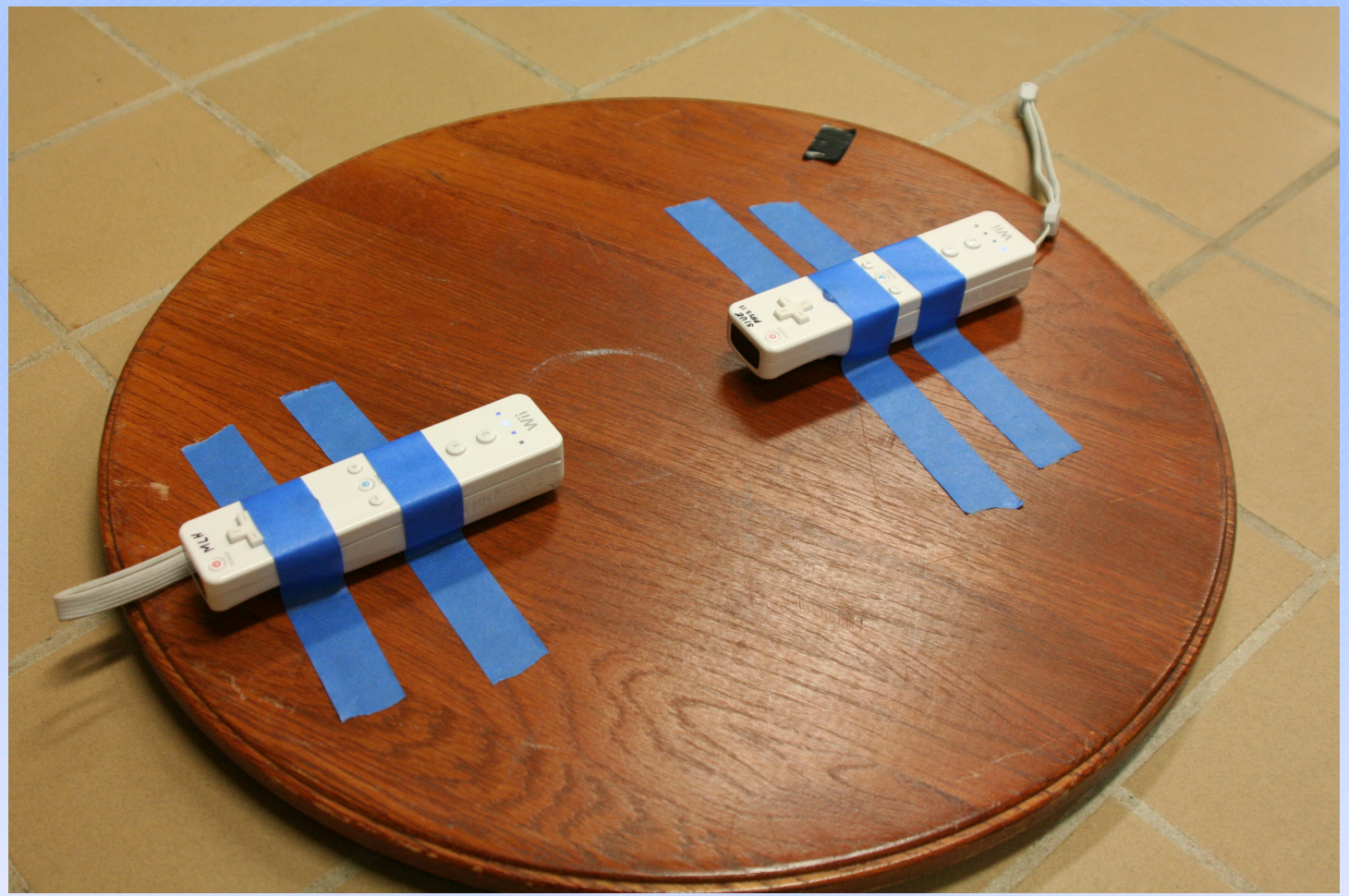


Wiimote + WiiExperiment and Physics – Content

- impulse: how time (or distance) over which a collision occurs affects maximum force needed
  - seat belts and other safety devices
  - Tape Wiimote to the cart. Determine how to stop the cart using the smallest maximum deceleration within a stopping zone no more than 6cm long.
- Newton's third law: equal and opposite forces in a collision

