COGS 300   <mark>Control 02</mark>   Sep 25/25
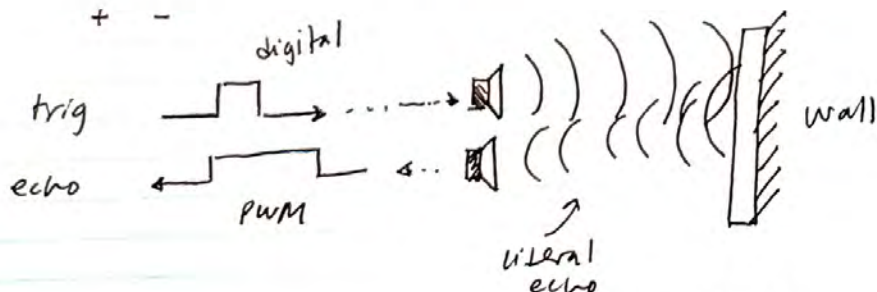
TODAY: ultrasonic sensor for long distance
            sensing...
                                    — wknd
                                    acves!.

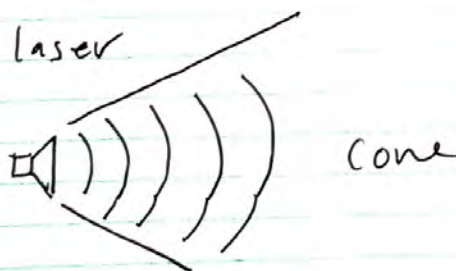but first the project. — Lab 06
        we'll have time for it.

- under $50 (sign out lab equipment)
- timeline + budget in Lab 06 (start now)
- paper prototype in lab 10 demo
- final demo in 10ᵗʰ class after tournament
- 1 sketchbook meeting (TAs will put up sched)

t: trigger
e: echo

v+e Gnd

+ −

digital

trig ⌐‾⌐ → ...→ ◁))) }((/ ((| wall

echo ← ⌐‾‾⌐ ◁.. ◁ ((((((

PWM

literal
echo

X not a laser

cone

advantage:
    bigger FOV

dis advantage:
    bigger FOV

☆ like bats.

Some people think ultrasonics are "bad"
    because they're not LiDAR, but...
    they're used in real sensing!
        safety - critical!!
        like auto-braking... still errors!

ultrasonic ~ ultrasound = higher hz than
                                    hear.

        ↳ see babies!

☆ wire your ultrasonic.
        ↳ where does distance come
                from? Draw a diagram.

    ☆ PAUL: upload Uis

Get into the habit of making Uis... ChatGPT
    is great for this now.
                                    show
                                      on
                                  ↙ screen.
Notice: signal is too bumpy.
secret button: filter. (enter)

        ↳ filter math.

Signal = measurement now = m

but we want to account for past
   measurements, make m an array/list

$m[t]$ = measurement now
$m[0]$ = first measurement

signal = $\dfrac{m[t] + m[t-1]}{2}$ average filter

signal = $\dfrac{m[t] + m[t-1] + \cdots + m[t-n+1]}{n}$

= average filter w/ running window size n

signal = $avg(m[m:t])$
          ↑   ↑
        slice start end.

median filter is

signal = $median(m[n:t])$

apply any statistical method
   you want!

threshold filter

signal = 1 if m > threshold else $\emptyset$

PID + filters.

PID: you set, pos   from
     choose ↗   ↖ measure   ultrasonic

$$pos = m$$

$$error = set - pos$$
$$proportional \ multiplier = p$$
$$output = p(error)$$

set = 5cm

$$p = \frac{-1}{2}$$

wall

10cm
||
pos

ultra
snic
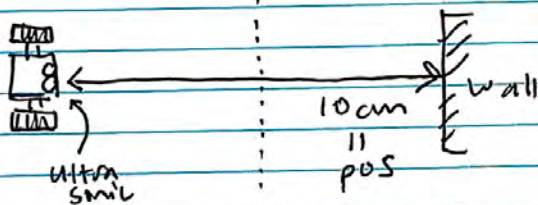
$$error = set - pos = 5 - 10 = -5$$
$$output = p(error) = -\frac{1}{2}(-5) = 2.5$$

