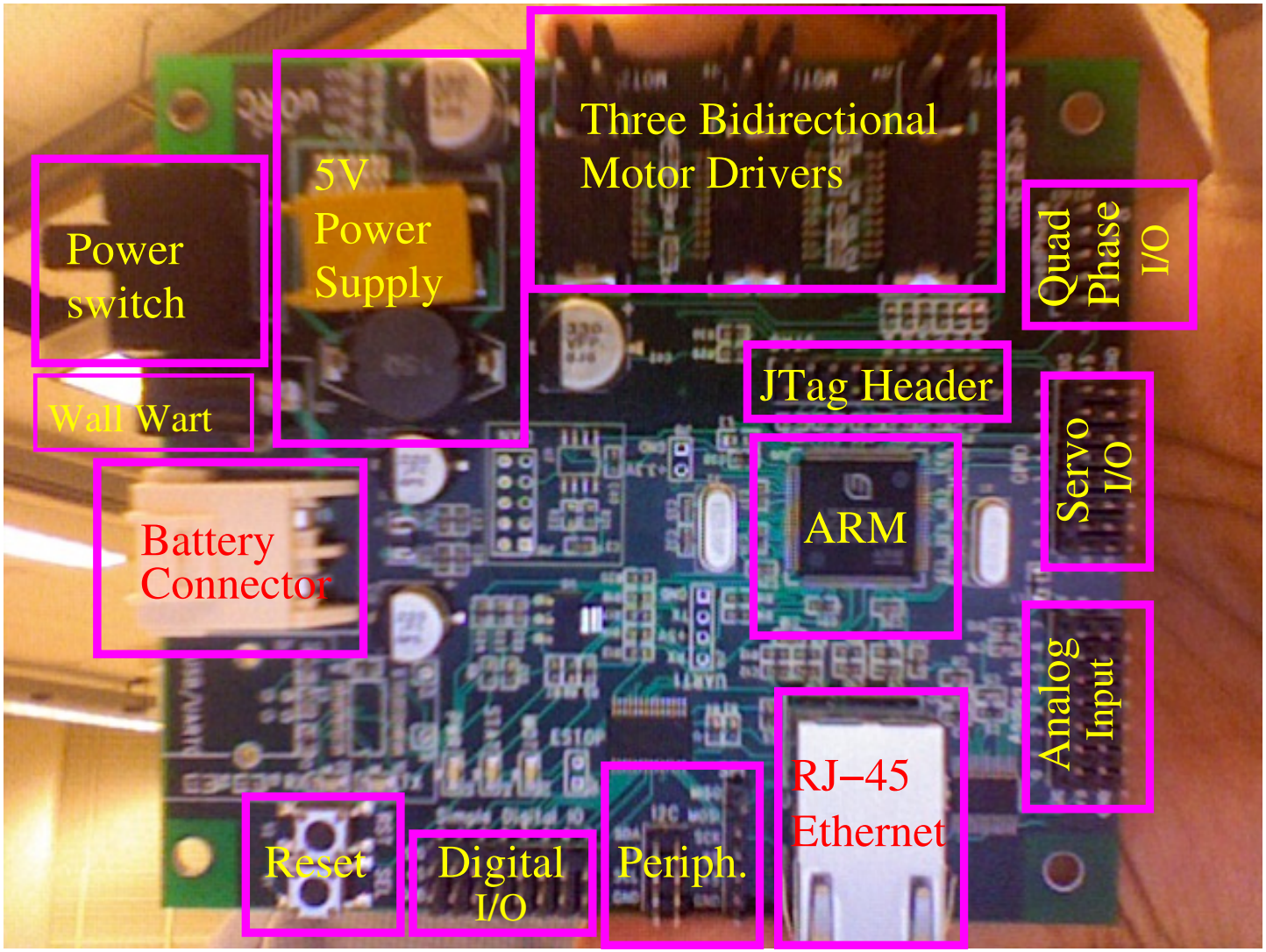
Maslab — Sensors 2009

Bhaskar Mookerji

6.186 Mobile Autonomous Systems Laboratory

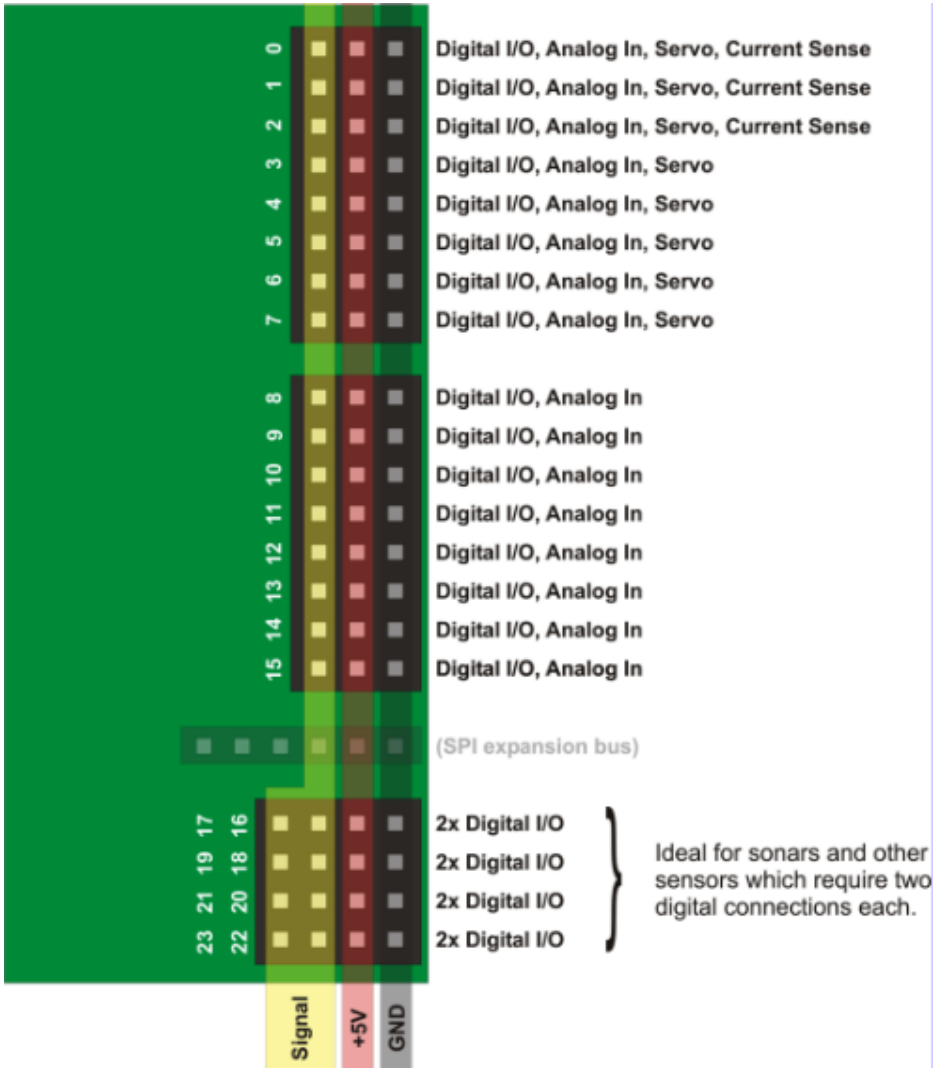
5 January 2009


Three Bidirectional Motor Drivers
5V Power Supply
Power switch
Wall Wart
Battery Connector
Quad Phase I/O
JTag Header
Servo I/O
ARM
Analog Input
RJ–45 Ethernet
Periph.
Digital I/O
Reset

Don't do anything that will harm you or the OrcBoards.

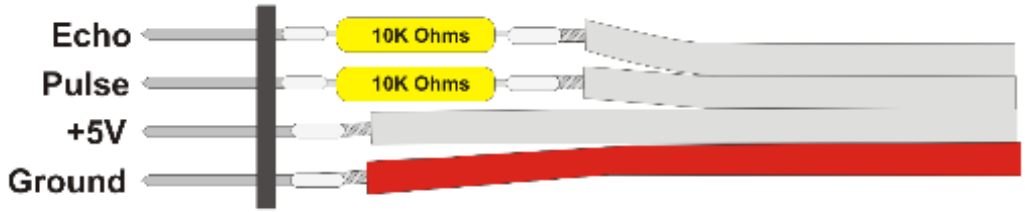
- Avoid shorts: Use electrical tape on back of the OrcBoard.
