Measurement and Analysis

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ES 100

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Agenda

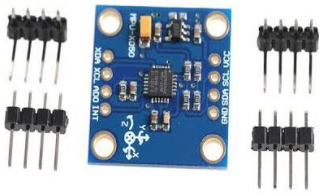
- How do we measure things?
- How should we analyze the data?
- Measurement and Analysis Demos:
  - Computer Vision
  - Accelerometers
  - EEG Data

Measuring? Why?

- We want to measure things because we need to quantify and verify goals and targets

- Example: my ES100 project (bicycle electronics charger)
  - Destroyed a cell phone…Why?
  - Didn't measure top speed of bike → didn't know max voltage

- How do we measure things?
  - Cameras → Computer Vision
  - Sensors → Accelerometers, GPS, etc.



3Axis Gyro+6Axis Accelerometer
$8USD

GPS/GLONASS Module
$35USD

GoPro Hero 4 (240fps)
$400USD

Smartphone
$0USD* (if you own one)

→ Measurement is a fundamental step in QC and verification

CV Measurement Demo: Chaotic Pendulum

- What is a double pendulum?
- What do we want to know?
  - Position, angle, velocity, force
- How do we measure its motion?
  - Shaft encoders
  - Accelerometers
  - Computer vision
  - Anything else?
- What are some drawbacks?
  - Shaft encoders add bulk and weight
  - Accelerometers have very limited accuracy (you will see soon)
  - CV may require proper lighting, high framerate, may not be realtime

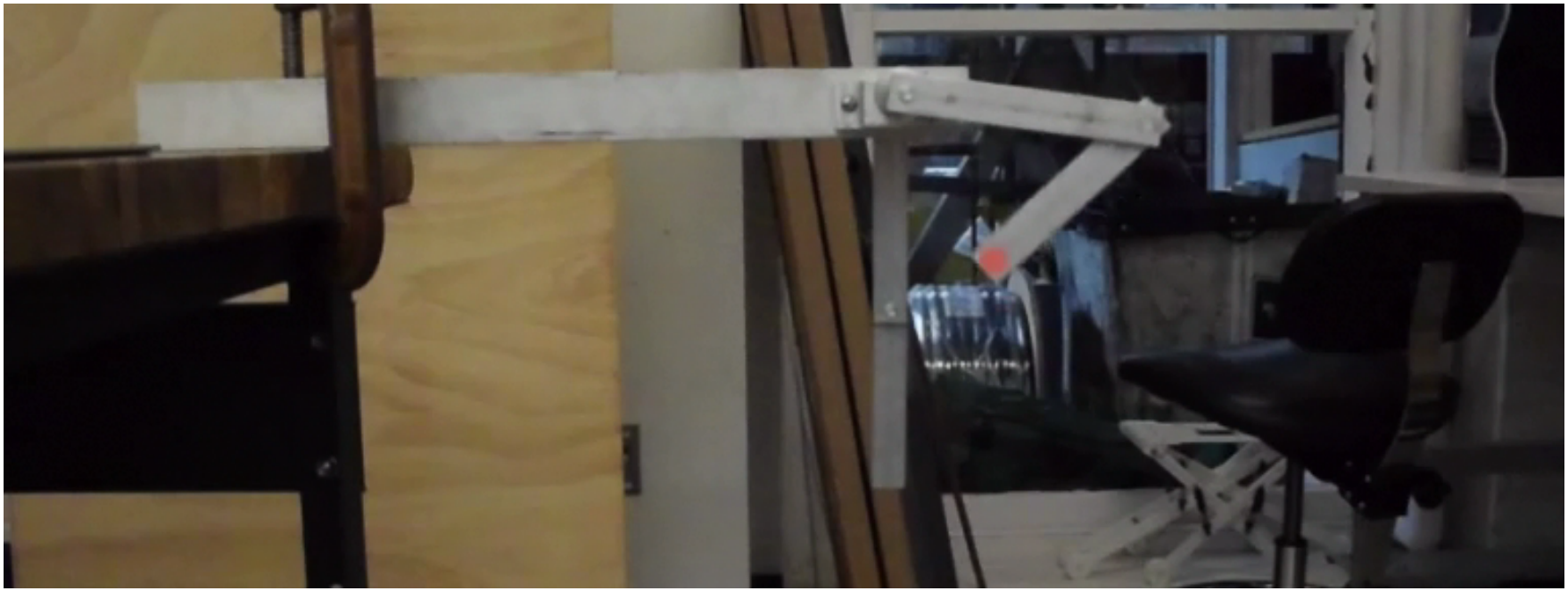
$$\dot{\theta}_1 = \frac{6}{m\ell^2}\frac{2p_{\theta_1} - 3\cos(\theta_1 - \theta_2)p_{\theta_2}}{16 - 9\cos^2(\theta_1 - \theta_2)}$$

