EECS192 Lecture 7  
Feb. 27, 2018

Notes:
1. Check off-
   • 3/2/2018: benchtop velocity control
     + Lab Clean (individual)
   • 3/9/2017: benchtop line tracking (line camera+servo)
   • 3/16/2018 drop-and-run, figure 8
2. Community Spirit: PCB peer review, Piazza, helping fellow students
3. CalDay Sat. April 21 @ UCB,

Topics
• PCB quick note
• Speed sensing/velocity control- quick intro
• Line sensor- processing
  – Automatic Gain Control
  – Edge detection/fitting
  – Sanity check: median/outlier
• HW1 Python template and Natcar team1 data
  (under Resources on Piazza)
On board- quick intro

- Shaft encoder
- Incremental position
Hamamatsu Optical Detector

**BLOCK DIAGRAM AND FUNCTIONS**

- **CONSTANT VOLTAGE CIRCUIT**
  - TO EACH PART
  - **Vcc**

- **BUFFER**
  - **I**

- **COMPARATOR**
  - **Vout**

- **SIGNAL PROCESSING CIRCUIT**
  - **OUTPUT CIRCUIT**
  - **CATHODE (LED)**
  - **GND**

- **OSCILLATOR**
  - **LED DRIVER**

- **PREAMP**
  - **REF. VOLTAGE**

- **PD**

- **velocity sensing**
Sharp GPS260

100 us response time

velocity sensing
Sharp GPS260

- Choose current 4 mA in LED
- $V_{cc} = 3.3$ V
- May want regulated/clean voltage for $V_{cc}$

**Fig. 9 Test Circuit for Response Time**

**Fig. 13 Detecting Position Characteristics (2)**

- Relative collector current (%) vs. OMS card moving distance (mm)
- OMS test card
- Sensor
- $V_{ce} = 2$ V
- $I_F = 4$ mA
- $d = 1$ mm
Non-inverting amp to measure motor current. Back EMF can be estimated from battery voltage and motor resistance.

3.3V

To A/D

0.01 ohm (10 squares)
Velocity Sensing

• On board: estimating $\Delta x/\Delta T$

Note: care about velocity sensing usually at cruise speed (also stopping)
Velocity Control overview

On board…
Proportional control:
$U = kp*e = kp*(r-y)$;

Proportional + integral control
$U = kp*e + ki*e_{sum}$;
$e_{sum} = e_{sum} + e$;
TSL 1401 line sensor

Functional Block Diagram

Line sensor
TSL 1401 line sensor

PARAMETER MEASUREMENT INFORMATION

Figure 1. Timing Waveforms

Figure 2. Operational Waveforms
TSL 1401 line sensor NATCAR 8 bit

Frame 0

Frame 1

Frame 1-Frame 0

Frame 0

Frame 2

Frame 2-Frame 0

Line sensor
# track_center_list - A length n array of integers from 0 to 127.
   Represents the predicted center of the line in each frame.

# track_found_list - A length n array of booleans.
   Represents whether or not each frame contains a detected line.

# cross_found_list - A length n array of booleans.
   Represents whether or not each frame contains a crossing.

natcar2016_team1.csv

Start line

Steps

crossing

finish line
Extra Slides
Differential amp to read back EMF for H Bridge driving motor. Change values for 12V Back EMF…

Back EMF velocity sensing
Back EMF velocity sensing

\[ V_{DS} = 10V - V_{DIODE} \]