- Avoid ground loops: Keep cables short, twisted.
- Check polarity of connections. Insert sensors with the OrcBoard off.
- Connect to power *LAST*.

- Low-pass filter on analog/IO
- Built-in (approximate) current sense (All Motors, servos 0/1)
- 12-bit, 400Hz ADC, CMOS/TTL compatible:
  - Bump sensors
  - Hall magnetic sensors
  - Reed switches, etc.

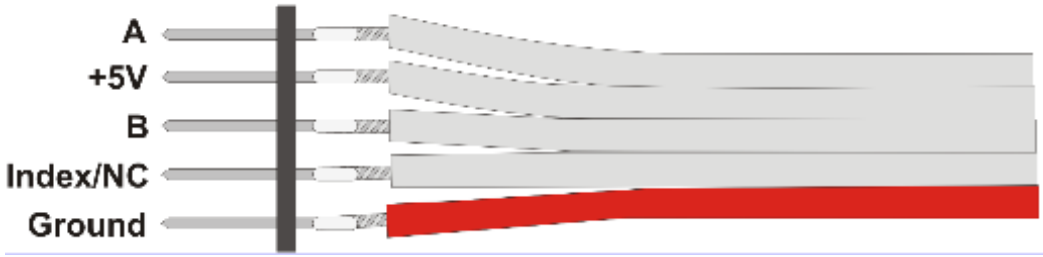


Analog Input, Digital Output, or Servo

Digital in with pullup (buttons/switches)