and

$$\dot{\theta}_2 = \frac{6}{m\ell^2}\frac{8p_{\theta_2} - 3\cos(\theta_1 - \theta_2)p_{\theta_1}}{16 - 9\cos^2(\theta_1 - \theta_2)}.$$

→ Don't just go out and measure, make sure you have the right tool and setup

CV Measurement Demo: Chaotic Pendulum

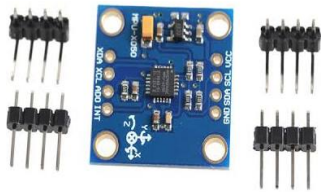


CV Measurement Demo: Chaotic Pendulum

Accelerometer Measurement Demo

- Say we want to figure out the position of an object…what do we do?

- What sensor should we use?
  - GPS?
    - Good for ~+/-3m
  - Computer vision?
    - Needs line of sight, have to have camera following it
  - Accelerometer
    - Need to do a double integration
  - Anything else?



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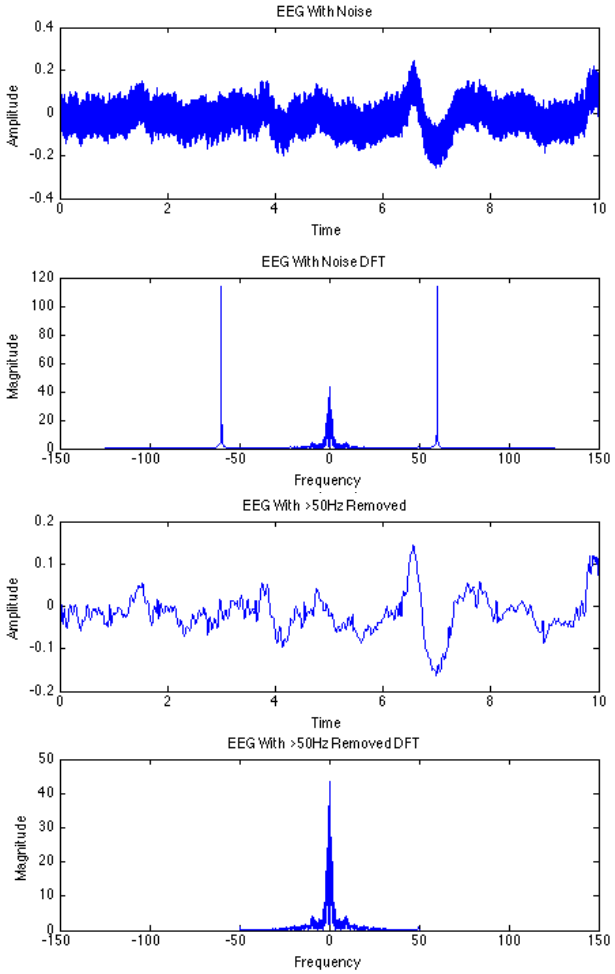
$8USD

$$\hat{s} = \int \hat{v} \cdot dt = \iint \hat{a} \cdot dt^2$$

→ Use the tools you have at your disposal, but know their drawbacks

We've measure the data…what now?

- **Analyze the data: find nuances, find interesting experiment errors**
- **Sanity check: does this look right?**
  - **Compare to model? Does one exist?**
- **Example:**
  - **EEG Data: Why is it so fuzzy?**
  - **What's that at ~ 60Hz?**
  - **How do I get rid of it?**
  - **Clean up (filtering,smoothing)**



→ Real life data is never cute…you need to analyze!