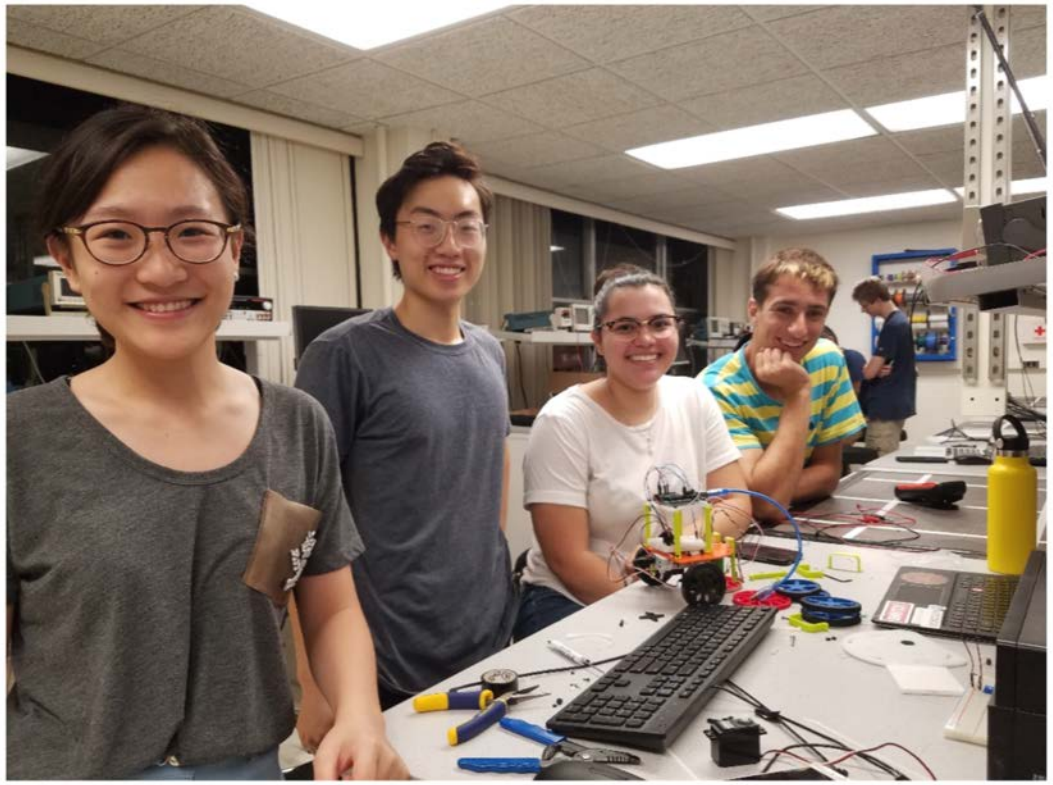
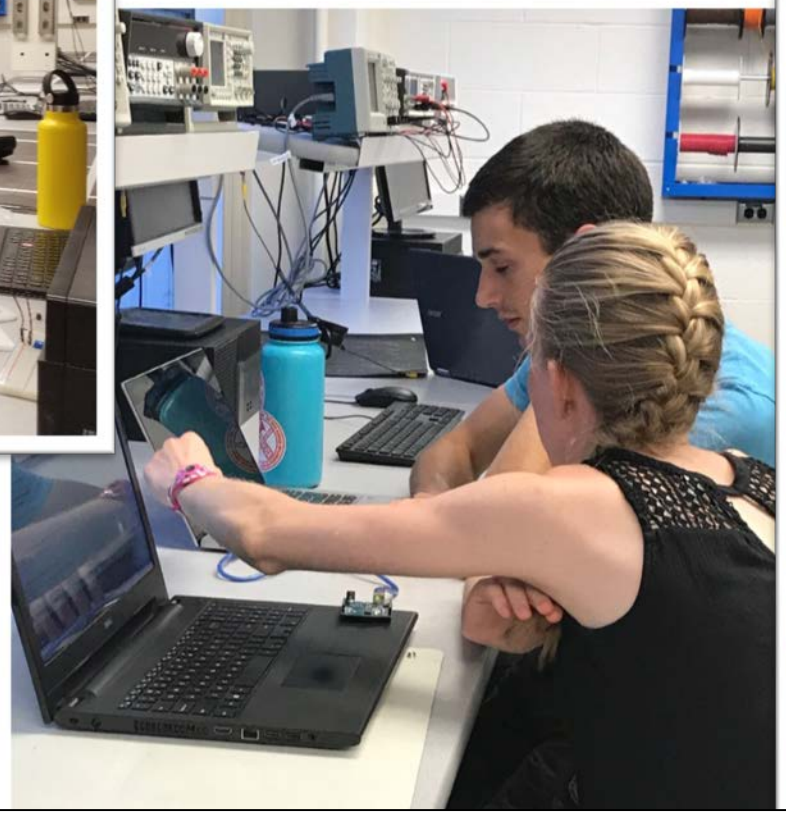
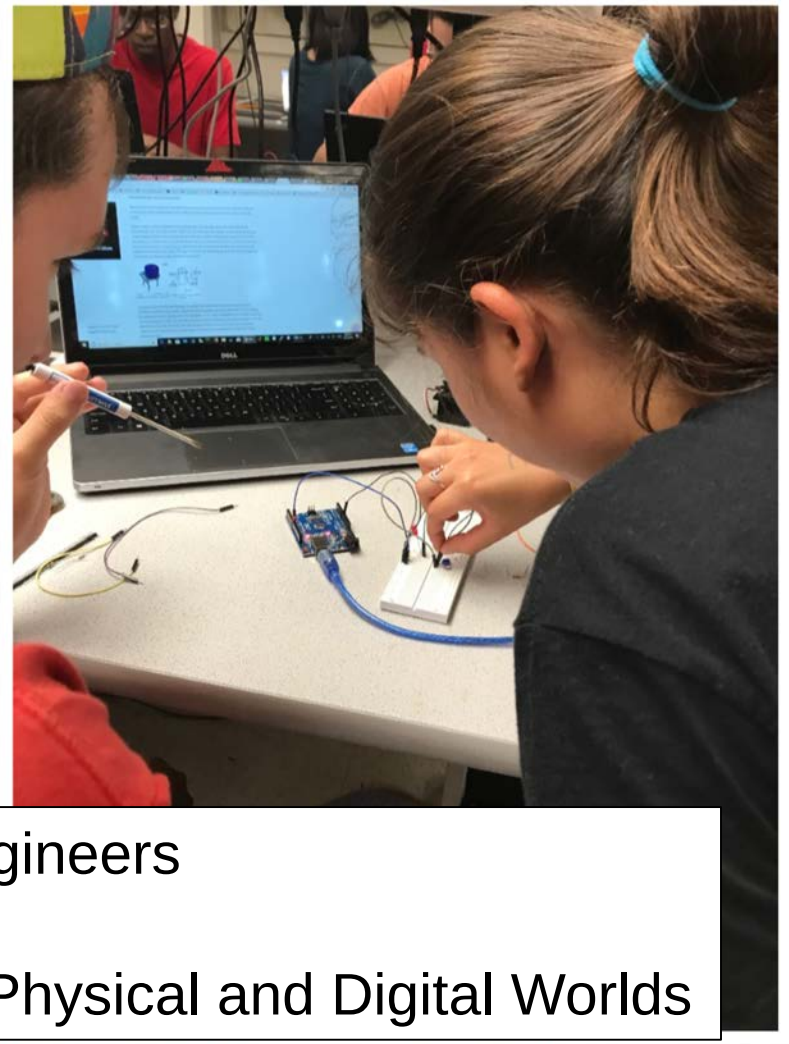
ECE3400: Intelligent Physical Systems







