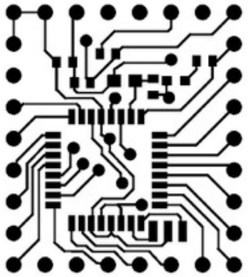
CENTER FOR URBAN SCIENCE+PROGRESS



Rapid Prototyping of Urban Sensors

Lecture 3: Sensors

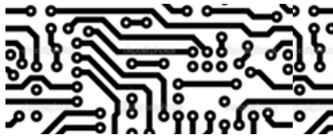
“Sensors are the way that we read the physical world using computers.”

–Tom Igoe

SENSORS

- A **sensor** is a device which detects some characteristic of its environment and provides a corresponding output.
- Sensors convert physical forms of energy into electrical signals which can then be read and interpreted by **microcontrollers**
- Sensors are often **transducers** which are devices that convert one form of energy to another
    - a transducer is more than a sensor. It consists of a sensor along with some signal conditioning

WHAT/HOW ARE YOU MEASURING?



- Light, motion, temperature, magnetic fields, gravity, humidity, moisture, vibration, pressure, electrical fields, sound, and other physical aspects of the **external environment**
- **biometrics**
- **anything…**

SENSOR CHARACTERISTICS

- A good sensor should have a **high sensitivity.** Sensitivity means how much the output of a device changes with unit change in input
- The **range** of a sensor is the maximum and minimum values that can be measured well
- **High resolution**. Resolution is the smallest change in input that the device can detect

SENSOR CHARACTERISTICS

- **(non)Linearity** is having a constant sensitivity over the range of the sensor
- A sensor is considered **bias or offset** when the output signal is not zero when the property measured is zero. Or, the difference between the actual output value and the specified output value under some particular set of conditions
- Sensor **drift** is when the output signal slowly changes independent of the measured property. Usually occurs with the aging of the sensor.

SENSOR CHARACTERISTICS

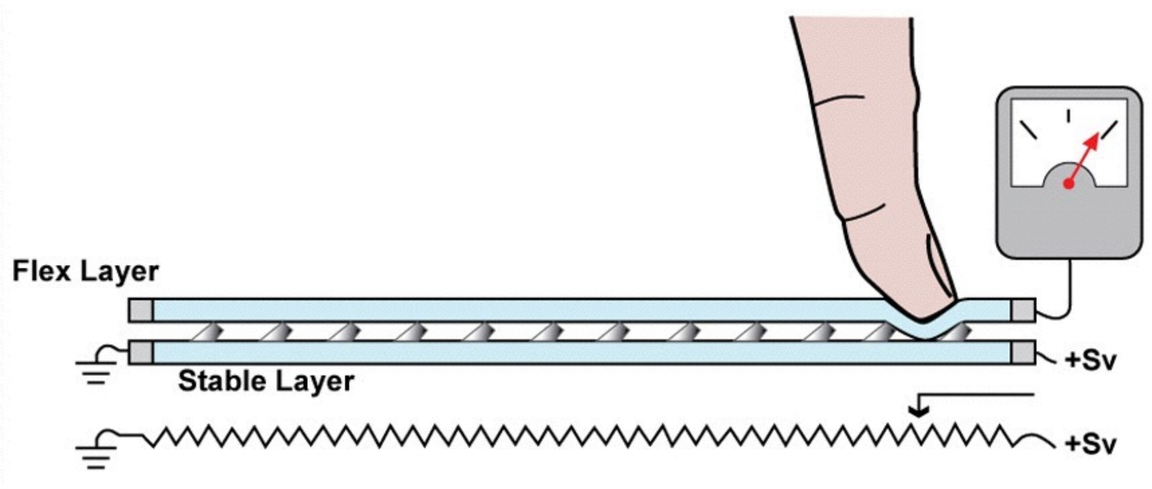
- **Calibration** is the necessity to compare an output of a sensor with an accurately known input
- How well the sensor measures the environment in an absolute sense is known as **accuracy**
- **Noise** is random variations in the signal over time

MECHANICAL ENERGY

- Switches, buttons, potentiometers…
- buttons are sensing the motion of your finger…
- hair trigger switch, magnetic switch
- potentiometer is a variable resister which outputs an **analog reading**