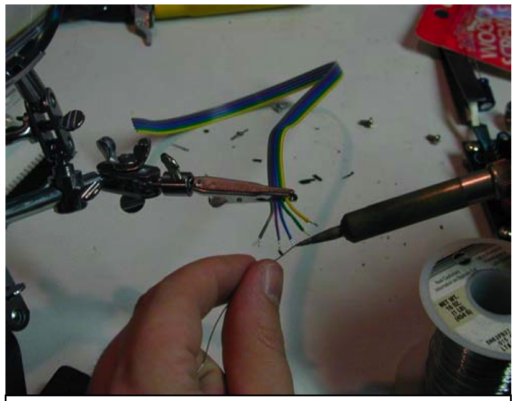
SRF04 Sonar



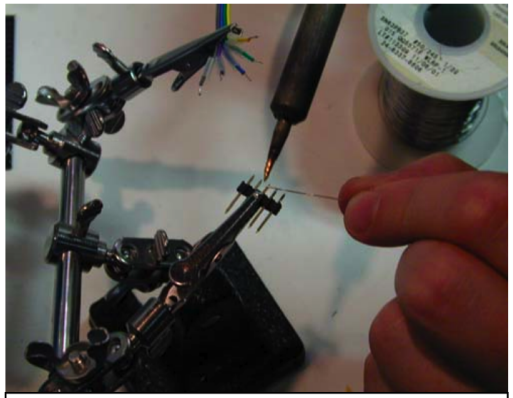
Quadrature Phase

Suggestions:

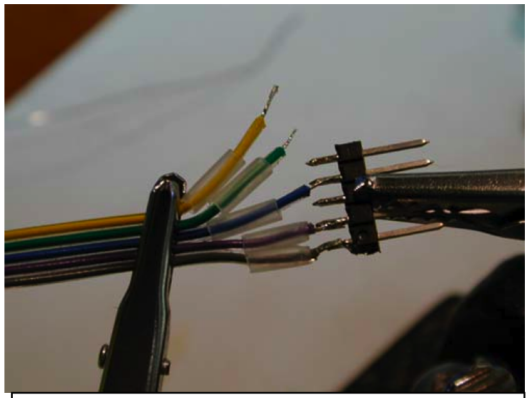
- Use 1/4" stranded wire
- Tin wire leads and header
- Protect connections with heatshrink (hot air gun)
- Plastic header melts easily
- Reinforce connections with hot glue (avoid shorting)
- Color code consistently for polarity (e.g., Ground–Black, +5V–Red, etc.)



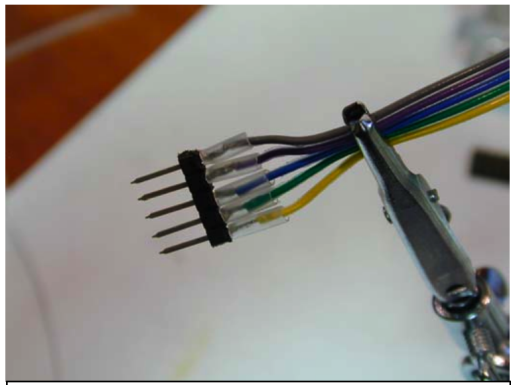
Pre-tin (add some solder) the stranded wire.



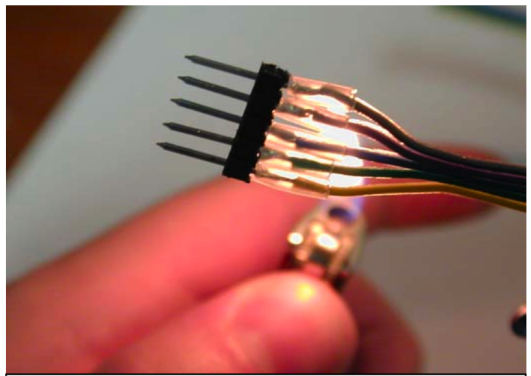
Pre-tin the connector.



Add heat shrink tubing and solder the pins together.