Week 3: Sensors and analog electronics

ECE 2100: Introduction to Circuits for Electrical and Computer Engineers
ECE 2200: Signals and Information
ECE 4320: Integrated Micro Sensors and Actuators: Bridging the Physical and Digital Worlds

Sensors

- Pushbutton
- IR line sensors
- IR wall sensors
- IR robot sensors
- Microphone
- (Camera)

Design good circuits

Signal to noise ratio (SNR)

Problems:

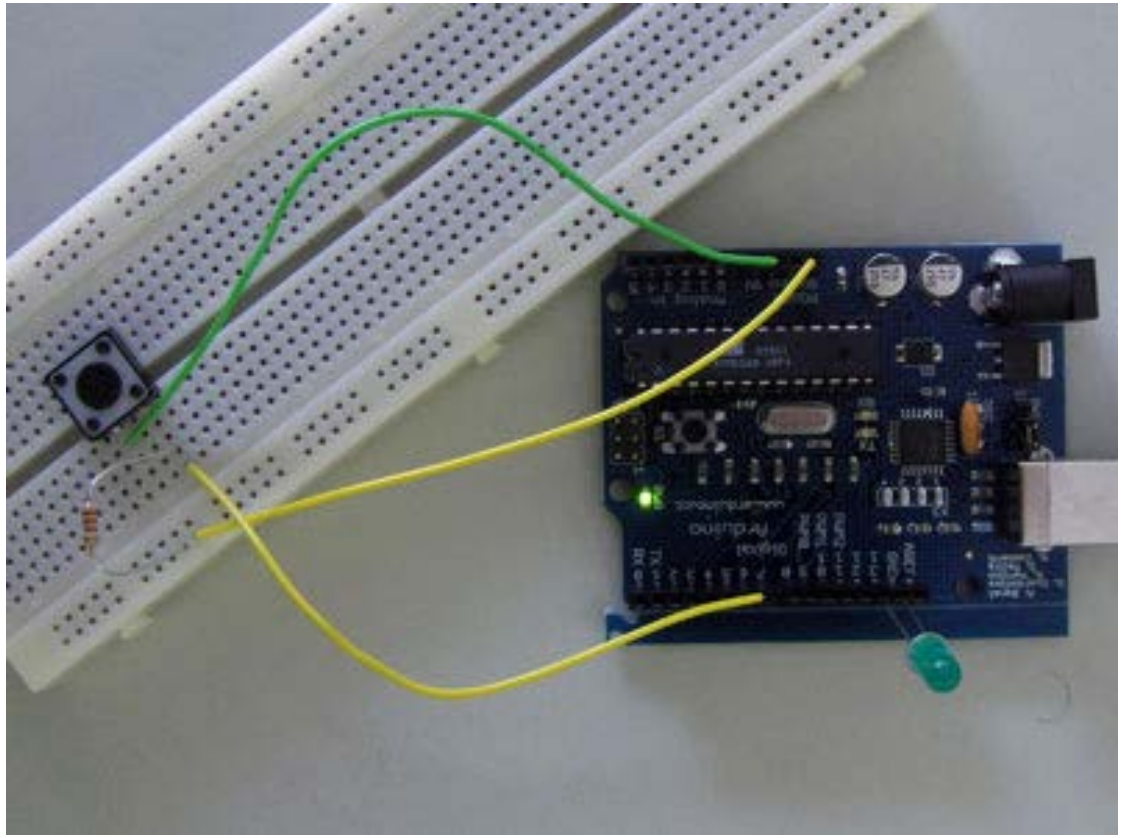
- *White noise*
- *Structured noise*
- *Malevolent noise*

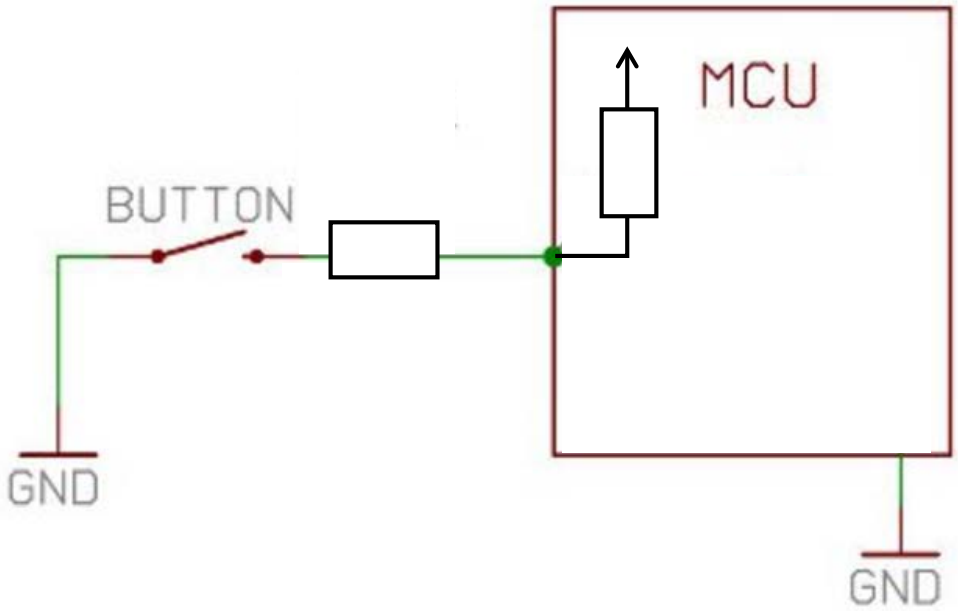
Solutions

- *Multiple samples*
- *Signal processing and systematic filtering*
- *Physical shielding*

