

Physical Computing

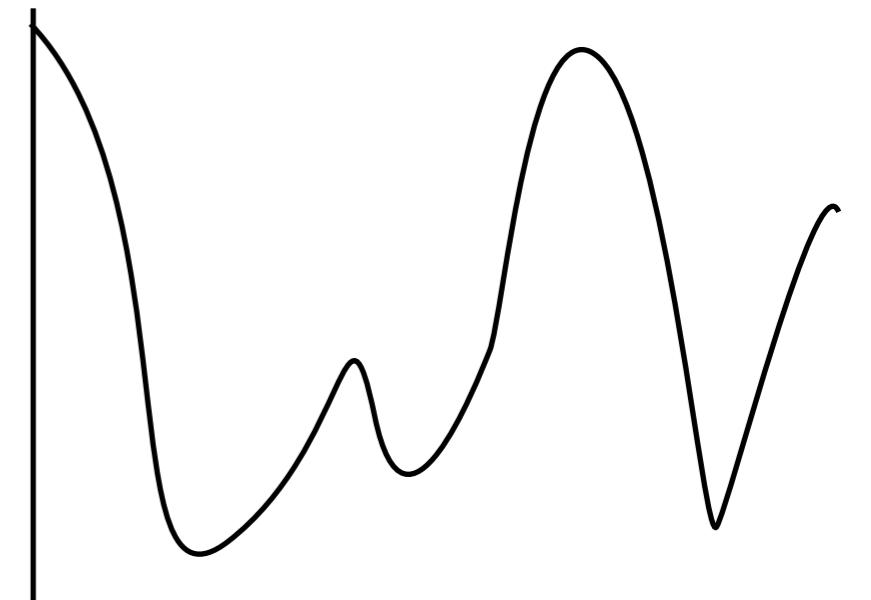
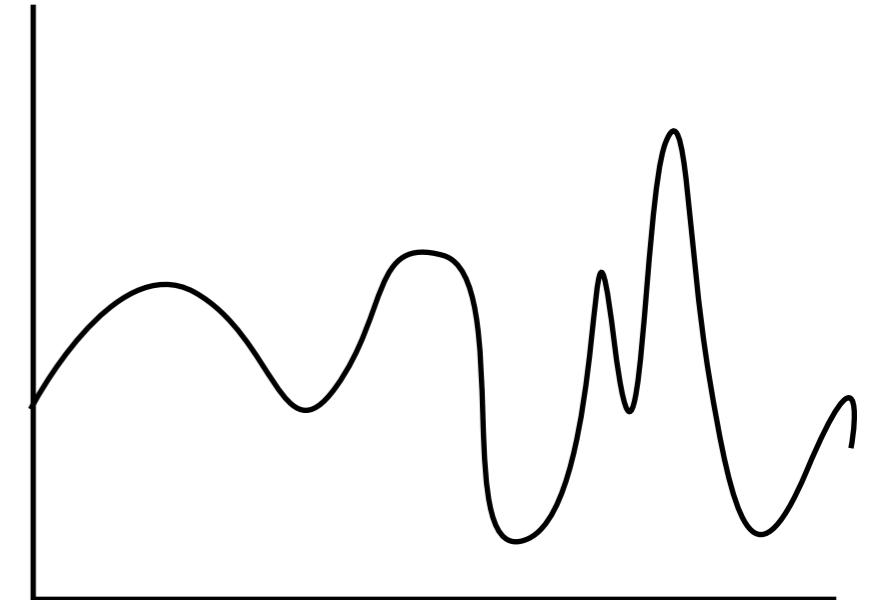
David A. Mellis