FORCE/STRETCH/BEND

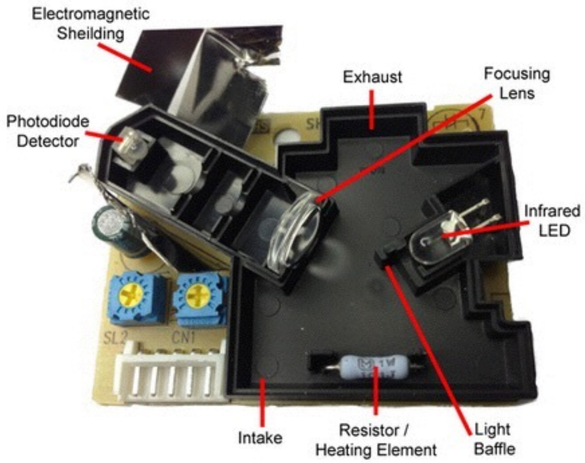
- resistive sensors which are made of conductive carbon so the resistance changes as it is deformed. This change in resistance is measured



OPTICAL SENSORS

- convert light into electrical signals
- used for a variety of purposes including distance, pulse, air quality etc…

Dust Sensor



LidarLite

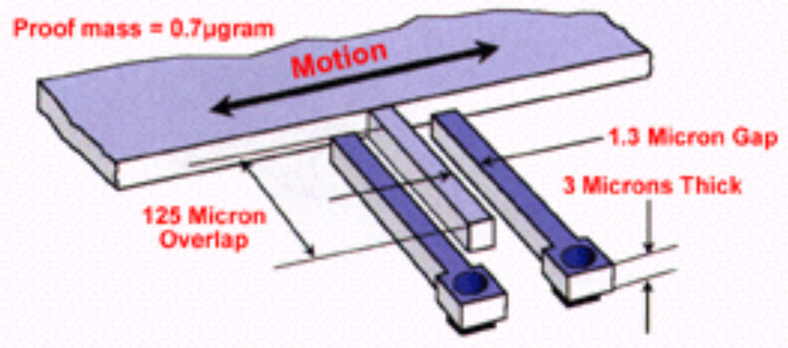
Range Finder

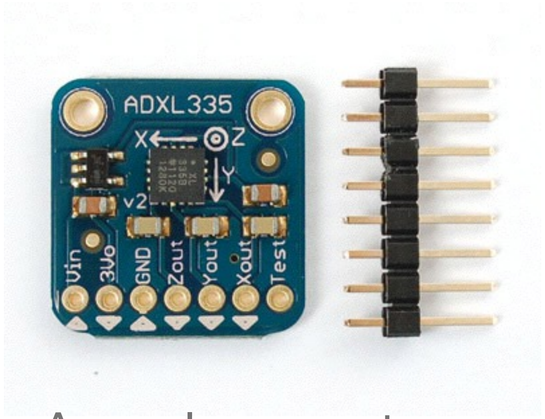
IR Distance

Pulse Sensor

MICRO-ELECTRO-MECHANICAL SYSTEM

- read a change in capacitance





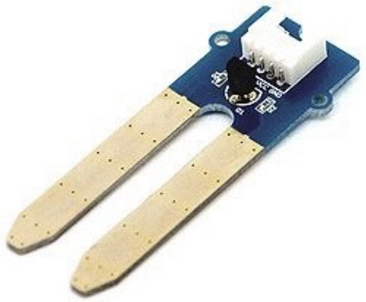
Accelerometer

Gyrometer

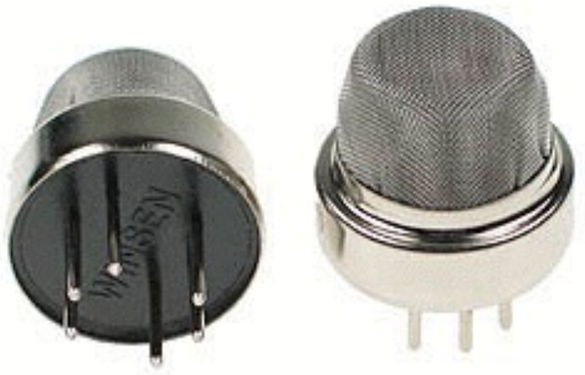
CHEMICAL SENSING

- often used for measuring concentrations, compositions and absorption

Conductivity

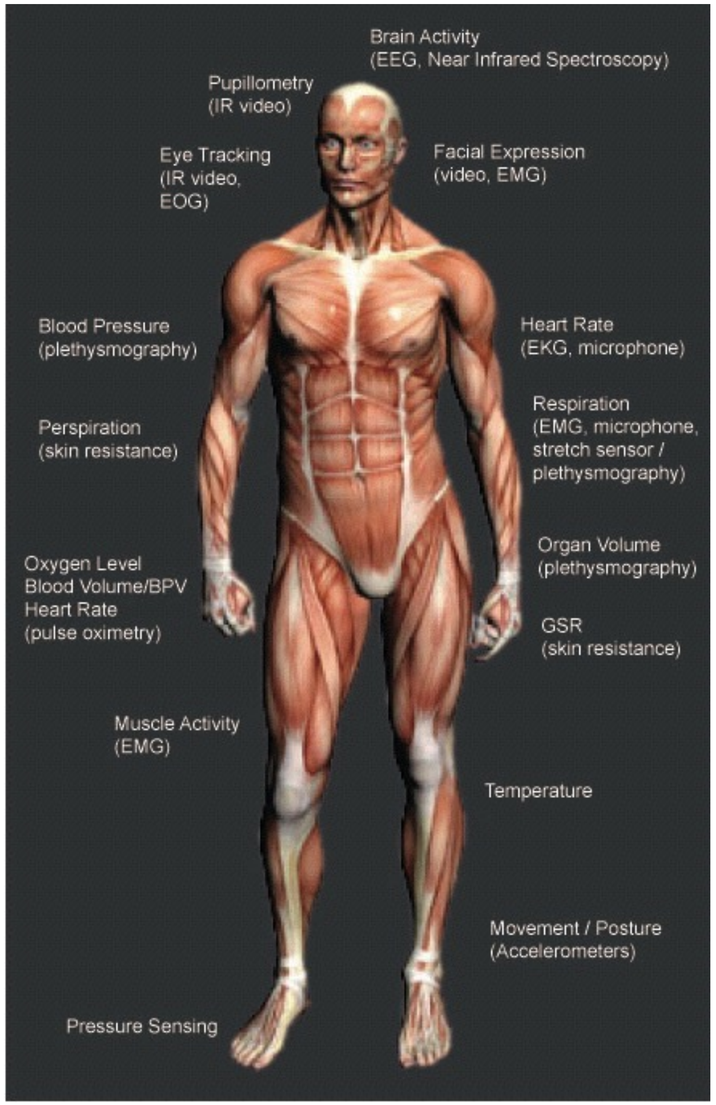


Moisture



Gas Sensors

BIOMETRIC



EEG

Stretch

Pulse Sensor

Sean Montgomery

Off the Shelf

beddit

HOME BUY FEATURES FAMILY TESTIMONIALS BLOG

Main Features

Heart rate

Respiration

Sleep cycles

Sleep time

Sleep Tips

Family

Smart Alarm

Check out the product page!

Parrot®

FLOWER POWER

An incredible sensor that assesses your plants' needs
and sends alerts to your smartphone

netatmo PRODUCT OUR COMPANY COMMUNITY BUY NOW $ 179

WEATHER STATION ACCESSORIES WEATHERMAP SPECIFICATIONS

Data Sheets

DATA SHEETS

- Tell you how to operate an electronic device. **The instruction manual**.
- Includes: description of the sensors, pin outputs/inputs, electrical characteristics, output voltage, and the ‘data’ conversion
- make sure you supply the appropriate voltage and current to run on
- graphs - curves that should be expected
- package specifications

GP2Y0A21YK/ GP2Y0D21YK

General Purpose Type Distance Measuring Sensors

■ Features

1. Less influence on the color of reflective objects, reflectivity
2. Line-up of distance output/distance judgement type
   Distance output type (analog voltage) : **GP2Y0A21YK**
   Detecting distance : 10 to 80cm
   Distance judgement type : **GP2Y0D21YK**
   Judgement distance : 24cm
   (Adjustable within the range of 10 to 80cm [Optionally available])
3. External control circuit is unnecessary
4. Low cost