Pushbuttons

- *What is the issue here?*
- *What if I just wanted to count the number of button presses?*





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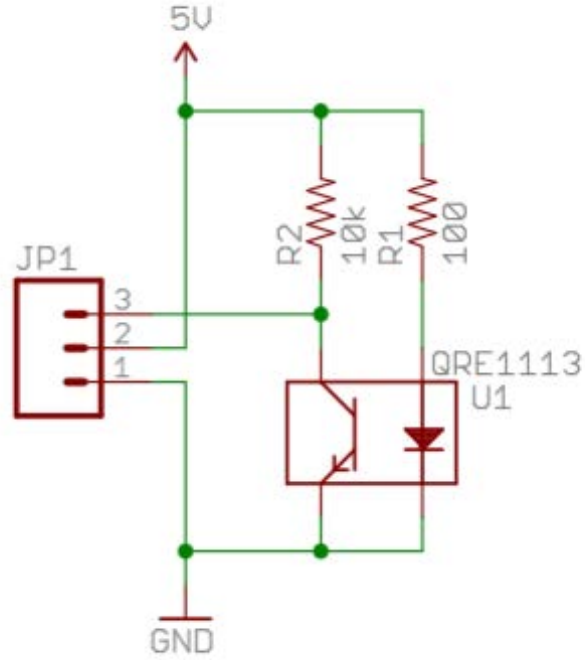
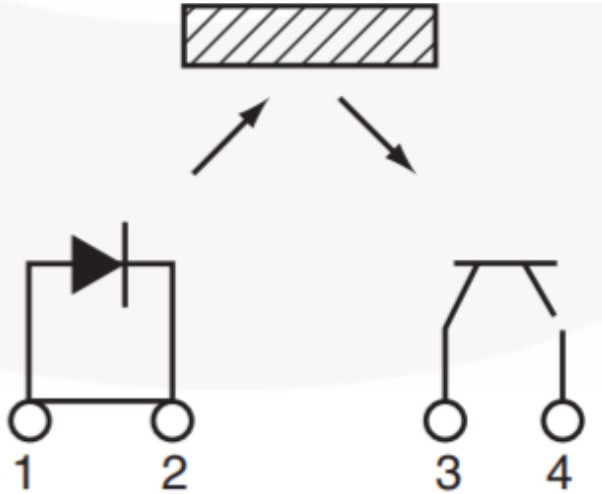
IR Line Sensors

- *How does the line sensor work?*
- *What is the value of p3 if the base is brightly lit?*
- *What if I wanted the opposite signal?*
- *What could mess up this signal?*
  - Ambient light
  - Changing substrate color
  - Different mounting heights