Bill Verplank

INTERACTION DESIGN



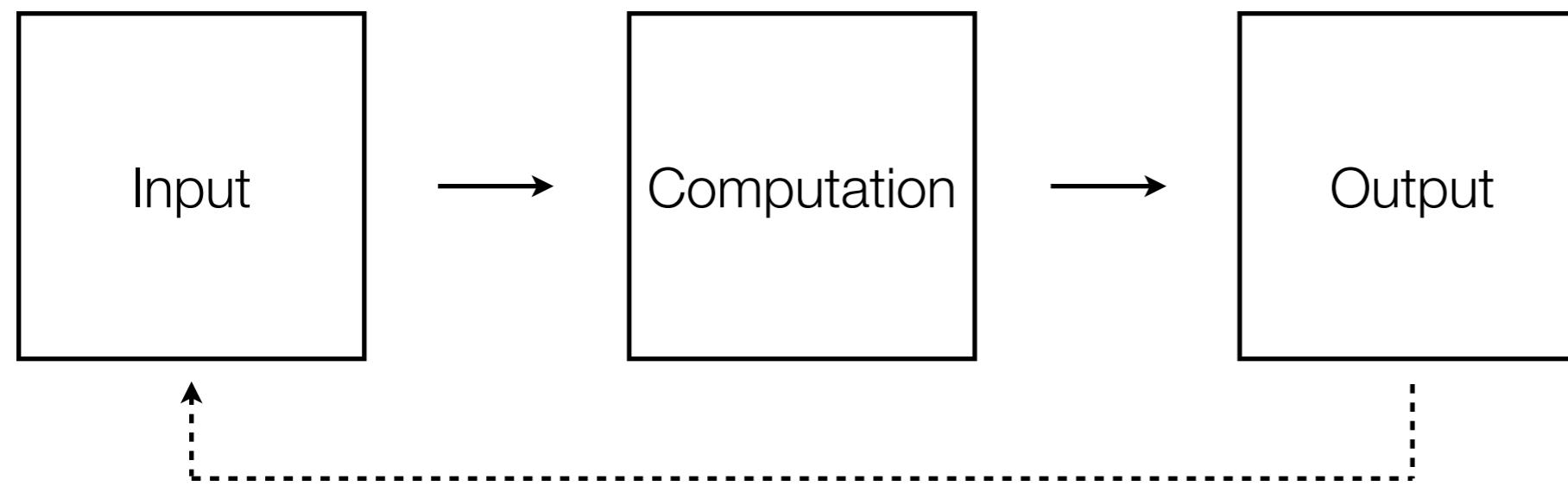
From Physical World to Electrical Signal



Images from Control Freaks by Haiyan Zhang, <http://failedrobot.com/thesis/>

See also: *Ideal and Real Systems: A Study of Notions of Control in Undergraduates Who Design Robots* by Fred Martin
http://llk.media.mit.edu/papers/CiP_Martin.pdf

Translation: Your Ideas to Electronics



Questions

- What do you need to sense?
- What do you need to actuate?
- How are you going to power it?
- What do you need to communicate with?
- How are you going to put it together?