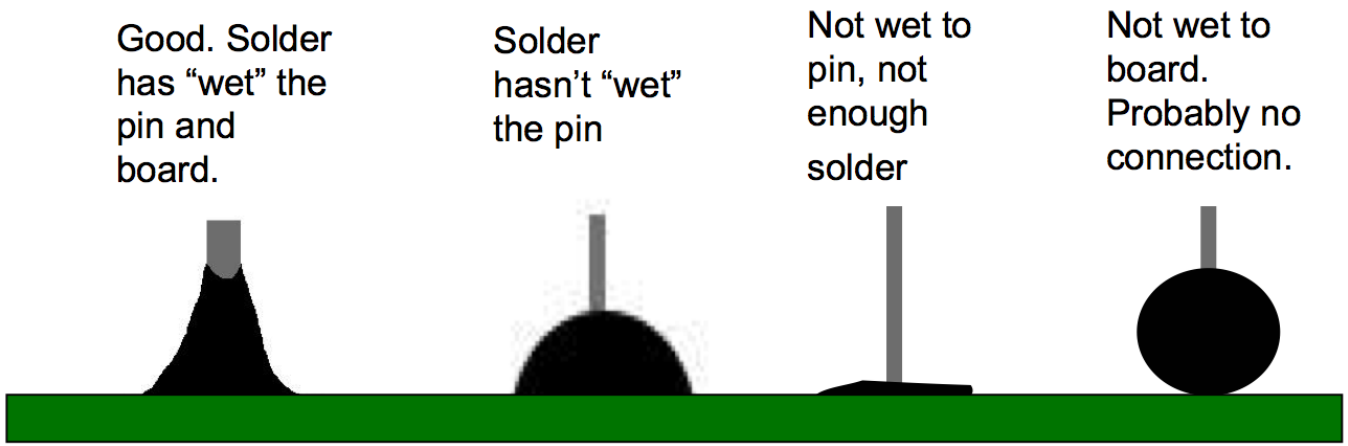
This cable is now ready for shrinking.



Shrink the heatshrink tubing.

Soldering

- Keep *wet* sponge for cleaning iron tip
- Heat joining surfaces
- Beware joint oxidation and other bad connections:



See:

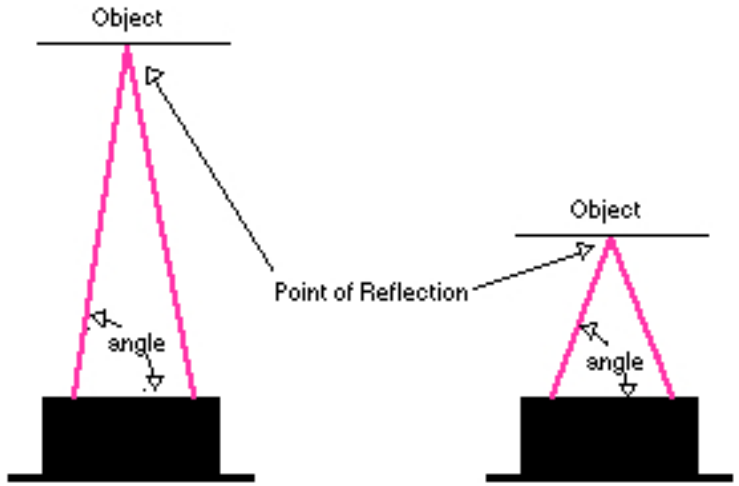
- `http://www.sparkfun.com/commerce/hdr.php?p=tutorials`
- `http://orcboard.org/documentation/soldering.pdf`

IR sensors ($\lambda = 850 \pm 70$nm):

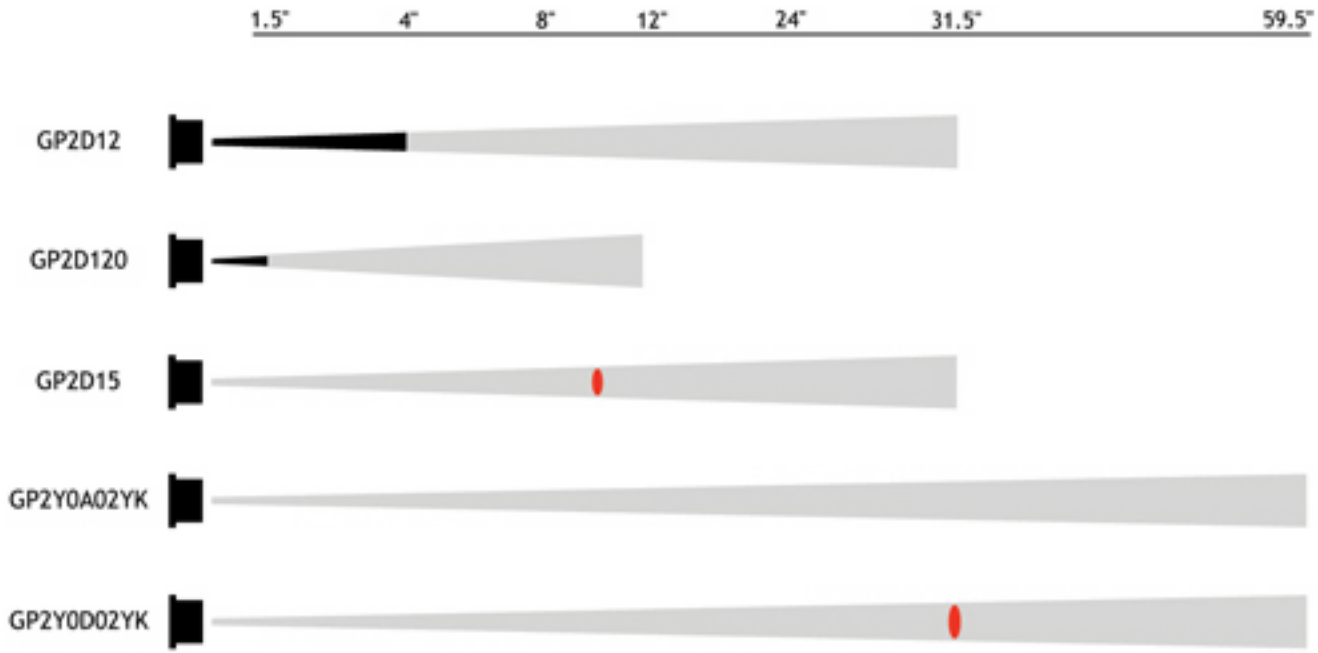
- IR pulse is emitted
- Lens transmits reflected light onto linear CCD array
- Angle of reflected light $\rightarrow$ barrier range