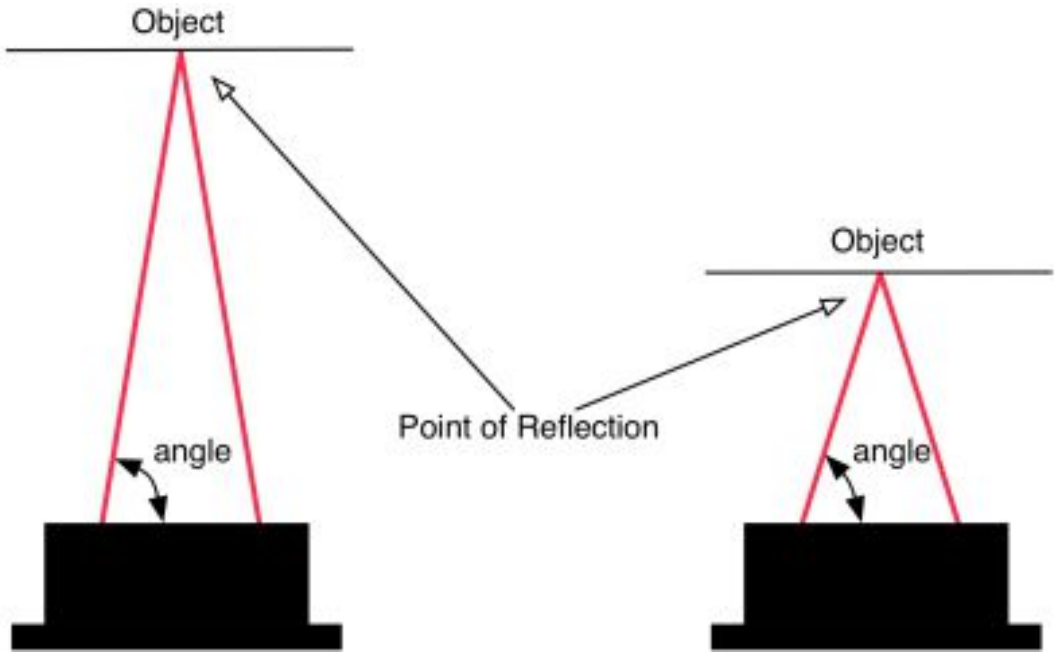


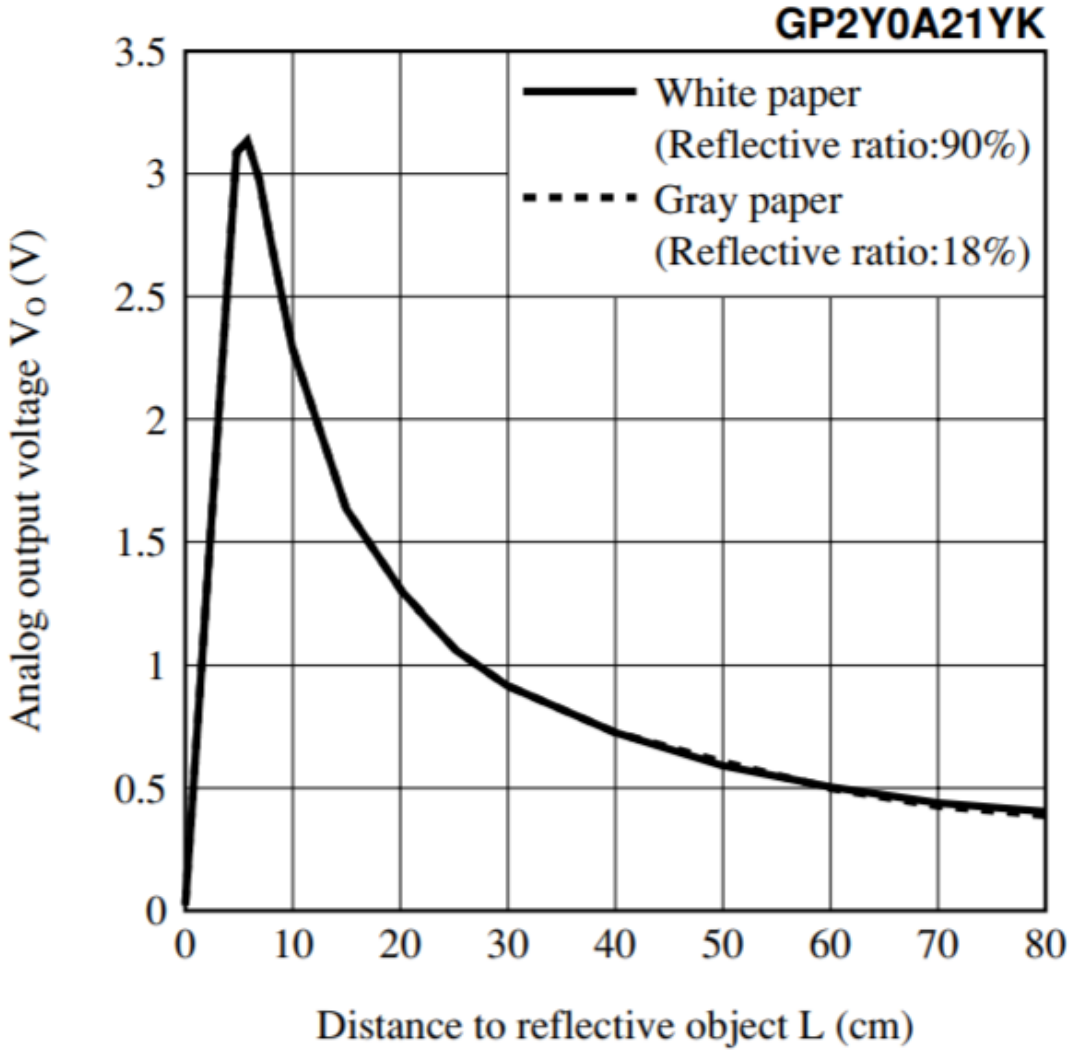
Pin 1: Anode
Pin 2: Cathode

Pin 3: Collector
Pin 4: Emitter

IR Wall Sensors

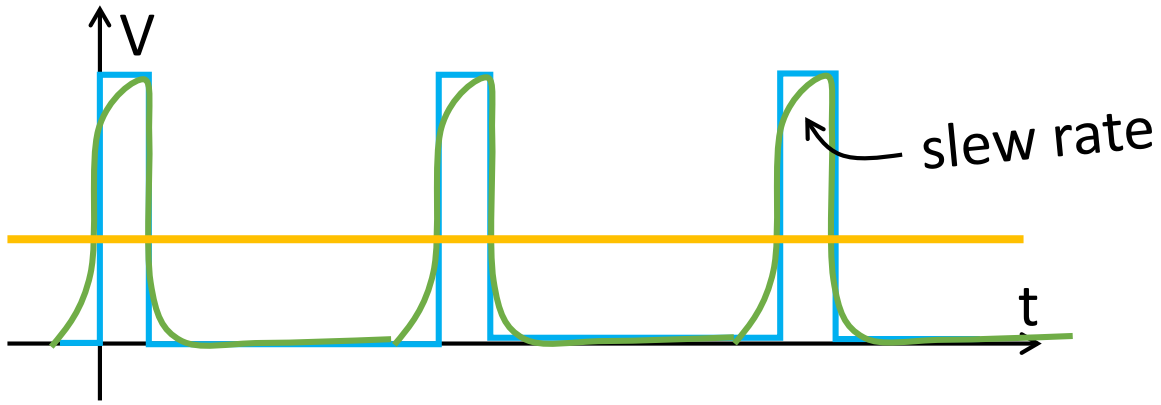
- *How to make IR distance sensors that are independent on color?*
  - Time of flight sensors
  - Angle sensitive sensors



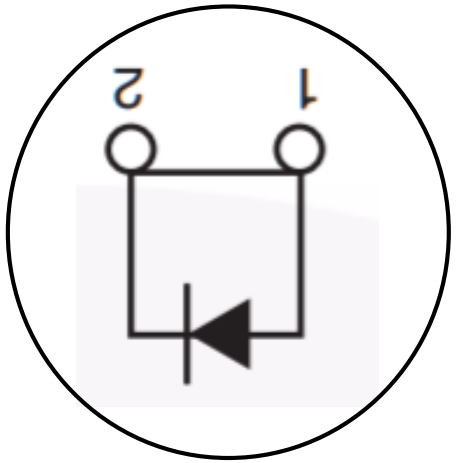


IR Robot Sensors

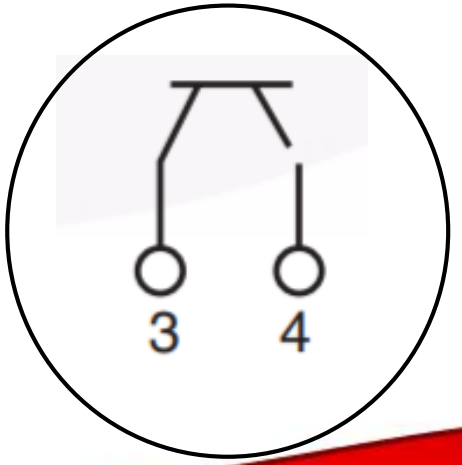
- *How are we driving the IR LEDs?*
- **DC**
  - Low maximum power, distance limited
- **AC**
  - Pulse Width Modulation
  - Higher pulses, longer distance
  - *What do you expect the sensor signal to look like?*



IR hats (OP298)