Outline

Computation

Sensors

Actuators

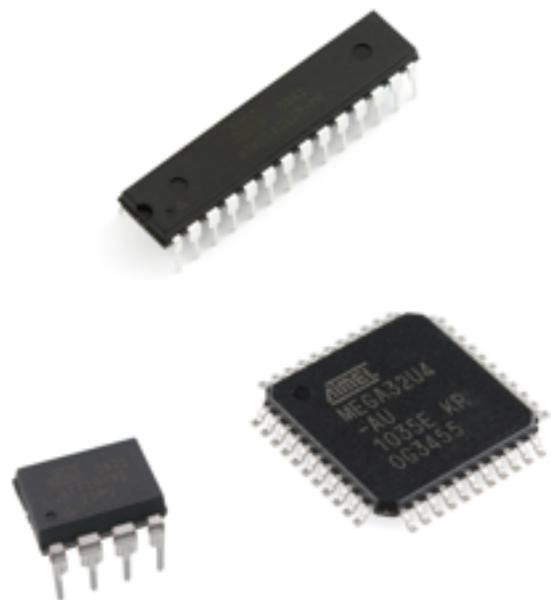
Communication

Power

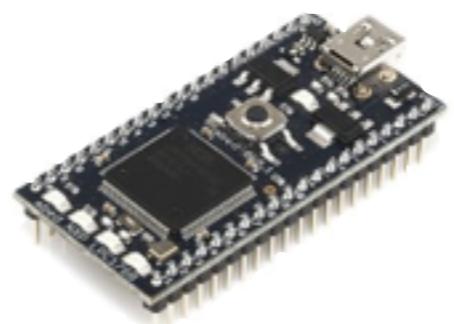
Computation

Computation

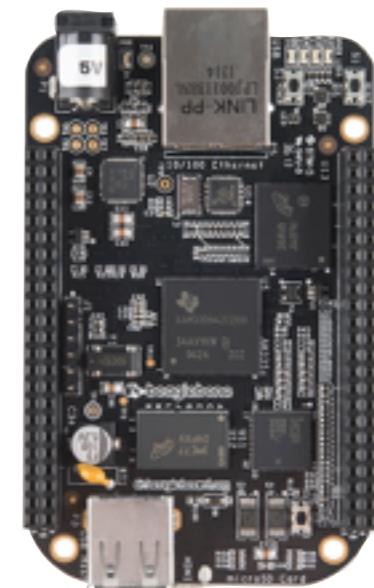
Microcontroller
\$1 – \$10



Microcontroller Board
\$10 – \$75



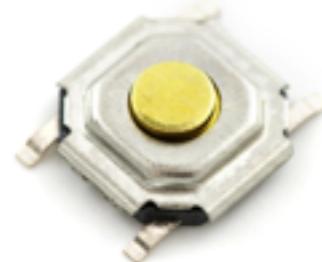
Single-Board Computer
\$25 – \$150



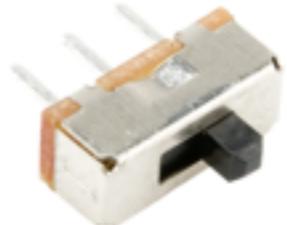
Sensors

Buttons, Switches, Knobs, etc.

