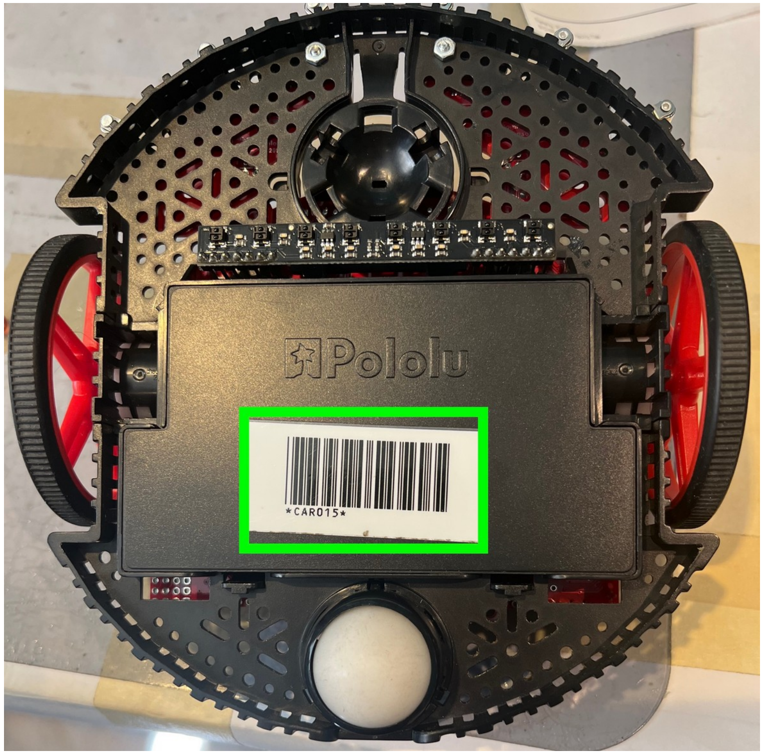
ECE3 PROJECT TIPS

RECORD!

Protect Yourself!
Take a picture of the project car Library label



FINAL REPORT PREVIEW

- There are five parts (5 questions to answer in the Gradescope Assignment
  - Plan Your Tests
  - Conduct Your Tests (NO CALIBRATION DATA!)
  - Analyze Your Data
  - Interpret Your Analysis
  - Appendix
- You will keep a LOGBOOK of your tests:
  - This is mandatory because I want you to experience this, and:
    - It gives you a record of what you have tried previously.
    - It is evidence in patent applications.
    - It is evidence in Intellectual Property trials.
  - If you do not have a separate logbook, I will give you one.
  - In a lab:
    - Logbooks a bound books where removed pages are obvious.
    - Experimenters use non-erasable pens (no pencils).
    - Erros are crossed out (not erased) and the correction is entered nearby.
  - Tablets are OK (for this class only).

FINAL REPORT PREVIEW

<u>The Final Report is about test and development, not calibration.</u>
Do NOT present calibration data! I will take off points if you do.

<u>Your log is not a table.</u>
The log's purpose is to create a record of your efforts. Your log is only a chronicle. The log's purpose is not to analyze, though you may do some analysis in a column. I will take off pints if you just label your log as a table.
<u>Your log is NOT meant to be read from beginning to end.</u>
Your log is a repository of events to be sampled. The reader is guided by data presented in Analysis. Do NOT force the reader to spend lots of time perusing your log to find meaning.
<u>Your log is a source for the Analysis and Interpretations sections.</u>
In your log, find patterns or stories and present them via graphs, tables, and illustrations in the <u>Analysis</u> section. In the <u>Interpretation</u> section, you spell out the meanings that are in the graphs and tables. The graphs and tables are the support material for your Interpretations.