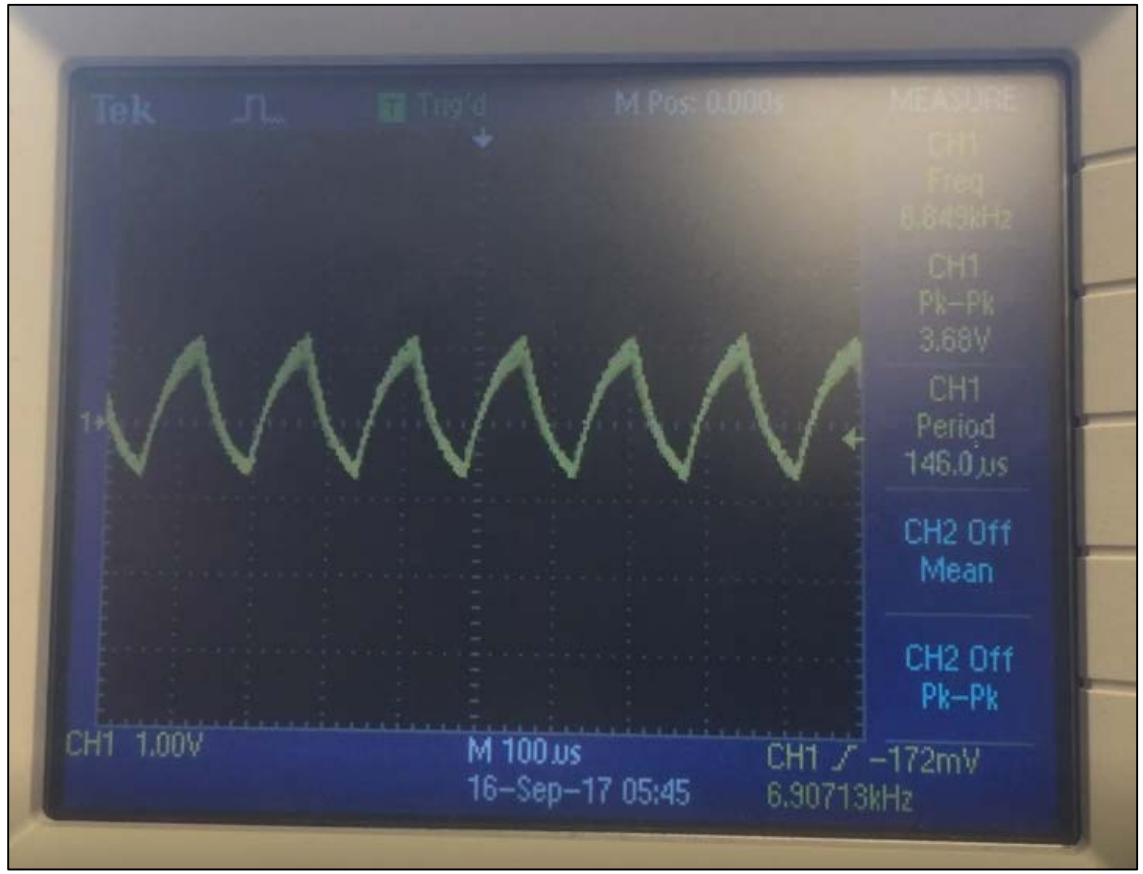


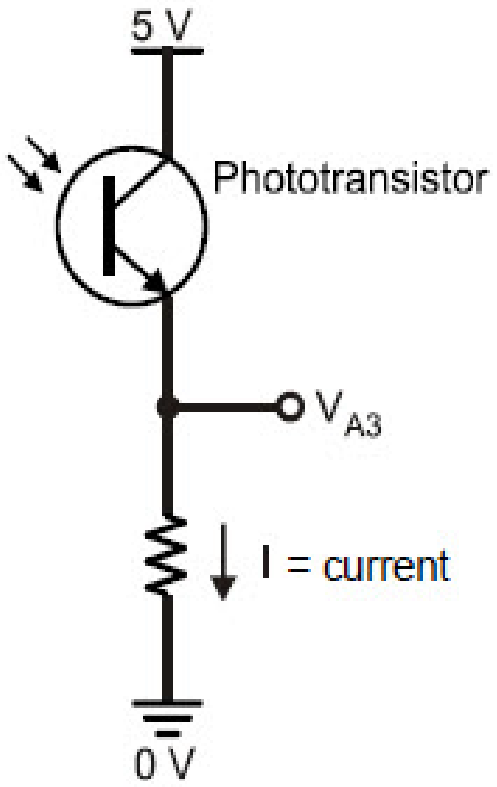
your robot (OP598)



IR Robot Sensors

- *Why could this be a problem?*





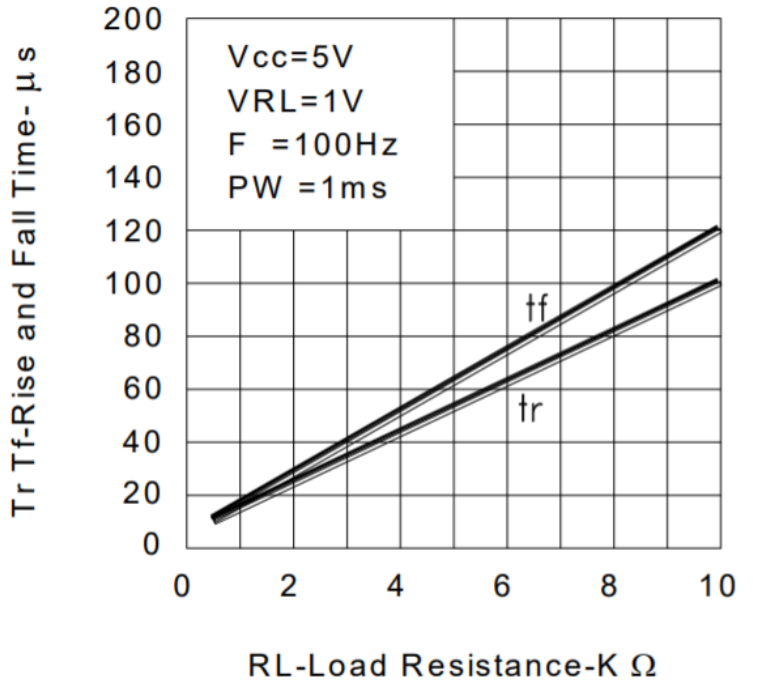


FIG.3 RISE AND FALL TIME VS LOAD RESISTANCE

IR Robot Sensors

- *How are we driving the IR LEDs?*
- **DC**
  - Low maximum power, distance limited
- **AC**
  - Pulse Width Modulation
  - Higher pulses, longer distance
  - *What do you expect the sensor signal to look like?*
- *What can you do against ambient light?*
- *What can you do against decoys?*
- *What if almost no signal comes out?*