Pushbuttons
\$0.25 – \$1



Switches
\$0.50 – \$1



Potentiometer
\$1 – \$5

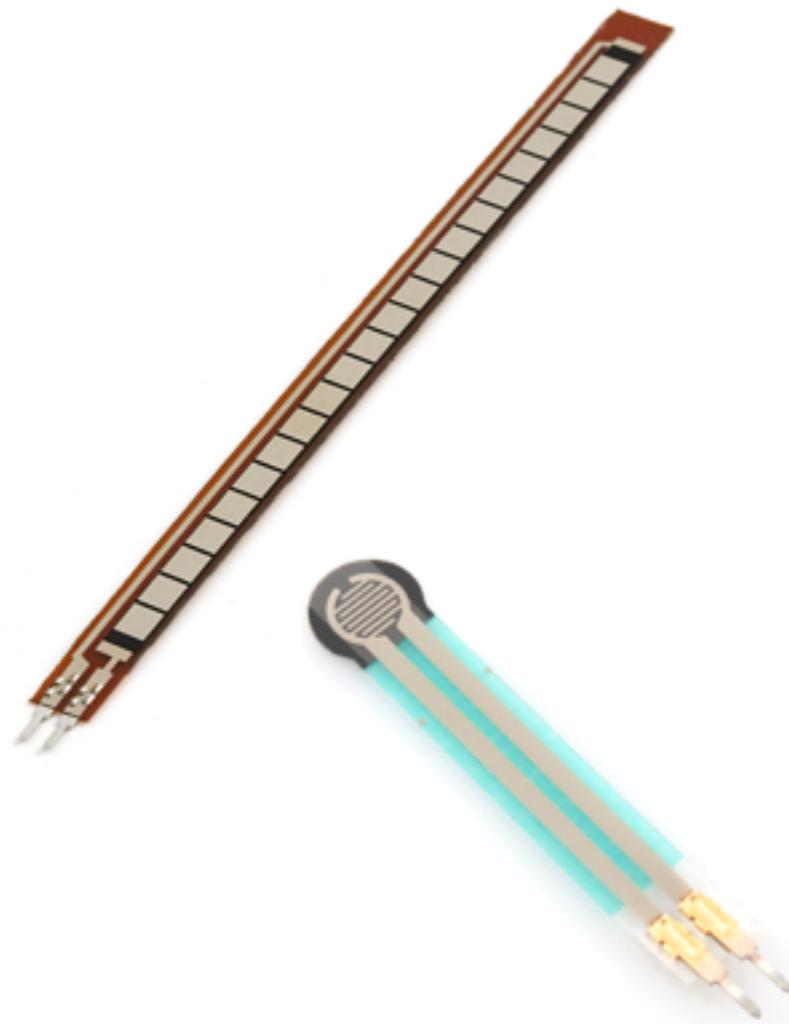


Resistive Sensors

Light, Temperature,
Magnets
\$1 – \$2



Bend, Pressure, Slide
\$5 – \$10

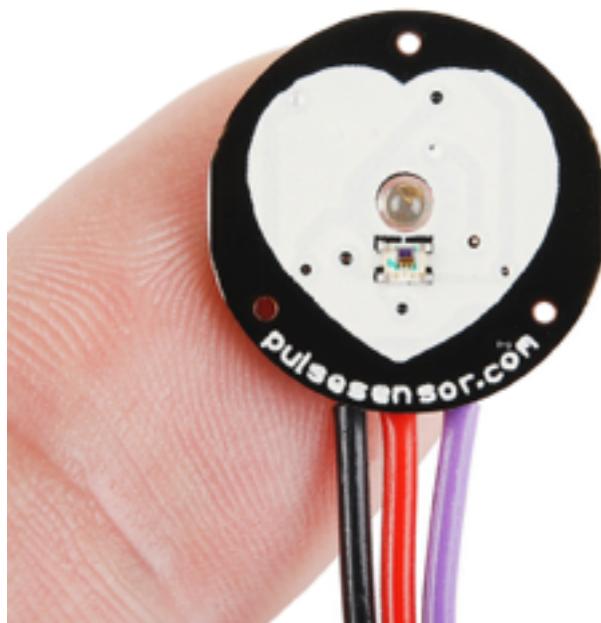


Gas and Alcohol
\$5 – \$10



Biometrics

Pulse Sensors
\$25



EMG / ECG / EEG
\$50



Motion and Orientation