<u>The Interpretation section is for your prose.</u>
In Interpretation, you spell out the meanings that are in the Analysis section data. Here, you tell the stories, make the claims, and list the implications that are embedded in the graphs and tables.
<u>The Analysis section is for graphs, table, and illustrations ONLY.</u>
Your prose is in the Interpretations section
If you have numerical data, then plot it in a graph. If not, then a table is OK. You need to pick sections of your log that tell a story, and put that in a graph or table.
For instance, one team plotted K_p vs K_d with points colored to show if the run was successful or not. Another team plotted distance traveled before running off the track vs K_d, with K_p held constant. A third team plotted completion time against K_p. Another plot might be amount of weaving on a scale of 1 to 5 (with 5 being very bad) vs K_d. There are other possibilities.
BTW, if you numericalize qualitative data such as the weaving example above, <u>tell me if 5 is the best or the worst</u>!
If you have no numerical data, then just use tables. There, the data can be qualitative instead of numerical. If you don't have any data, then you didn't follow the instructions to keep a logbook. Do not manufacture data after the fact. To do so is to LIE, pure and simple. In order to show something, then you can show your

DOCUMENT EVERY DEVELOPMENT TEST!

DON'T DO THIS!

"It must be noted that the above data is only a sampling of the most "mile stone" data points where I got it to handle a significant part of the track like the offset, at least two dozen more tests were done that yielded fruitless results that I did not feel were important enough to record."

(Quoted from student Final Report)

Every time you put the down onto a track, this is a new entry in your logbook.

QUANTIFY YOUR RESULTS

Allows you to make good graphs in Analysis (Question 3).

Not good enough:

- “Ran off track”
- “Unsuccessful”
- “Too much weaving”
- “Didn’t finish”

Do this instead:

- “Ran off track at Milestone 5”
- “Weaving amount 3/5 (5 is best)”

LOGBOOK EXAMPLE

25 Apr 2021

	Speed	Kp	KD	Start Pos	Batt Volt	Wts	Result
1	30	.35	3.5	0	7.6	8 4 / 2 1	Success, but takes long time to ctr on straightaway
2	30	.35	3.5	0	8.5 V	8 4 / 2 1	Failed on last turn (10)
3	30	.35	3.5	0	8.5	8 4 / 2 1	Failed on Turn 2
4	30	.35	3.5	0	8.5	8 4 / 2 1	Failed on Turn 9
5	30	.35	3.5	0	8.5	8 5 / 3 1	Failed on Turn 9
6	30	.35	3.5	0	8.5	8 5 / 3 1	Failed on Turn 9
7 = 6						10 6 / 3 1	Failed on Turn 9
8 = 7							Success but long ctring time
9 = 7							Success " " "
10 = 7		.70					Success, better ctring time
11 = 10							= 10
12							= 10 48.1 s
13	40	.70	3.5	0	8.5	10 6 / 8 1	Success
14 = 13							Failed on T 9
15 = 13							Success 36.7 s
16	40	1.0	3.5	0	8.0	10 6 / 8 1	Success 34.8 s

DELAYS ARE DEATH!

SERIAL.PRINTS ARE NEAR-DEATH!

“The big issue with my code, discovered late on Race Day, was that I had serial prints, which slowed down the execution dramatically.

REMOVE SERIAL PRINTS WHEN TESTING YOUR CAR!”

(Quoted from student Final Report)