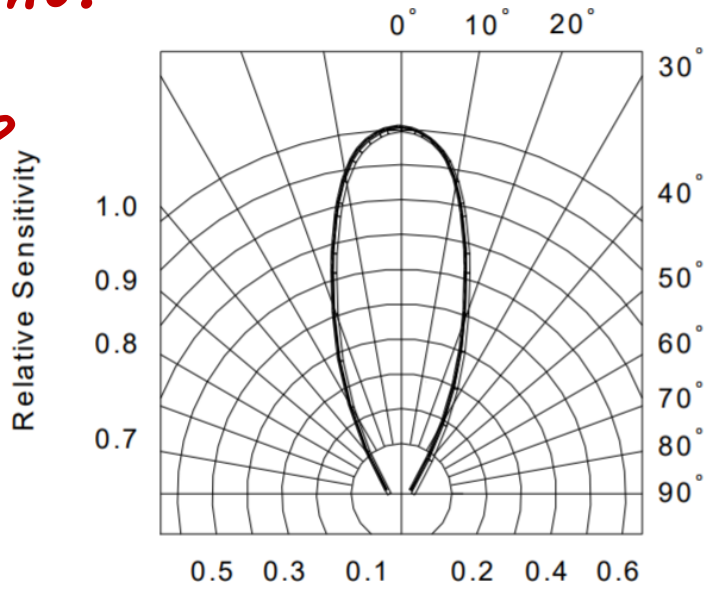
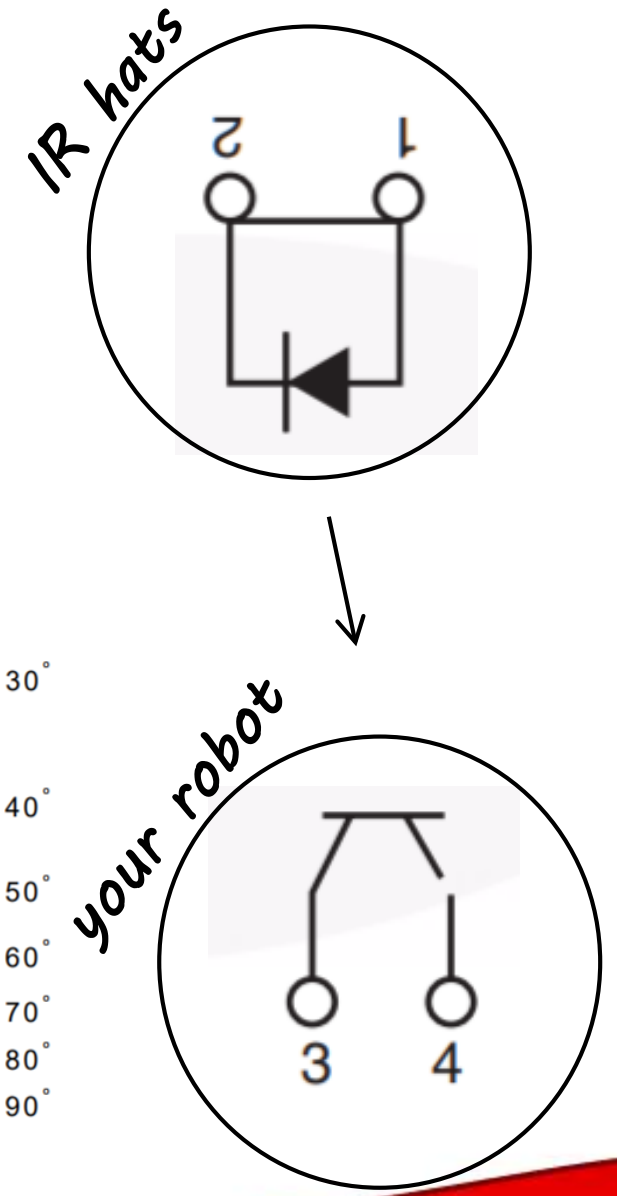


FIG.5 SENSITIVITY DIAGRAM



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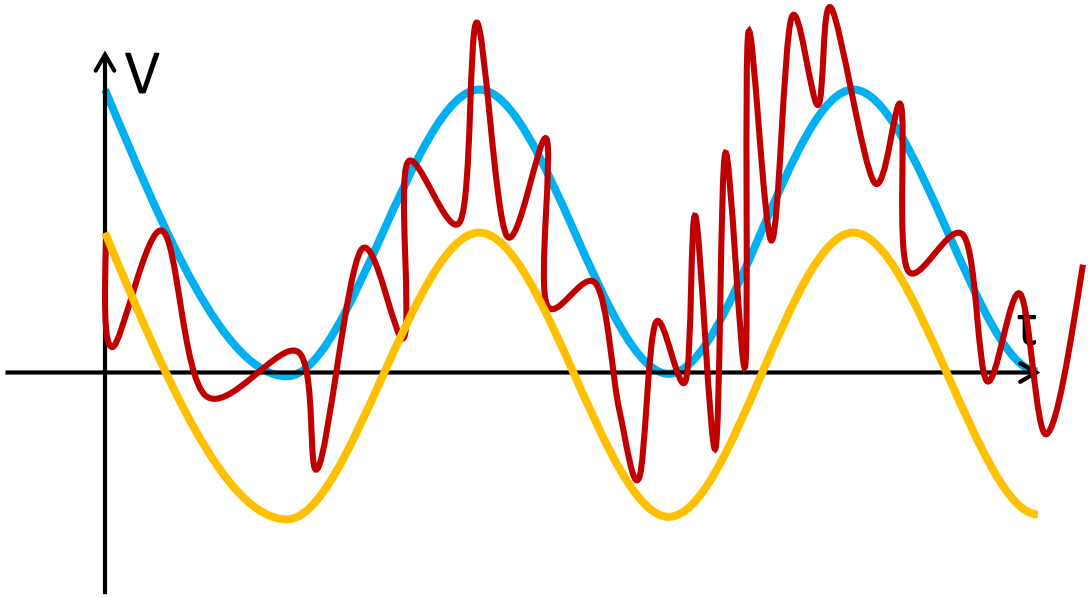
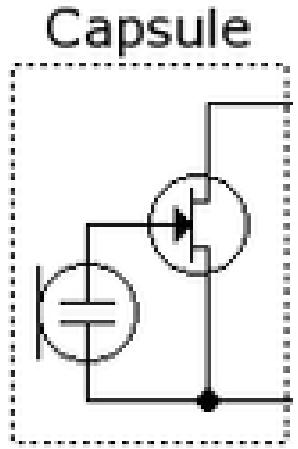
Microphone