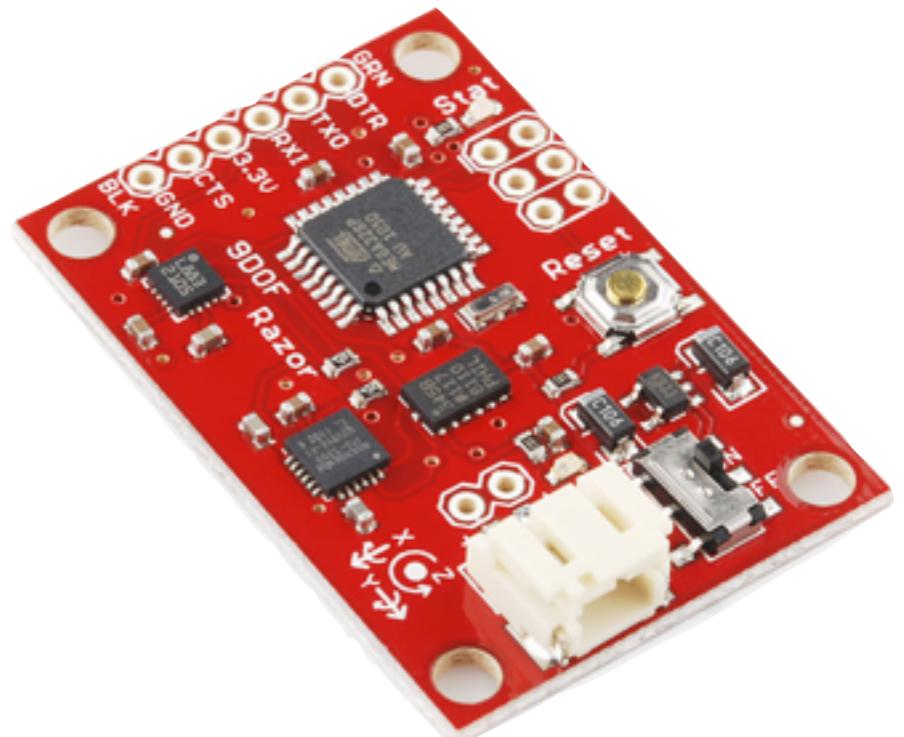
Tilt Sensor
\$2



Accelerometer /
Compass / Gyro
\$15 – \$35



IMUs
\$60 – \$100

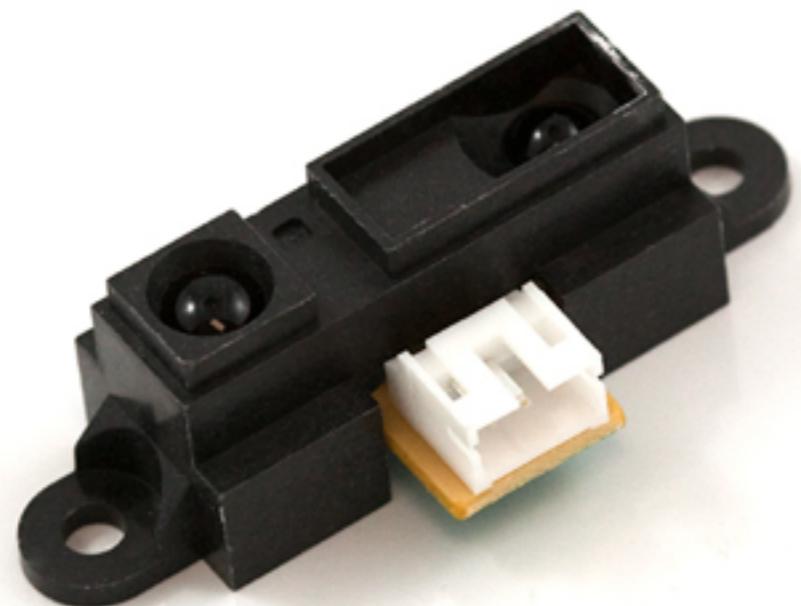


Distance and Proximity

Ultrasonic
\$25 – \$35



Infrared
\$15



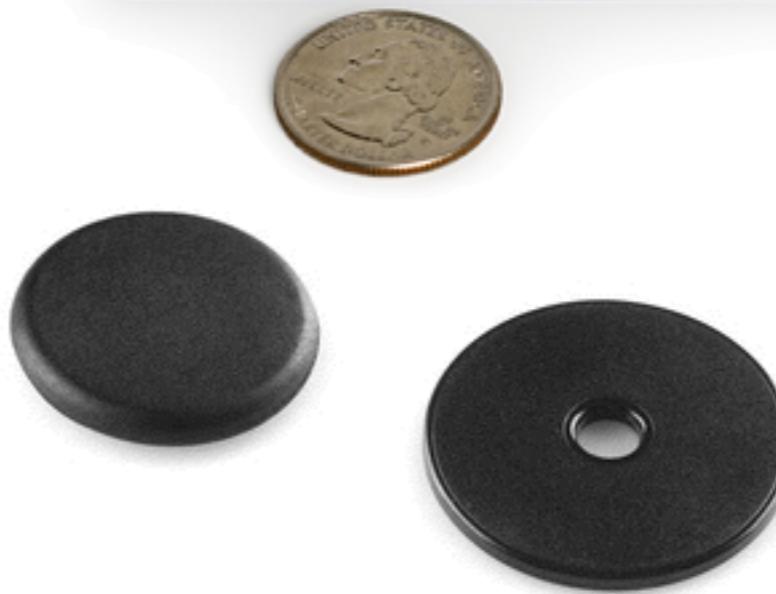
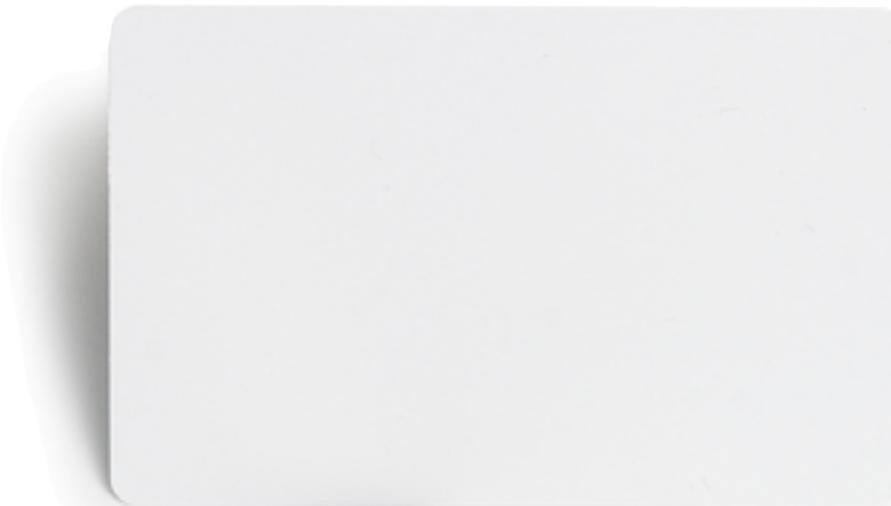
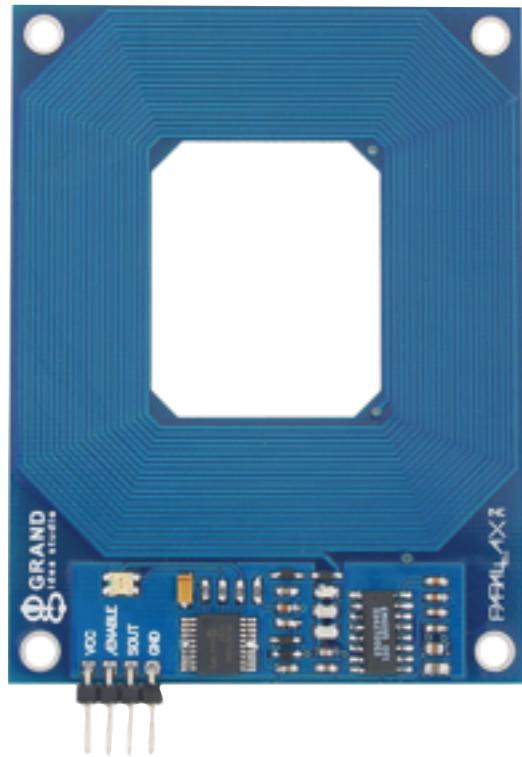
PIR
\$10