USE BUMP AND USER SWITCHES

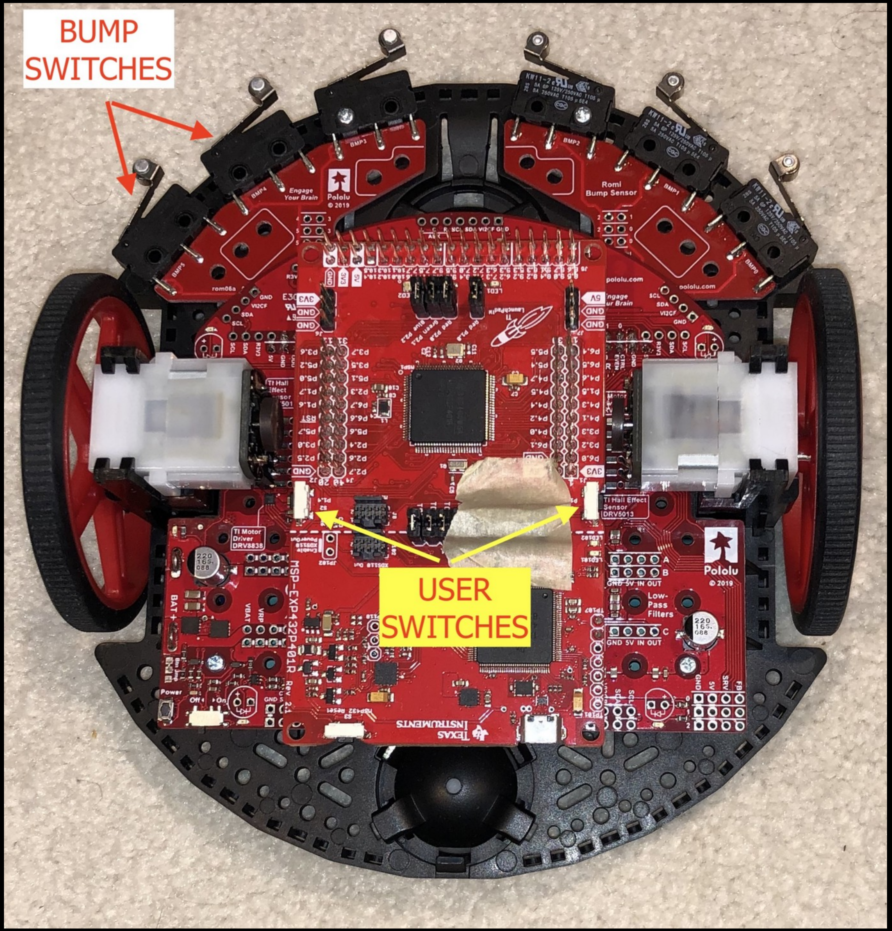
You can control your program:

- Base Speed
- PID gains
- Etc.

Pin Chart has pin #s for bump switches.

User switch pin #s:

Sw#	Pin#
S1	73
S2	74



IF A NEW ROOM, DO A SELF-CALIBRATION AT THE START OF EACH RUN

- Set the car on all white near the start.
- Take a series of readings. These replace your subtraction values in the fusion algorithm.
- This accounts for the ambient IR in the room.
- Set the car in the starting position and let it go.