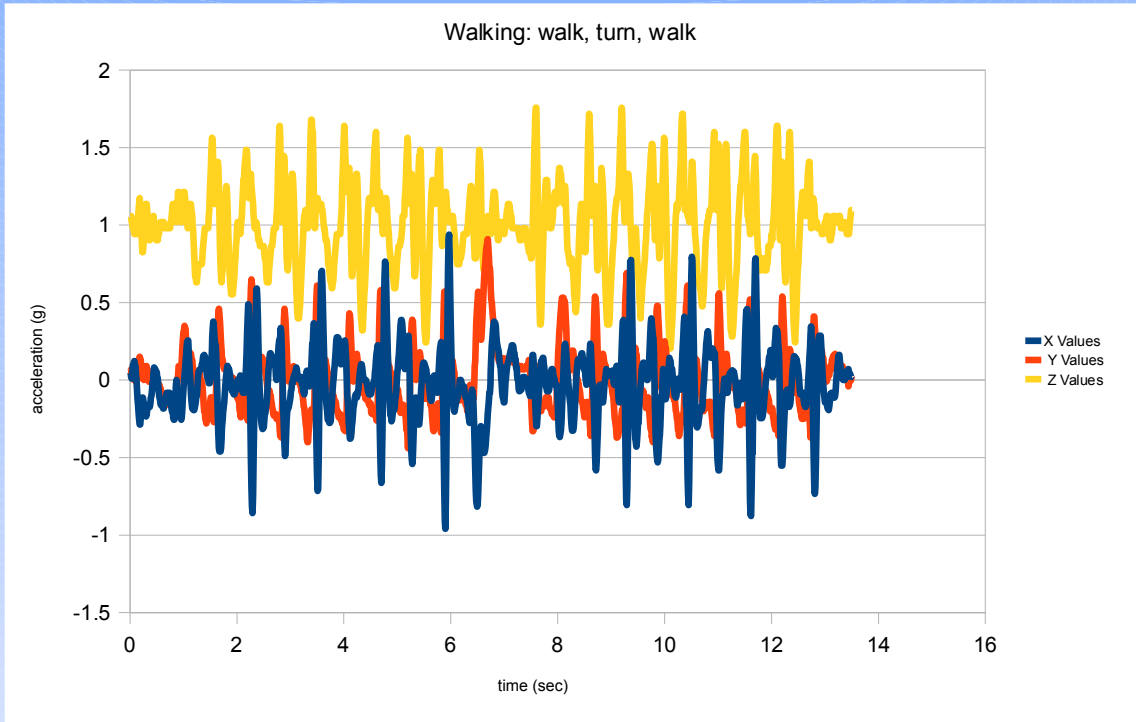
Wiimote + WiiExperiment and Physics – Content