RFID

Readers
\$25 – \$50

Tags
\$0.25 – \$5



Actuators

LEDs and Displays

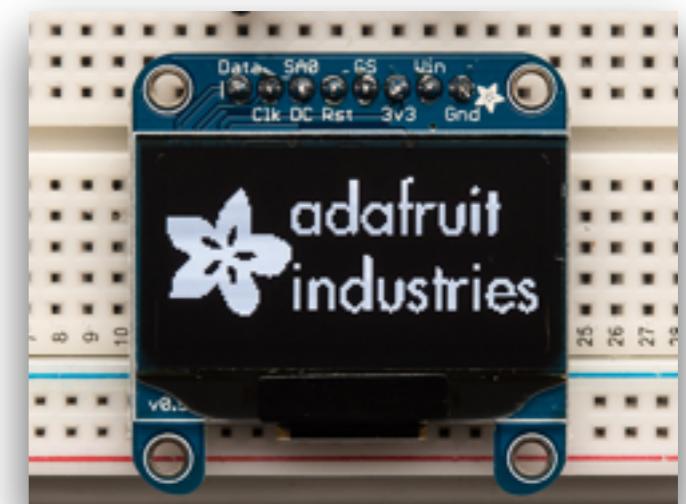
LEDs (3mm, 5mm, 10mm), RGB, IR
Ultrabright
\$0.05 – \$2