set = 5 cm

wall

7.5
cm
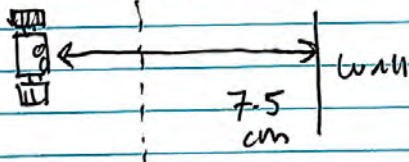
$$error = 5 - 7.5 = -2.5$$
$$output = p(error) = -1/2(-2.5) = 1.25$$
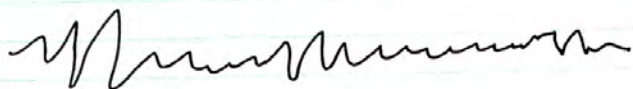
5cm

**sometimes
good
to be slow!**

wall

6.75
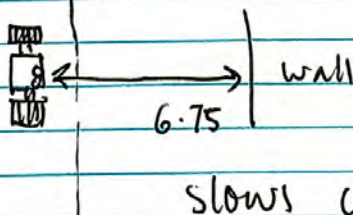
slows close
to set point!

But if your pos signal looks like:

what happens? Lots of vack + forth.
jitter!

chain your processes...

$$pos = avg(m[\overset{n}{0}:\overset{t}{m}])$$

D1. Design + build an ultrasonic radar tower.

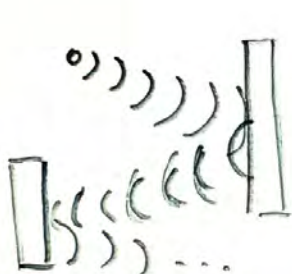↳ us. must stay in lab.

Are filters "real"?

↳ see activity.

WArm up: Draw reflecting
waves:

try many
bounces!

- weekend lab access: will announce
- project · under $50   Lab 06
  - plan: ·budget ·pitch
    ·schedule
  - demo w/ paper prototype. lab 10
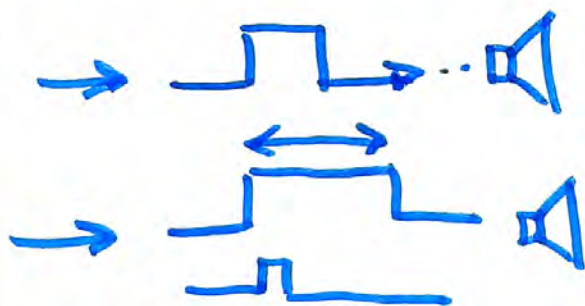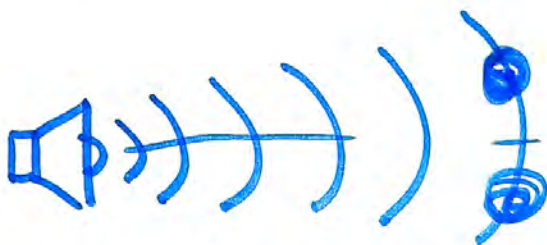 - sketchbook mtgs.
  - last lecture demo

②

ultra sonic

trigger
echo

+ −
t e

t

e

timer

Wall

distance

ultra sound

PWM

Noisy filter

window

signal = measurement = m

$$m[t] \quad \text{now}$$

$$m[0] \quad \text{first}$$

$$\text{signal} = \frac{m[t] + m[t-1]}{2}$$

$$\text{signal} = \frac{m[t] + m[t-1] + \cdots + m[t - \frac{n}{+1}]}{n}$$

$$\text{signal} = \text{avg}(m[n:t])$$

$$\text{signal} = \text{median}(m[n:t])$$

PID + filters

$$error = set - pos$$

set
pos

set = 5cm

wall

$$p = \frac{-1}{2}$$

10 cm
pos

$$error = 5cm - 10cm = -5cm$$

$$output = p(error)$$

$$\frac{-1}{2}(-5) = 2.5$$

wall

$$e = 5cm - 7.5cm = -2.5$$

$$o = \frac{-1}{2}(-2.5) = 1.25$$

7.5 cm

Design Challenge.