- Motion
  - circular motion - centripetal acceleration



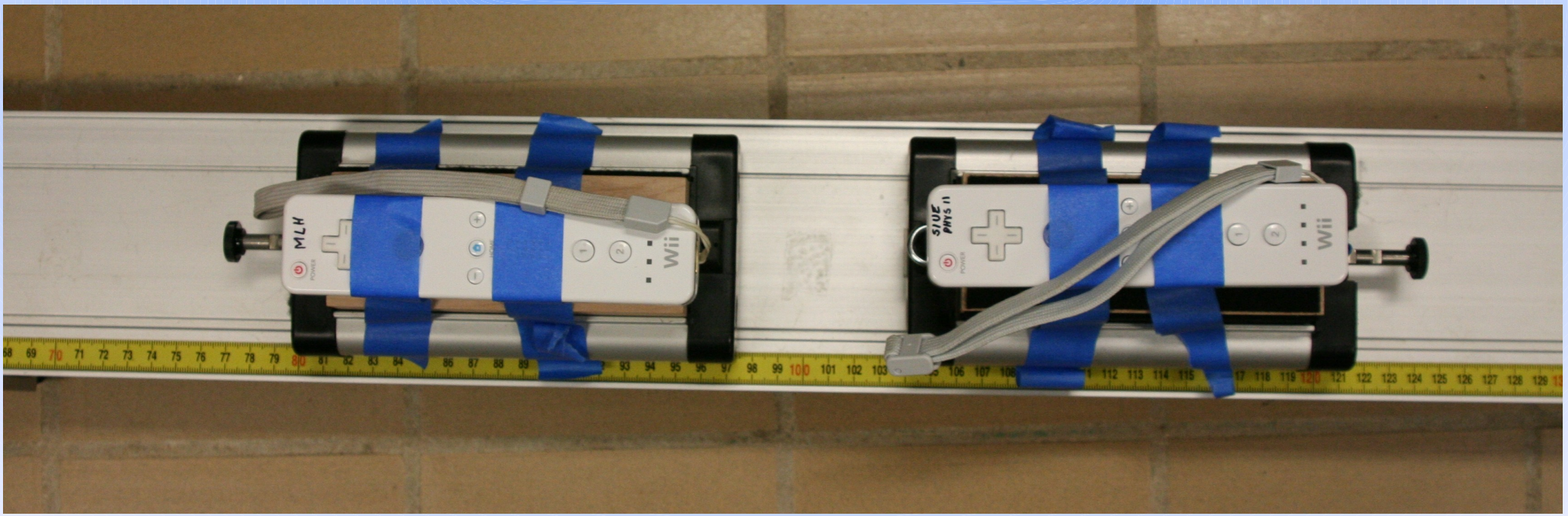
Wiimote + WiiExperiment and Physics – Content

- Motion
  - elevator motion
  - distinction between velocity and acceleration
  - non-constant acceleration