LED Matrices and Strips
\$10 – \$60



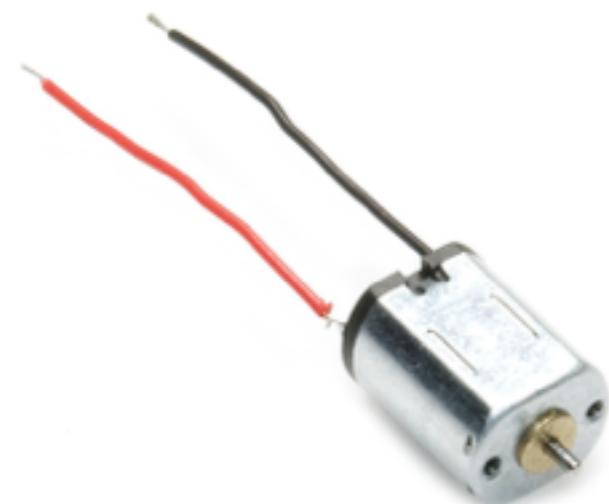
LCDs, TFT, OLED, etc.
\$10 – \$30



Motors

DC

\$2 – \$5



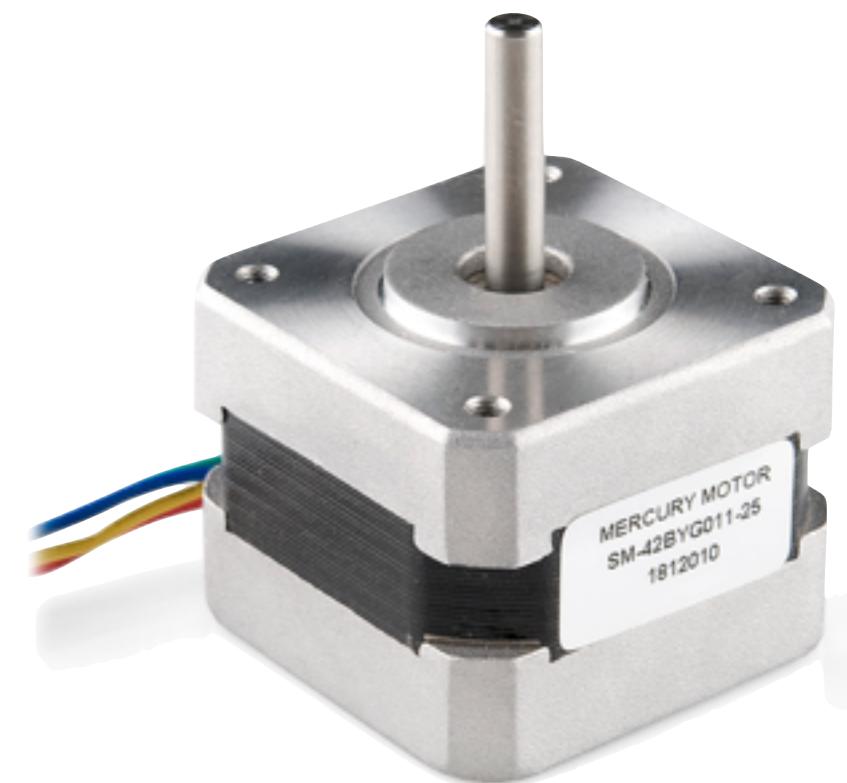
Servo

\$15 – \$30



Stepper

\$7 – \$30

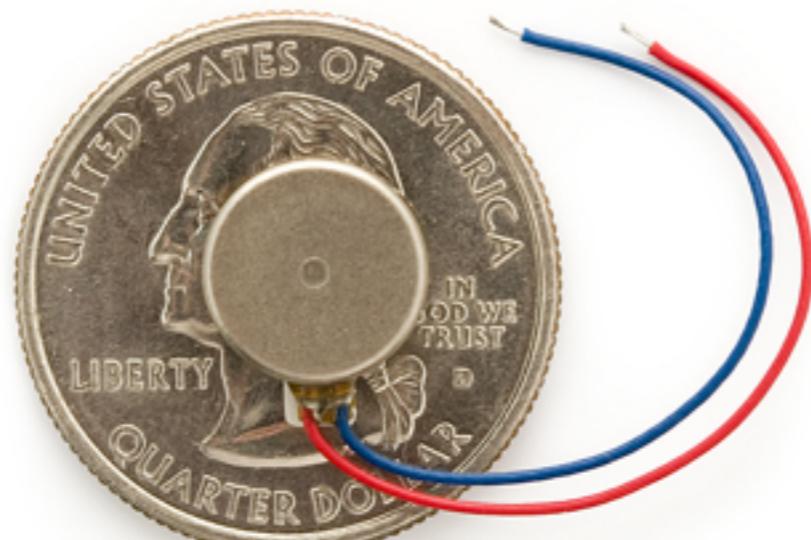


Other

Peltier Heat / Cool
\$10 – \$15



Vibration Motor
\$5



Solenoid
\$5 – \$15



Communication

Wired Protocols

USB

Computers.

Multiple protocols (serial,
HID, midi, etc.)

I2C (Wire library)
SDA, SCL

Up to 127 devices.
Sensors and
microcontrollers.

SPI

MISO, MOSI, SCK

Fast transfer.
Sensors, SD cards, etc.

