EECS 192: Mechatronics Design Lab

Discussion 6: Velocity Control

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1 & 2 Mar 2017 (Week 6)

- Velocity Sensing
- Feedback Control
- Summary

Velocity Sensing

Brainstorm!

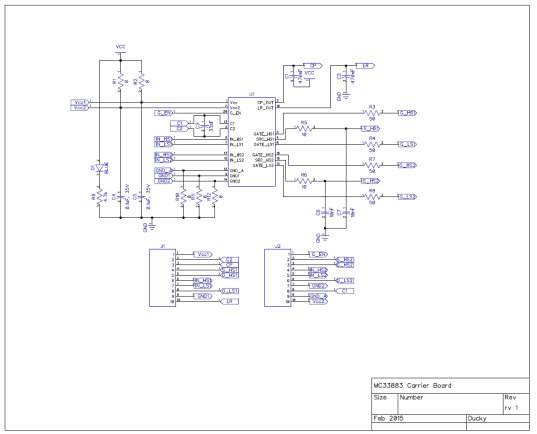
What are some ways to sense velocity?

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



Hopefully a fairly readable schematic

Hamamatsu S6986...

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

Software Techniques

Two simple ways to measure speed:

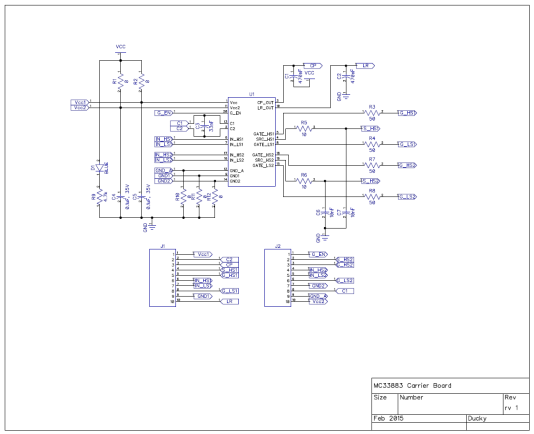
Pulse width measurement

- Measure width between transitions

Pulse counting

- Count number of transitions in timespan

Advantages and disadvantages of both?



Hopefully a fairly readable schematic

Live Demo!

Low speed demo

see blinking LEDs!

High speed demo

what waveforms should you expect to see?

Issues

skipped pulses, inconsistent pulse lengths

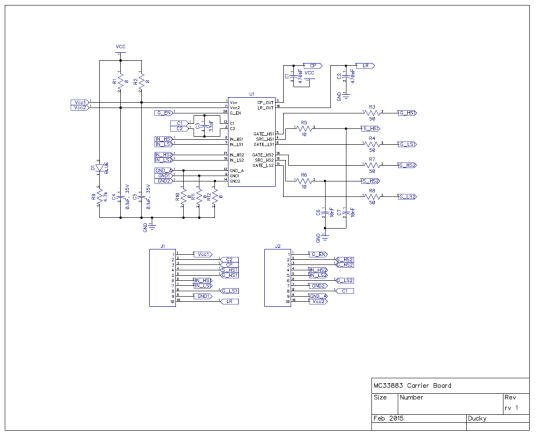
Uh-oh!

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 $p *$ (difference between sensor input and data)
  - Very intuitive- part of almost every PID scheme.
- Integral Control
  - Change output by $i *$ (integration of error over time)
  - Overcomes offset errors (example: friction)
- Derivative Control
  - Change output by $d *$ (instantaneous derivative of the error)
  - Helps prevent oscillation (example: steering)
- Video about PID control on vehicle
  - https://www.youtube.com/watch?v=4Y7zG48uHRo
  - Video courtesy of MIT Aerospace Controls Lab

Summary

- Optical Encoders
- The way you process data affects how you acquire data. Be aware of the effects of errors/noise
- PID control overview