- Detect a 660Hz signal
- *What is the background noise?*
  - Human speech (200-5kHz)
  - Music (200-20kHz)

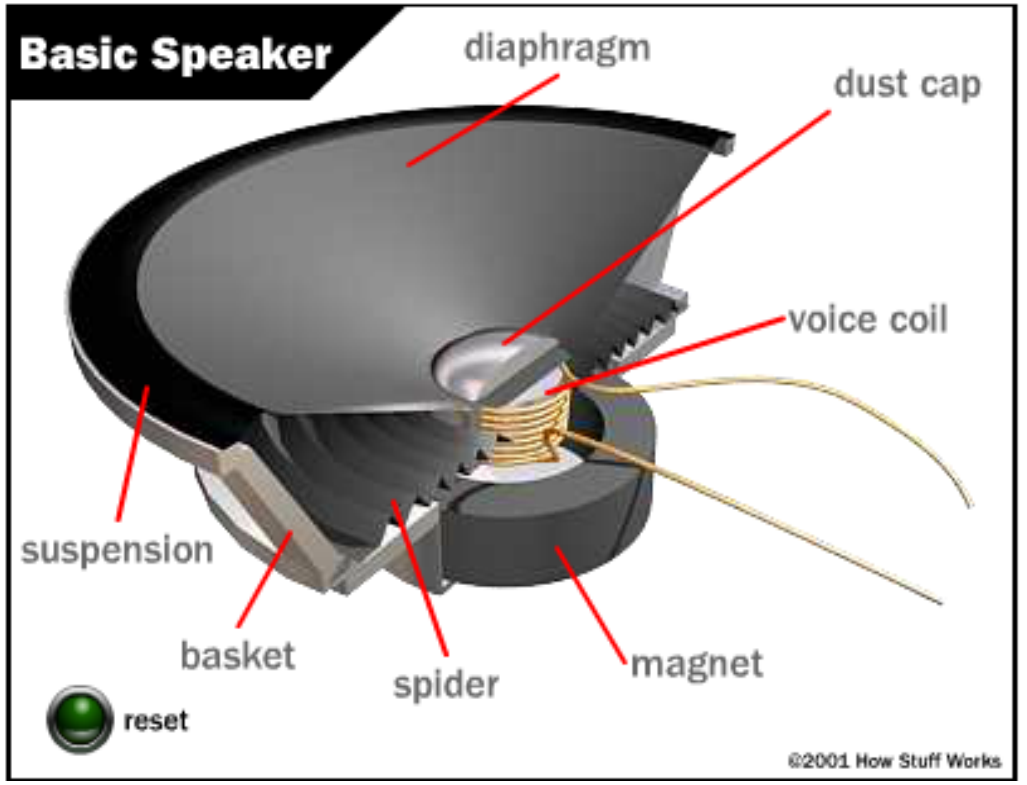


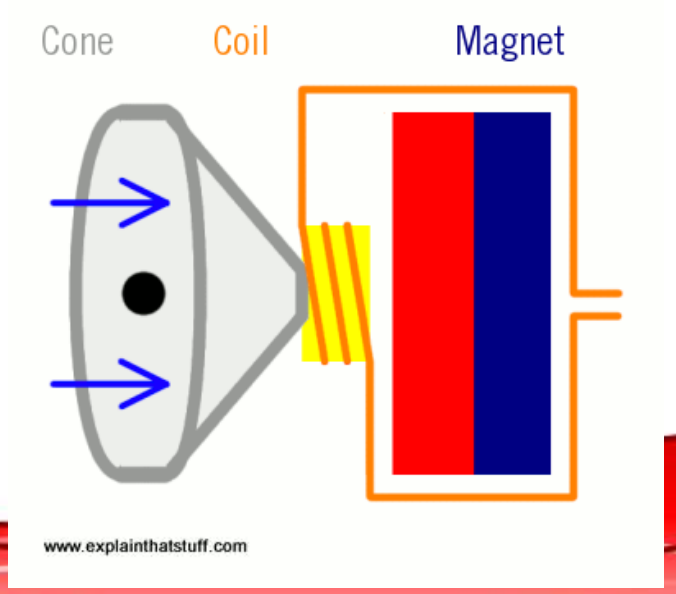


- *What does the output look like?*

Speakers

- Essentially the reverse of a microphone
- Electrical signals → physical vibrations
- Coil is in constant magnetic field
- Running current through coil creates electromagnet
- Switching current moves EM back and forth, creating sound waves