Serial / UART

RX↔TX

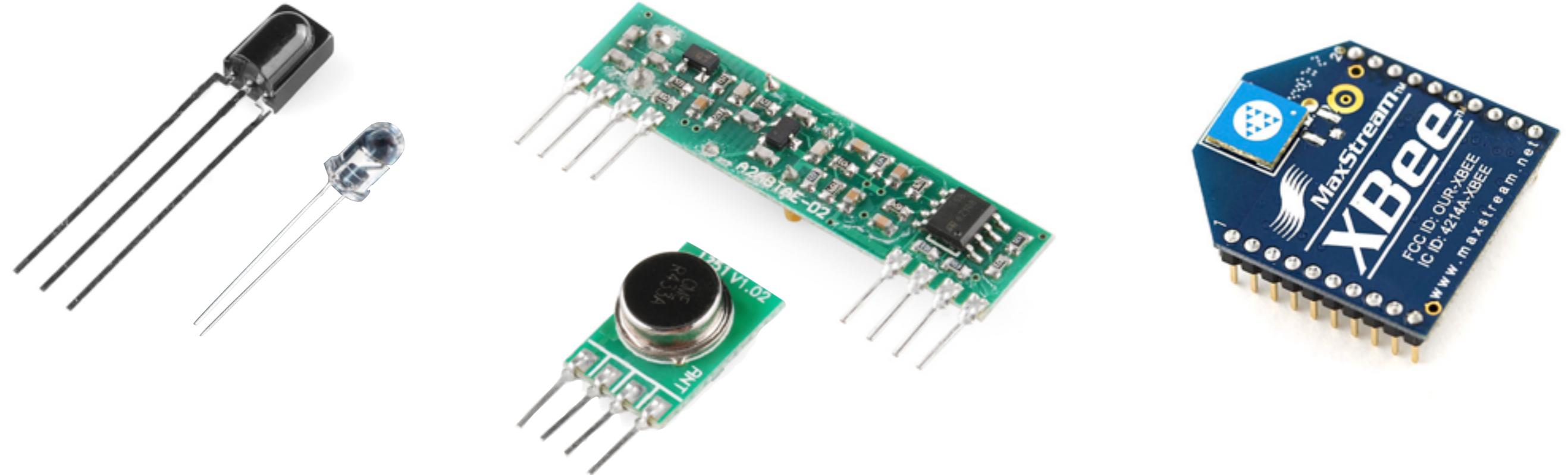
Microcontrollers, LCDs,
computers (over USB).

Wireless within Project

IR (Infrared)
\$2 – \$5

RF
\$5 – \$10

XBee (802.15.4)
\$25 – \$100



Wireless to Existing Networks

Wifi
\$35 – \$90



Bluetooth
\$25 – \$75



Cellular
\$50 – \$100



Power

Batteries

LiPo (3.7 or 7.4V)

\$8 – \$40

Rechargeable



Alkaline (1.5–9V)

\$1 – \$5



Coin Cell (1.5 or 3V)

\$1 – \$2

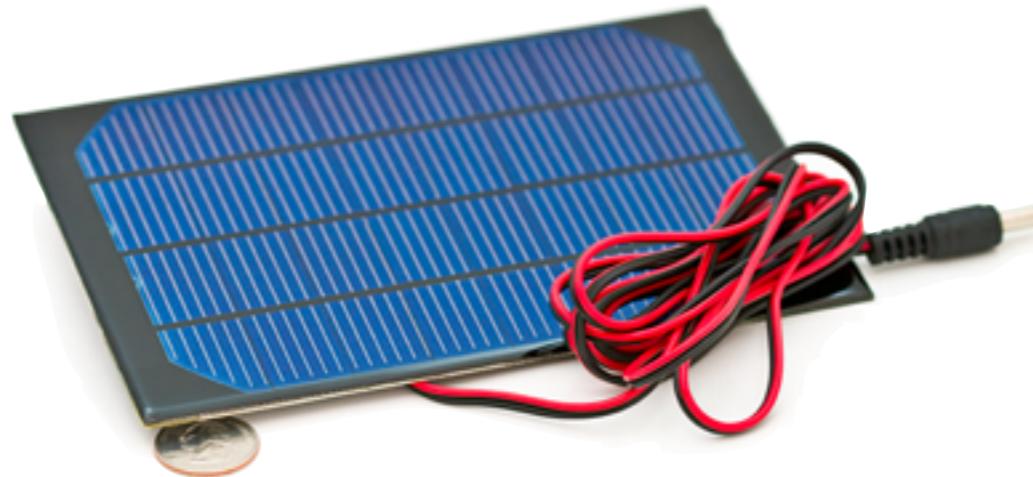


Other Power

Wall Adaptor
\$5 – \$25



Solar Panel
\$15 – \$45



Resources

Adafruit

SparkFun

Make Magazine

ITP PComp Site

That's it!