VISIBLE LIGHT DOESN'T COUNT

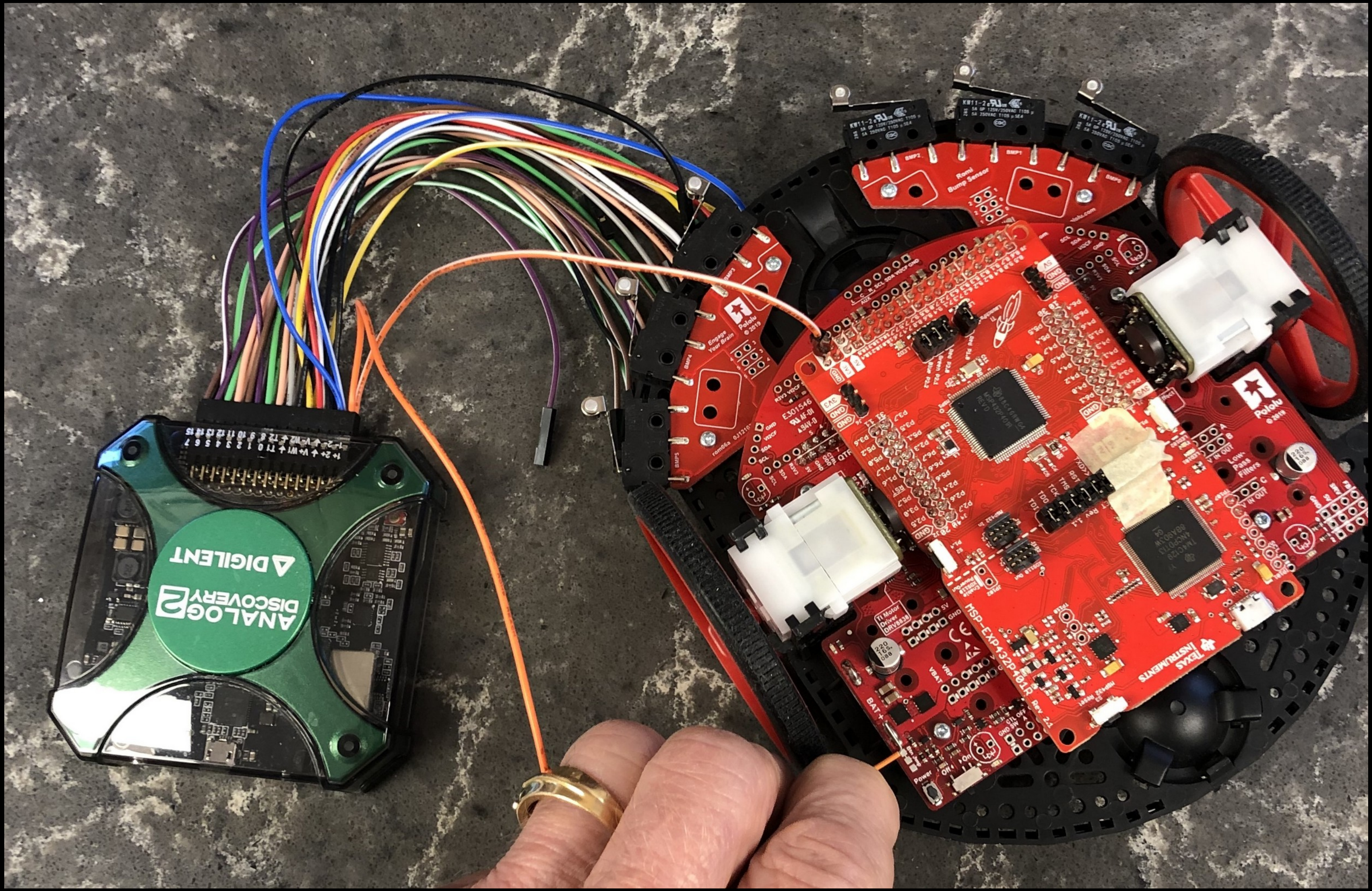
BUT SUNLIGHT CONTAINS IR

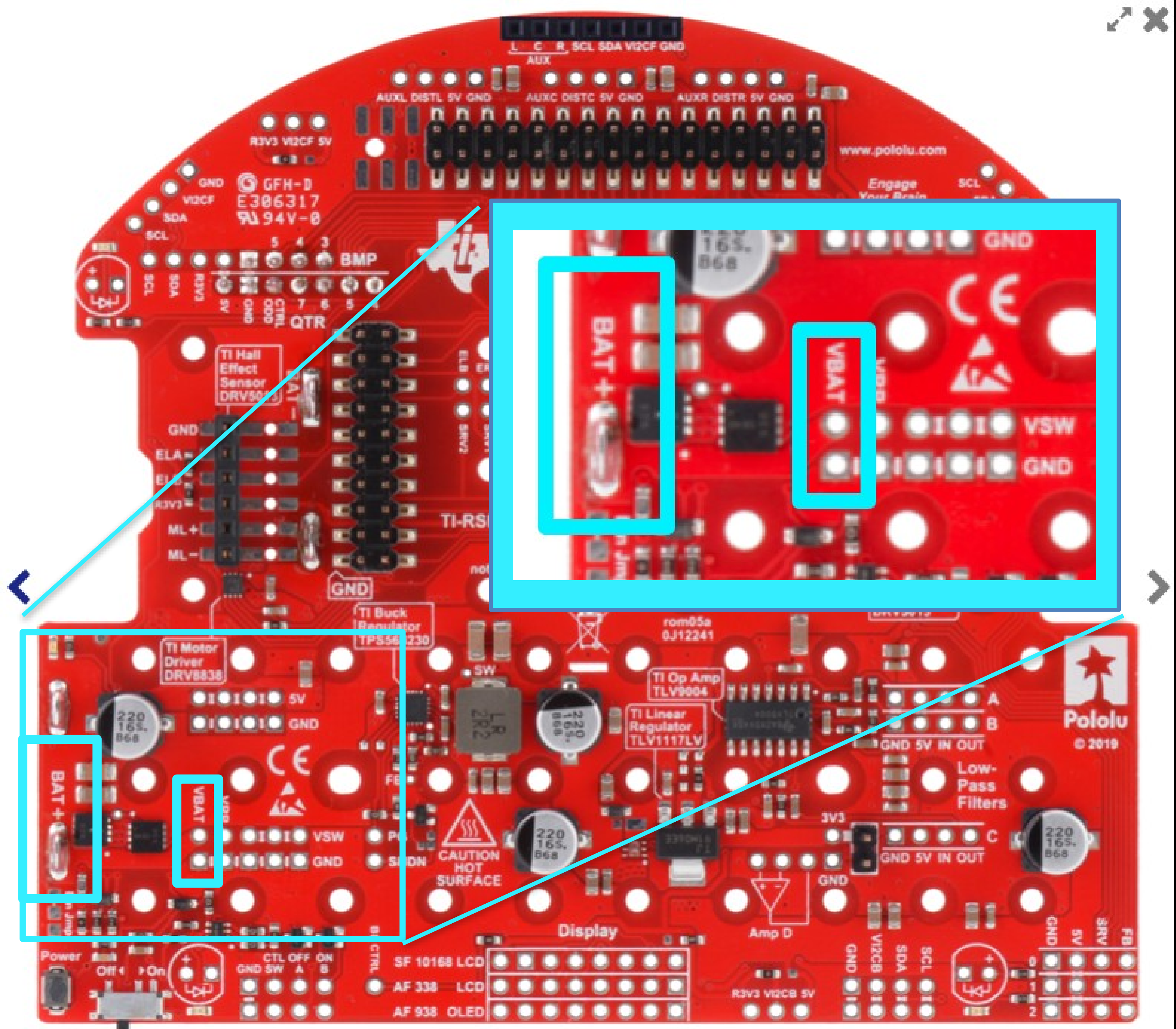
"… the IR reading for white paper would go from around 550 under daylight to around 750 under artificial lights at night."

"I made the mistake of trying to record the sensor data in a room filled with natural light, which ended up giving me abnormal values. "

(Quoted from student Final Reports)