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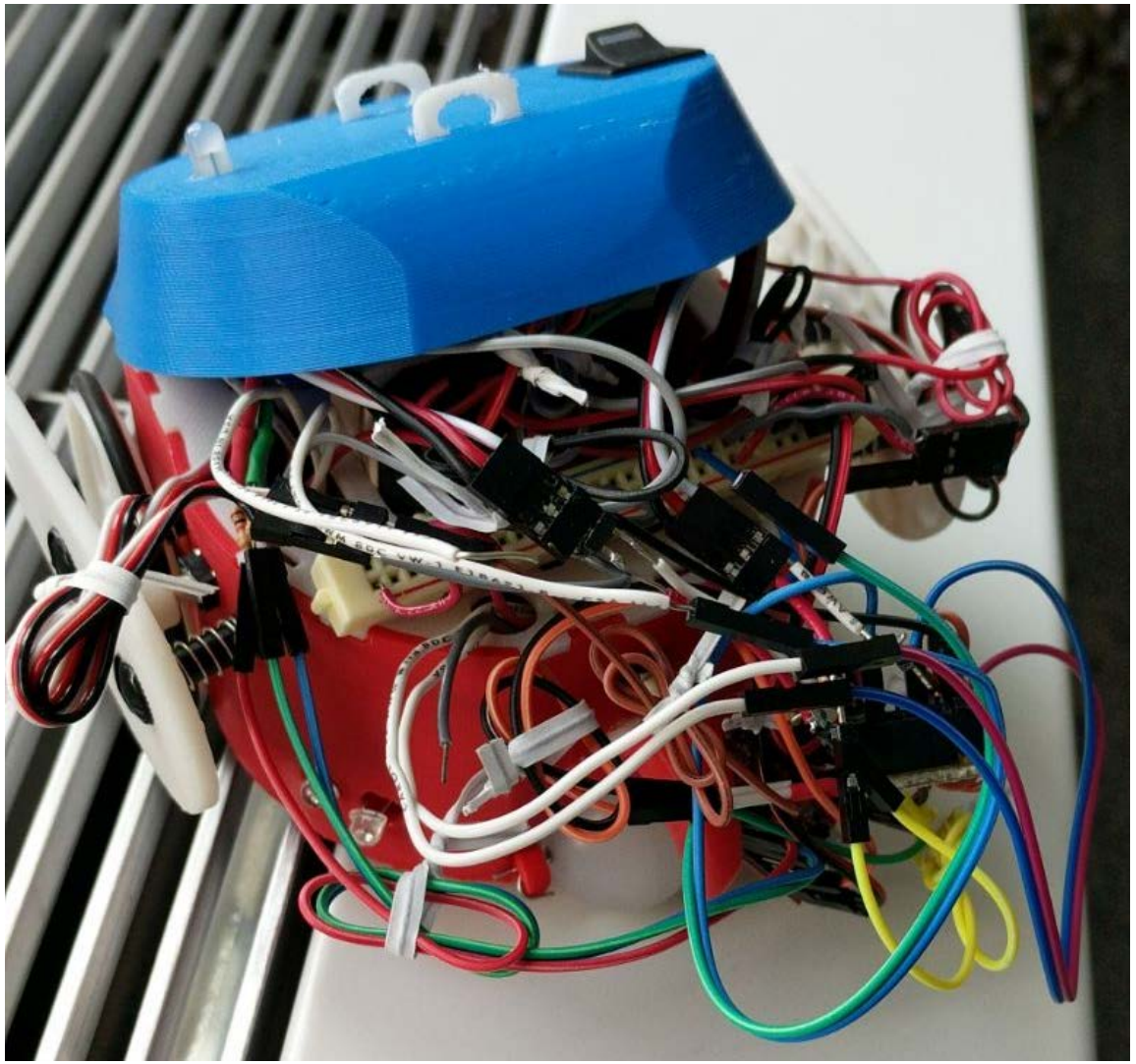
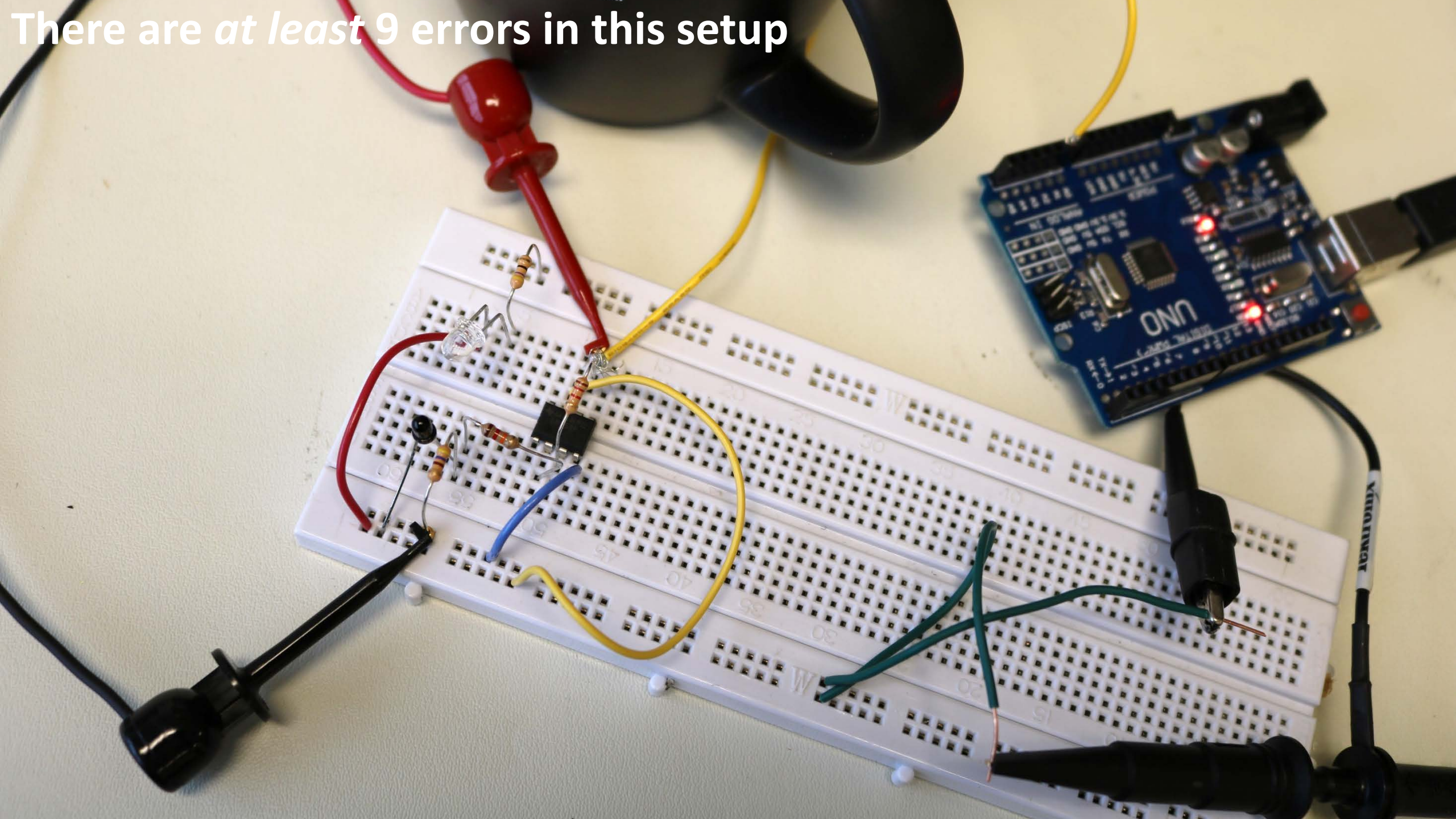
Typical cause of problems: Crazy Wires!

- Red/Black: VCC/GND
- Purple/Grey: Battery/return
- Other colors are signal wires (decide on a color scheme!)
- Shorten wires
- Twist out/return wires
- Plugs are removable, but soldered joints are smaller.
- Use soft over rigid wires on the robot




There are *at least* 9 errors in this setup
UNO

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