EECS 192: Mechatronics Design Lab
Discussion 6: Velocity Control

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- Velocity Sensing
- Feedback Control
- Summary
Velocity Sensing
Brainstorm!

What are some ways to sense velocity?

pros and cons of your methods?
Optical Encoders

Optical encoders...

- Detects when sensor lit up
- Reflective sensor: light up codewheel, sensor detects reflection
- Photointerruptors: direct light beam from transmittor to detector, interrupt by object
- Simple designs vulnerable to ambient light

Hamamatsu S6986...

- High-pass filter and LED modulation for background light rejection
- Open-collector output

Hopefully a fairly readable schematic
Software Techniques

Two simple ways to measure speed:

Pulse width measurement
- Measure width between transitions

Pulse counting
- Count number of transitions in timespan

Advantages and disadvantages of both?
Live Demo!

Low speed demo
see blinking LEDs!

High speed demo
what waveforms should you expect to see?

Issues
skipped pulses, inconsistent pulse lengths
Uh-oh!

What are some ways to deal with inconsistent pulse sizing / other issues?

pros and cons of your methods?
Moving Average Filter

- Average pulse widths over a entire revolution

Hopefully a fairly readable schematic
Feedback Control
PID

- **Proportional Control**
  - Change output by $p \times (\text{difference between sensor input and data})$
  - Very intuitive—part of almost every PID scheme.

- **Integral Control**
  - Change output by $i \times (\text{integration of error over time})$
  - Overcomes offset errors (example: friction)

- **Derivative Control**
  - Change output by $d \times (\text{instantaneous derivative of the error})$
  - Helps prevent oscillation (example: steering)

- **Video about PID control on vehicle**
  - [https://www.youtube.com/watch?v=4Y7zG48uHRo](https://www.youtube.com/watch?v=4Y7zG48uHRo)
  - Video courtesy of MIT Aerospace Controls Lab
Optical Encoders

The way you process data affects how you acquire data. Be aware of the effects of errors/noise

PID control overview