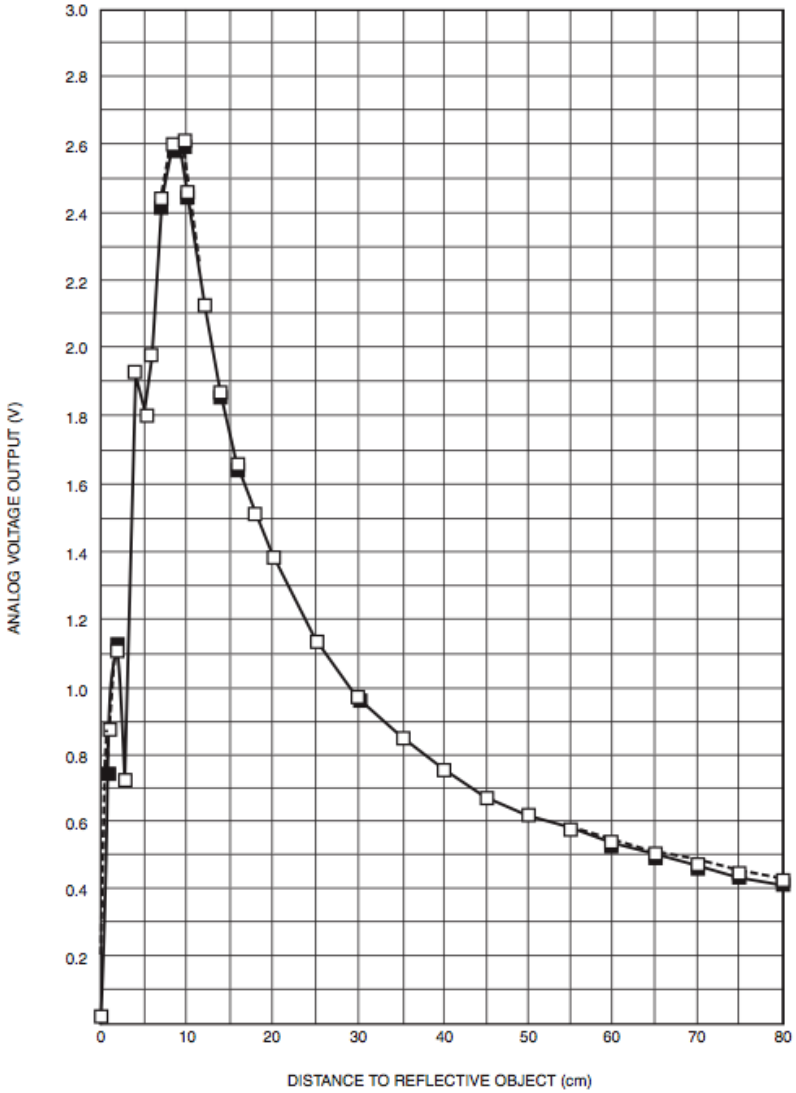
Two types:

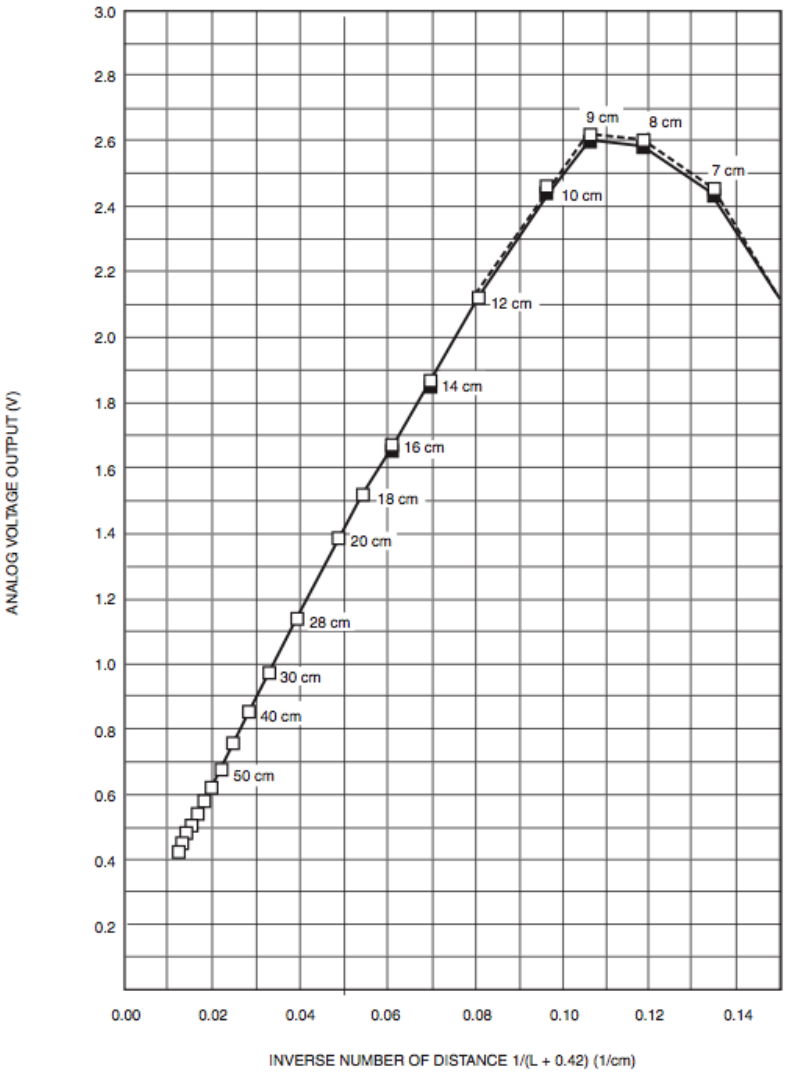
- GP2D12 (short range)
- GP2Y0A02YK (long range)



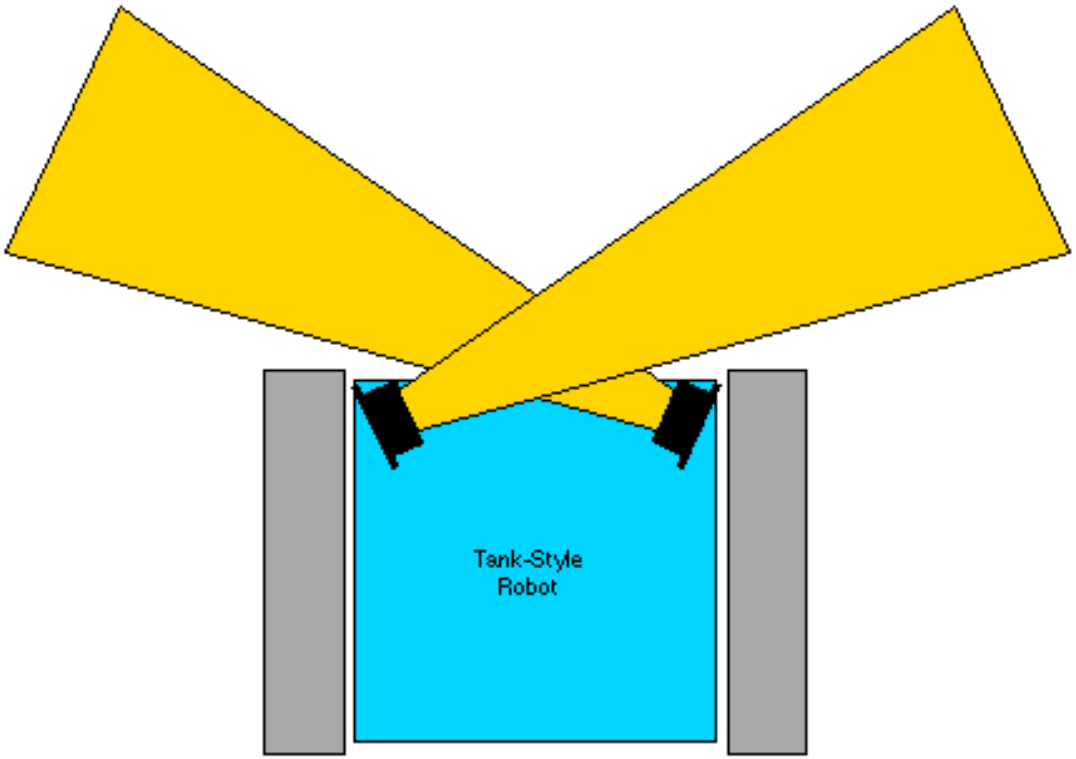
- Non-linear response: accuracy, resolution, and range
- Short-readings look far away



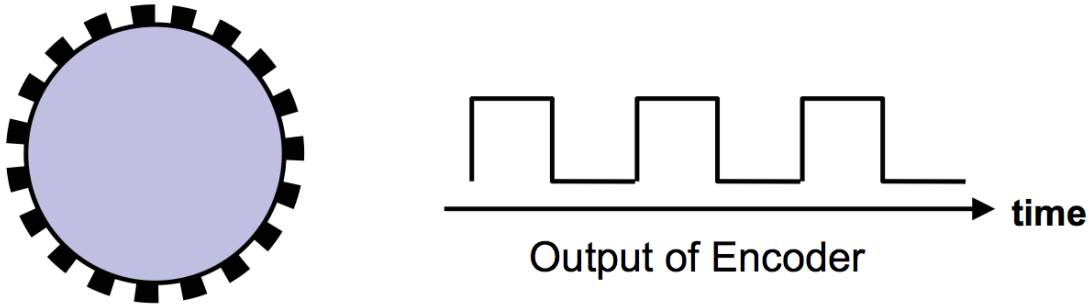

ANALOG VOLTAGE OUTPUT (V)
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
10
20
30
40
50
60
70
80
DISTANCE TO REFLECTIVE OBJECT (cm)