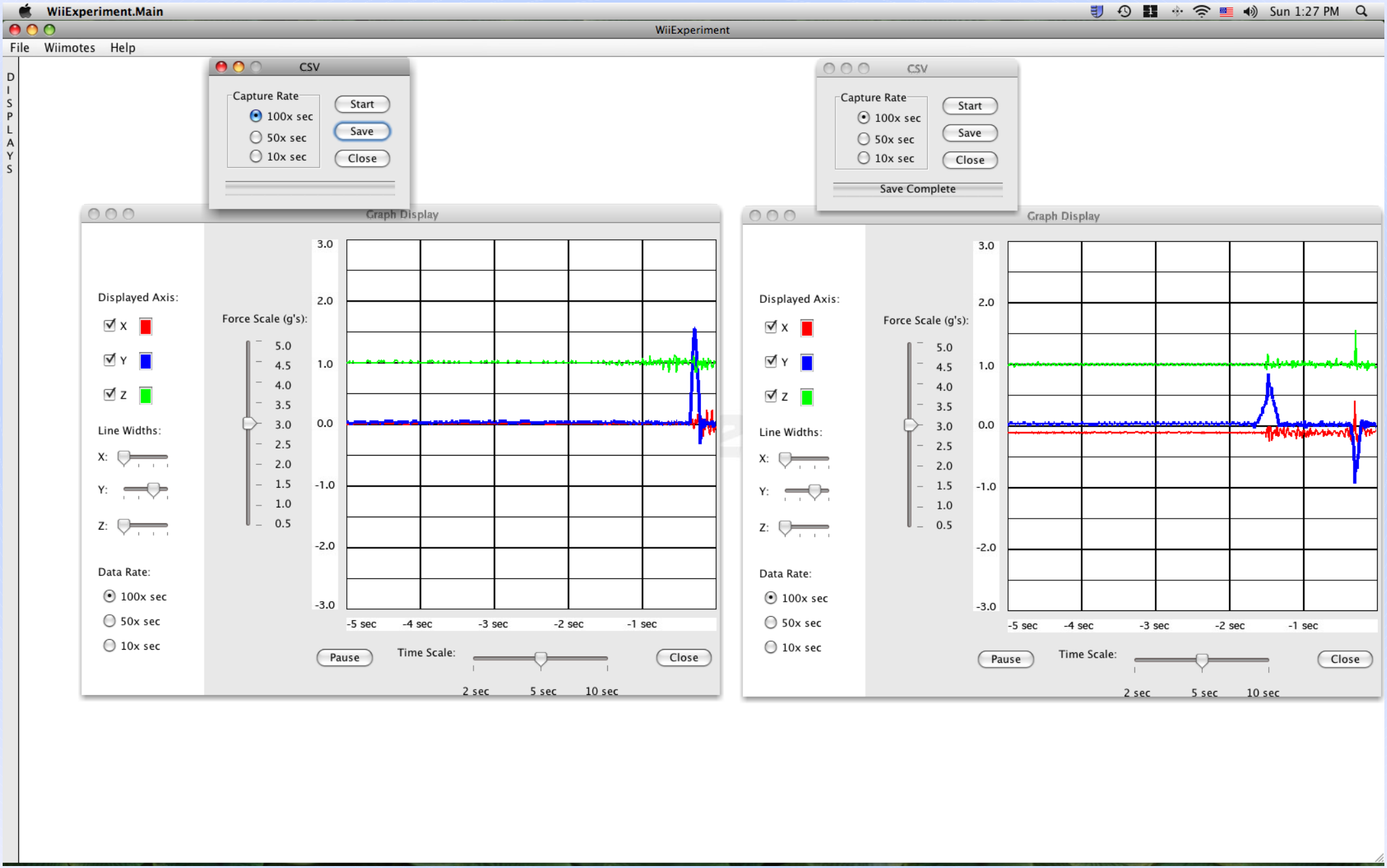


Newton's Third Law: Action and Reaction

Collide two carts of unequal masses on a low-friction track



Newton's Third Law: Action and Reaction



Wiimote + WiiExperiment and Physics – Content

- Galileo and free-fall
- springs – Hooke's law
- electricity – materials
  - connection between physical and electrical properties of materials – MEMS sensors
- experimental techniques – data-gathering
  - how often do we need to sample
  - uncertainty in measuring devices

Wiimote vs other accelerometers

- Advantages of Wiimote
  - something many students have and use rather than something they only see in class
  - proof that the things they study really do make it into the real world
  - price
- Disadvantages
  - currently cannot save data in itself
  - no altimeter
  - may be lower-precision model of sensor

Using WiiExperiment with Wiimote

- WiiExperiment is:
  - free & open-source
  - modular
  - extensible
  - can be used to for
    - conceptual/qualitative understanding
    - quantitative analysis
  - designed for
    - demonstration purposes
    - data collection

If you want to try this at home

- getting the software
  - wiiexperiment.org
- Windows or OS X computer with bluetooth
  - mostly built-in
  - dongle
  - upgrading drivers for Windows
- wii remote

Other Instructional Uses of Wiimotes

- cheap white board using IR tracking (Johnny Lee, Boon Jin, Uwe Schmidt)
- teaching toothbrushing (SIUE Dental school proposal for SIUE CS senior assignment)
- teaching percussion technique (Justin R. Belcher – MS at VA Polytech)
- Wiimote as controller for existing simulations
- creating good robot motion protocols (Micah Lapping et al. – Carr at Brown U; Andrej Gams et al. at Jožef Stefan Institute in Slovenia)

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