MEASURE VOLTAGE OFTEN



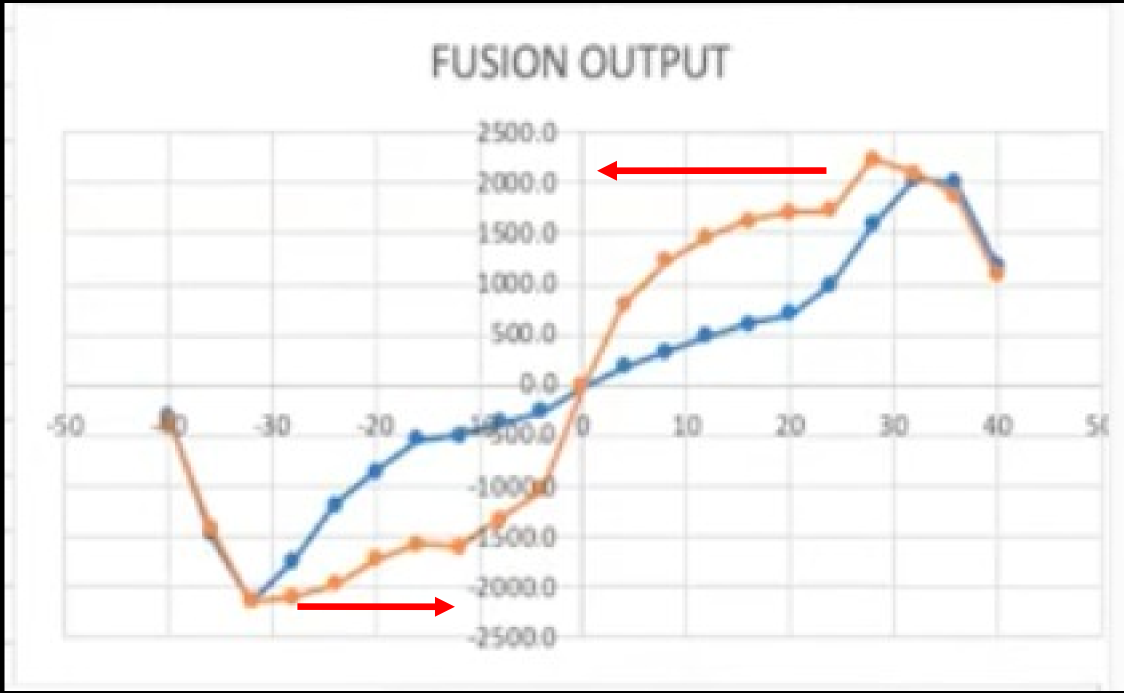


TI-RSLK Chassis Board v1.0 for TI-RSLK MAX, top view.

ERROR MARGIN

Maximum %age
of your Base speed.

MAX ERROR VALUE



EXAMPLE OF INITIAL K_P

- Select base speed (PWM)
- Find max error value from sensor fusion plot
- Choose K_P such that:

=50

Kp – Kd Ratio

If your code looks back one sample:

$K_P / K_D \approx 1/ (5 \text{ to } 10)$

Why?
Previous sample is only 6 ms old.
Δerror is very small.

HARD SURFACE, BUT NO TABLETOPS

EXCEPT FOR STATIC TESTS.

"The night before race day my car had fallen off my bed and the motor and wheel had come off the right side,…"

(Quoted from student Final Report)

BEWARE THE PHANTOM CROSSPIECE!

- Occasionally, for one time only, all sensors will report 2500.
- If this satisfies your turnaround criterion, your car will do a doughnut. In the middle of the track.
- The workaround: insist on seeing your criterion met