ANALOG VOLTAGE OUTPUT (V)
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
9 cm
8 cm
7 cm
10 cm
12 cm
14 cm
16 cm
18 cm
20 cm
28 cm
30 cm
40 cm
50 cm
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
INVERSE NUMBER OF DISTANCE 1/(L + 0.42) (1/cm)

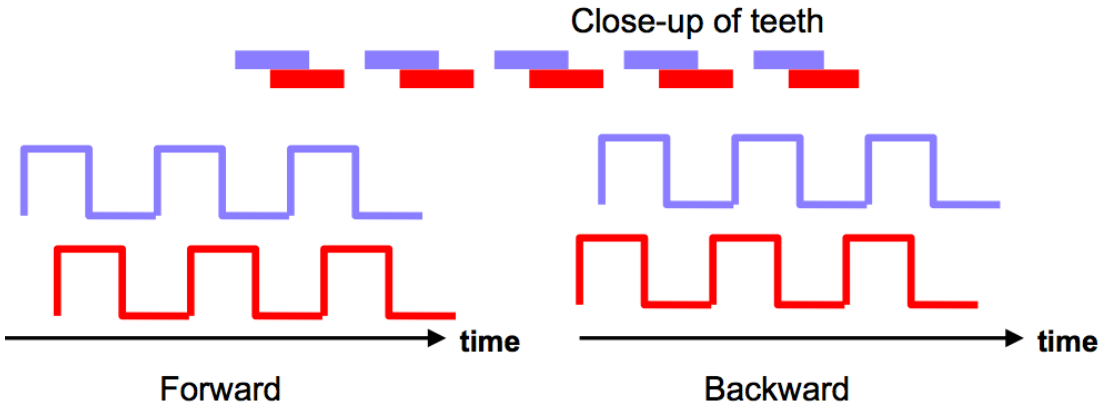
- Beam football-shaped, widest in the middle at 16cm
- Wide beam pattern in front/sides of robot using servos



Reflectivity sensor for a disk with black/white colored wedges



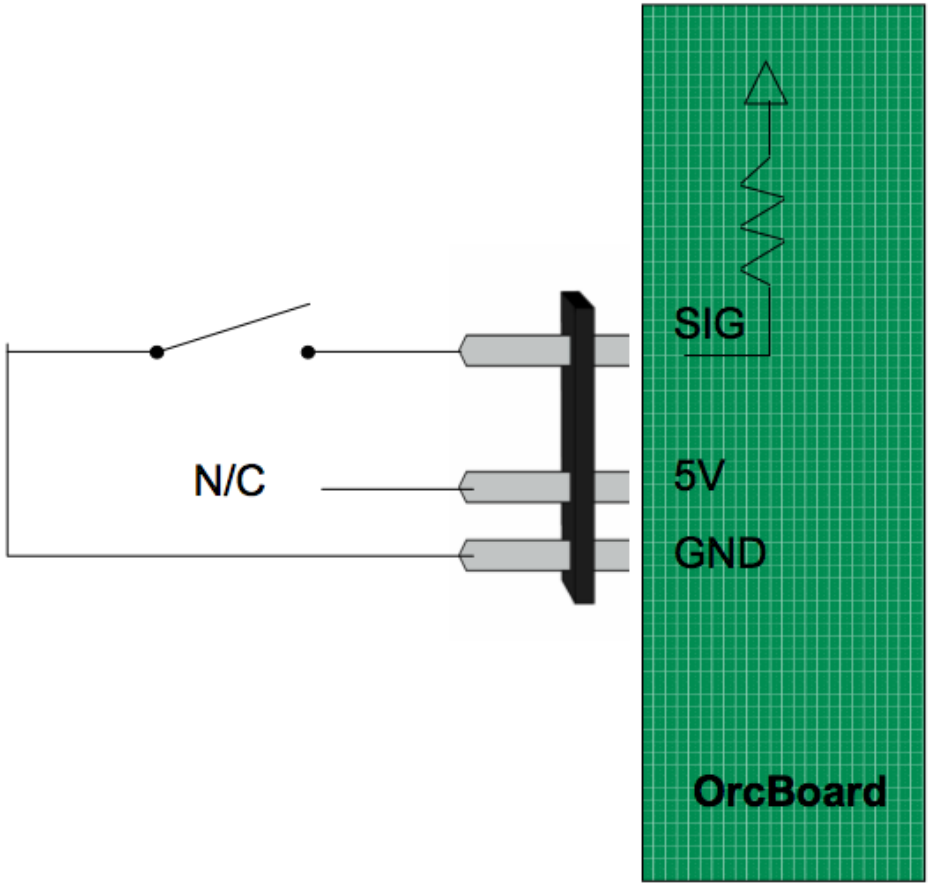
Two single encoders: $\pi/2$ phase difference to distinguish foward/backward movement:



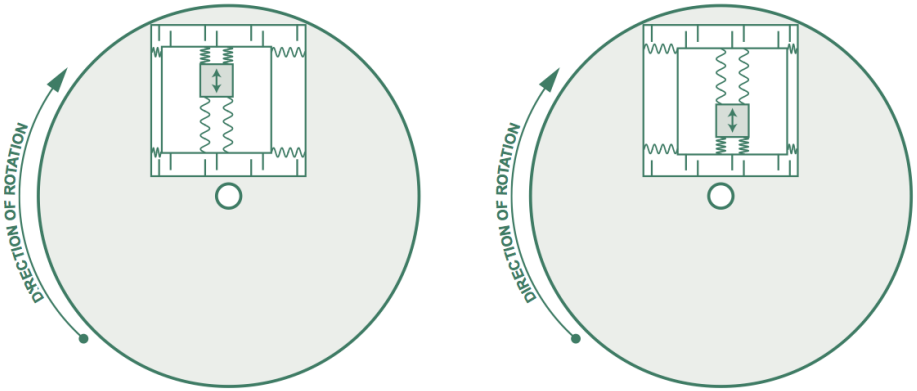
Quadrature phase detection for:

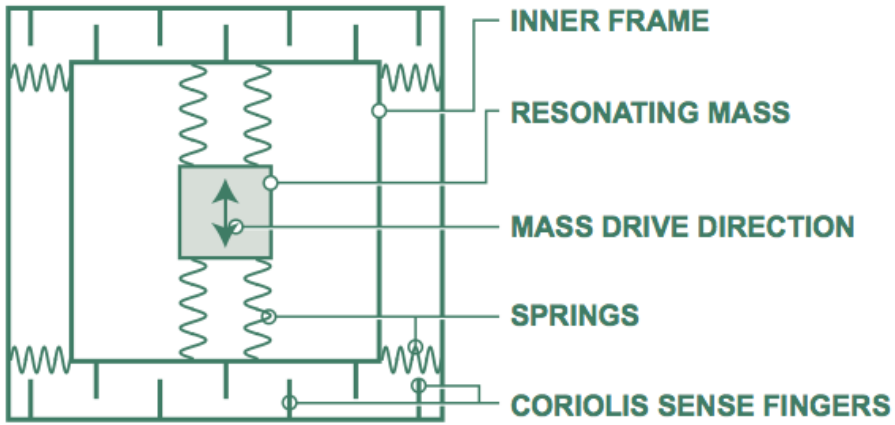
- Relative positioning
- Velocity control and feedback (PID controller). This, like vision, can detect stalling (important).
- Mapping and odometry

- Very reliable barrier detection
- Spring-loaded NES buttons
- Or, fabricate your own whisker switches



- Non-inertial reference frame: Coriolis acceleration: $a = -2(v \times \omega)$
- Orc samples at full ADC rate, integrates
- Slow turns, noise, integration $\rightarrow$ drift
- Important for:
  - Dead reckoning with other sensors
  - Feedback: Straight lines, turns





- Read PS/2 protocol from `/dev/mouse0`
- Java `FileInputStream` returns encoded (*dx*,*dy*) bytestream

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 1	Y overflow	X overflow	Y sign bit	X sign bit	Always 1	Middle Btn	Right Btn	Left Btn
Byte 2	X Movement							
Byte 3	Y Movement							

See:

- `http://www.microsoft.com/whdc/device/input/mcompat.mspx`
- `http://www.computer-engineering.org/ps2mouse`

- Ball detection? Breakbeam sensor
- Debugging? LED lighting
- Stalling? Don't let this happen to you!

Reminders

- Start early.
- Mind the size of your robot, camera calibration, and the limits of your sensors.
- Competition is timed, program accordingly.
- Sensors can be noisy or fail entirely, depending on how you use them.
- Use Athena SVN repositories for backup/version control.
- Read past journals/papers.
- Ordering new parts? (under $100!)
  - `http://www.allelectronics.com/`
  - `http://www.mcmaster.com/`

- `Java` got you down? Try Ed Faulkner's Java tutorial! `http://maslab.lcs.mit.edu/2004/lectures/javareference.txt`
- uOrc's self-assigned IP address—`192.168.1.7`. To connect your EeePC and the uOrc on the same local network, `sudo ifconfig eth0:1 192.168.1.100`.
- Updates are still being made to orc.jar (.java):
  - Camera
  - DigitalInput, DigitalOutput
- Easy way to disable default Gnome display:
  - `sudo apt-get install rcconf; sudo rcconf`
  - Disable `gdm` in menu.