■ Applications

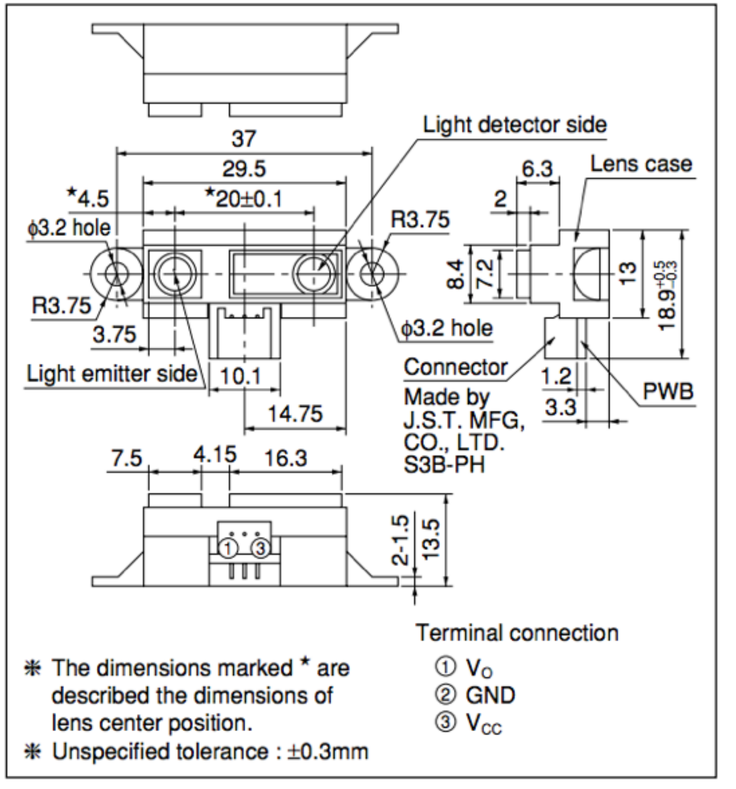
1. TVs
2. Personal computers
3. Cars
4. Copiers

■ Absolute Maximum Ratings (T_a=25°C, V_{CC}=5V)

Parameter	Symbol	Rating	Unit
Supply voltage	V_{CC}	−0.3 to +7	V
Output terminal voltage	V_O	−0.3 to V_{CC} +0.3	V
Operating temperature	T_{opr}	−10 to +60	°C
Storage temperature	T_{stg}	−40 to +70	°C

■ Outline Dimensions

(Unit : mm)



https://www.sparkfun.com/datasheets/Components/GP2Y0A21YK.pdf

INTERLINK ELECTRONICS
Sensor Technologies

FSR® 400 Series Data Sheet

Force Sensing Resistors®

Features and Benefits

- Actuation Force as low as 0.2N and sensitivity range to 20N
- Cost Effective
- Ultra Thin
- Robust; up to 10M actuations
- Simple and easy to integrate

Description

Interlink Electronics FSR® 400 series is part of the single zone Force Sensing Resistor® family. Force Sensing Resistors®, or FSRs, are robust polymer thick film (PTF) devices that exhibit a decrease in resistance with increase in force applied to the surface of the sensor. This force sensitivity is optimized for use in human touch control of electronic devices such as automotive electronics, medical systems, industrial, and robotics applications.

The 400 series sensors come in six different models with four different connecting options.

FSR® 400 Short
5mm Circle X 20mm

FSR® 400
5mm Circle X 38mm

FSR® 402 Short
13mm Circle X 25mm

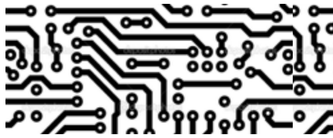
FSR® 402
13mm Circle X 56mm

http://www.adafruit.com/datasheets/FSR400Series_PD.pdf

Where to buy: Order early….

Sensor Interfacing

INTERFACING



- reading an **analog value**
- serial communication

Homework - Midterm Project

- Choose a sensor to experiment with.
- Purchase the sensor, get it working, and contemplate and test various applications of the sensor.
- We will be creating a database of sensors. Consider the project to be a ‘sensor review’.
- Compare the ‘low-cost’ version to the more expensive sensor. What’s the difference?
- Due in 2 Weeks. You will give a 5min presentation on your work