First Seven Sensors

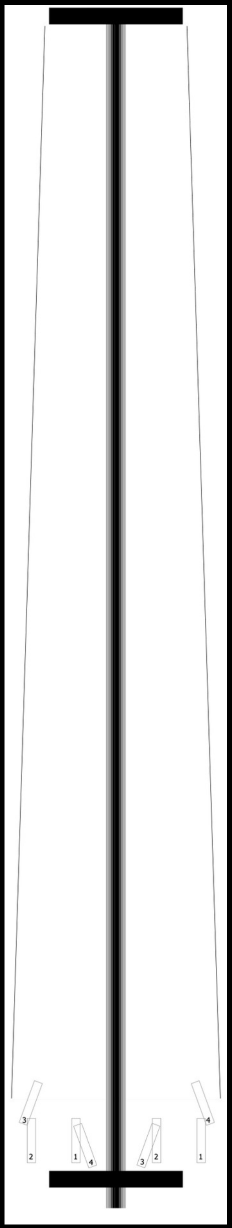
Steering Command

707	777	754	979	2192	884	801	-1033	-43.65
707	777	754	979	2192	884	801	-1031	-52.55
698	768	768	981	2207	886	792	-1013	-33.65
707	777	753	978	2191	883	800	-1028	-42.40
708	778	754	979	2192	884	801	-1033	-51.65
698	768	768	980	2207	886	792	-1040	-61.00
708	777	754	979	2192	884	801	-1033	-71.65
708	777	754	979	2192	884	801	-1033	-56.65
2500	2500	2500	2500	2500	2500	2500	-398	615.10
705	775	752	976	2188	882	799	-1031	-42.55
707	777	753	978	2192	884	800	-1031	-49.55
707	777	753	978	2191	883	800	-1028	-46.40
707	777	753	978	2192	884	800	-1031	-684.55
707	777	753	978	2191	883	800	-1028	-48.40
707	777	753	978	2191	883	800	-1028	-48.40
707	777	754	979	2192	884	801	-1033	-56.65
708	778	754	979	2192	884	801	-1033	-53.65
707	777	754	979	2192	884	801	-1033	-56.65
707	777	753	978	2191	883	800	-1028	-51.40
706	775	752	977	2188	882	799	-1030	-48.50

STRAIGHT TRACK FIRST

TO BE SURE THE CAR IS STABLE.

- Make a straight track from copies of Straight Line Stability Check.pdf
- Start the car from one of the start positions



DEBUG TIPS

- Use LEDs to signal something of importance in the code.

- Always have fresh batteries on hand.

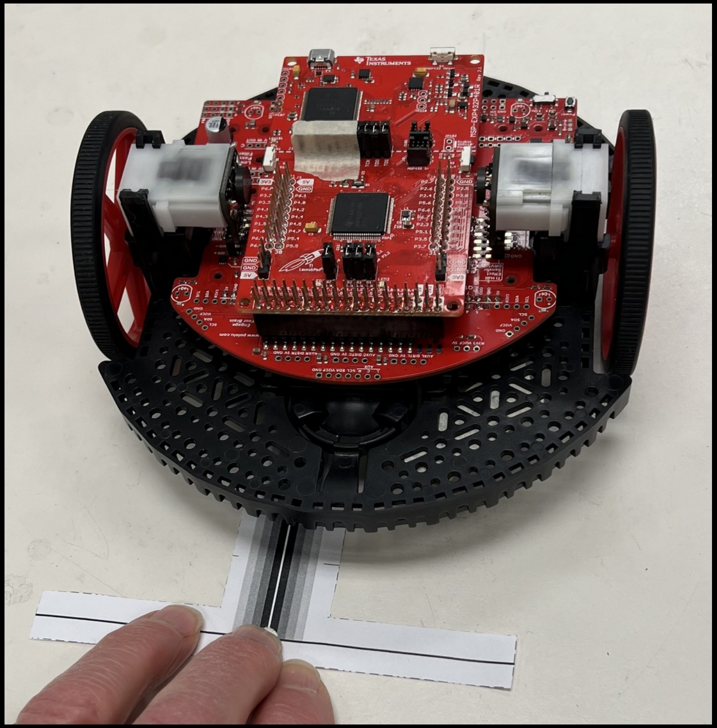
- Check the signs of K_p and K_d

  - Check K_P:
    - Set K_D to zero.
    - Place car offset from, but parallel to, the track.
    - Watch the first turn.

  - Check KD:
    - Set K_P to zero.
    - Place the car offset from, but angled toward, the path.
    - Watch the first turn.

DEBUG TIPS

- Set the NSLP pins to LOW.
  - NSLP: “Non-Sleep”
  - When LOW, the car ignores the analogWrite() command and the DIR pin state.
- The car will not move but the rest of the code is working.
- Now, add Serial.print() commands to monitor your calculations.
- Move the track under the car and watch the Serial Monitor.



DEBUG TIPS

- Detect when car has left the path.
- Warning: it looks the same as zero error!
- Develop path recovery algorithm.

DON’T USE DOUBLE!

- This is real-time, embedded system programming that you are doing.
- Limited resources in embedded computing.
- Float is fine.

INTEGER ARITHMETIC

- In embedded, real-time applications, it is good practice to use integer arithmetic.
- Sensor readings are returned as integer arithmetic
- Beware, especially divides and subtractions!

FINIS