2 weeks only to the Assignment-1 presentation!!

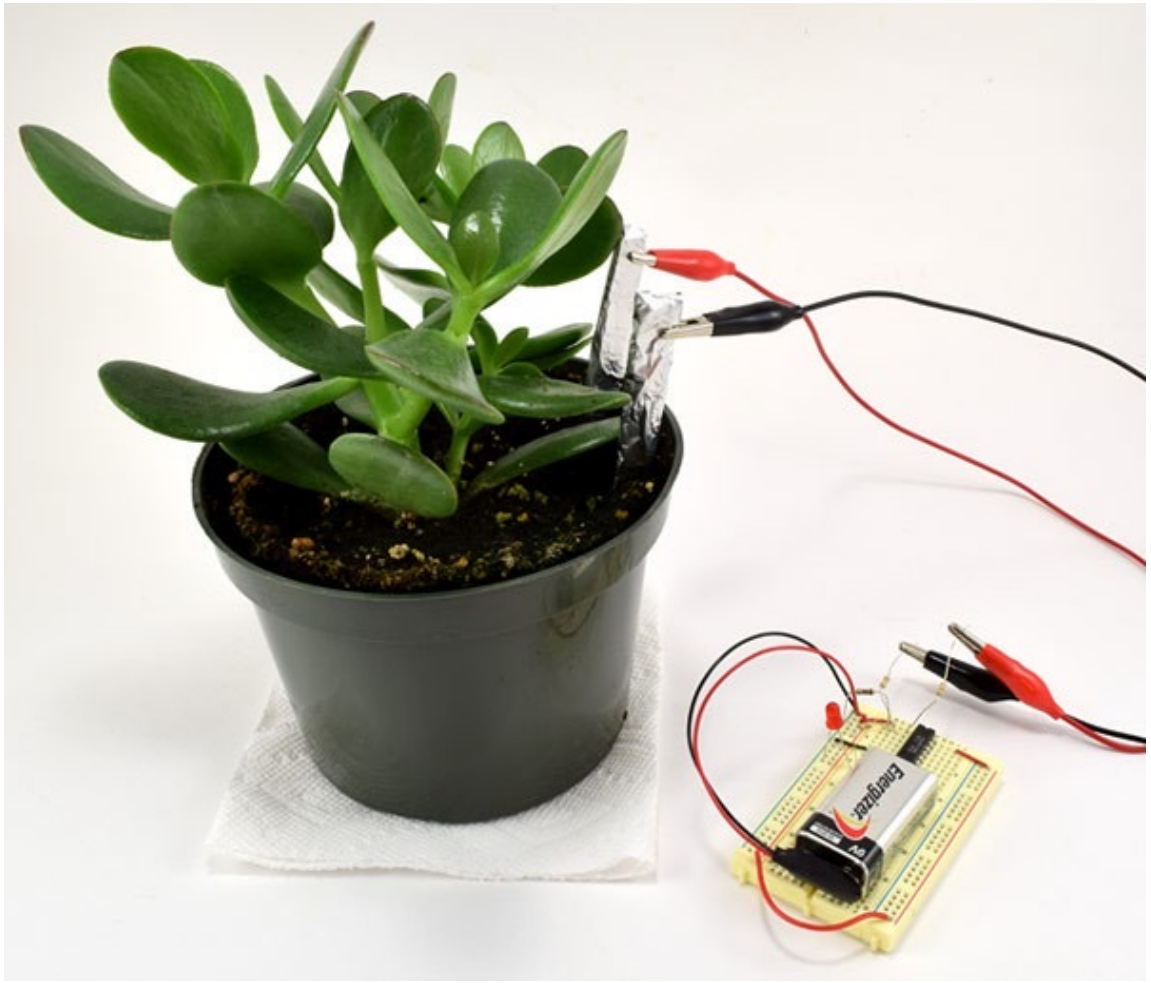
Start working!!!

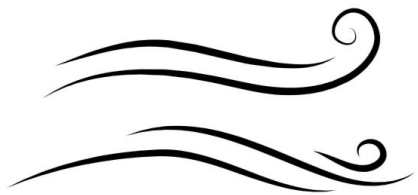
Measurement: Read the Plant

Kening Zhu

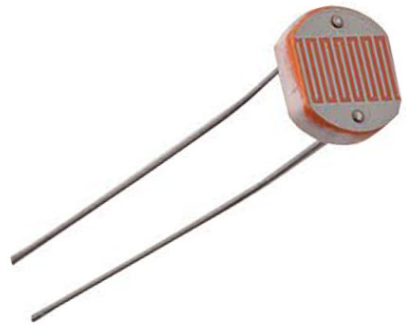
School of Creative Media

City University of Hong Kong





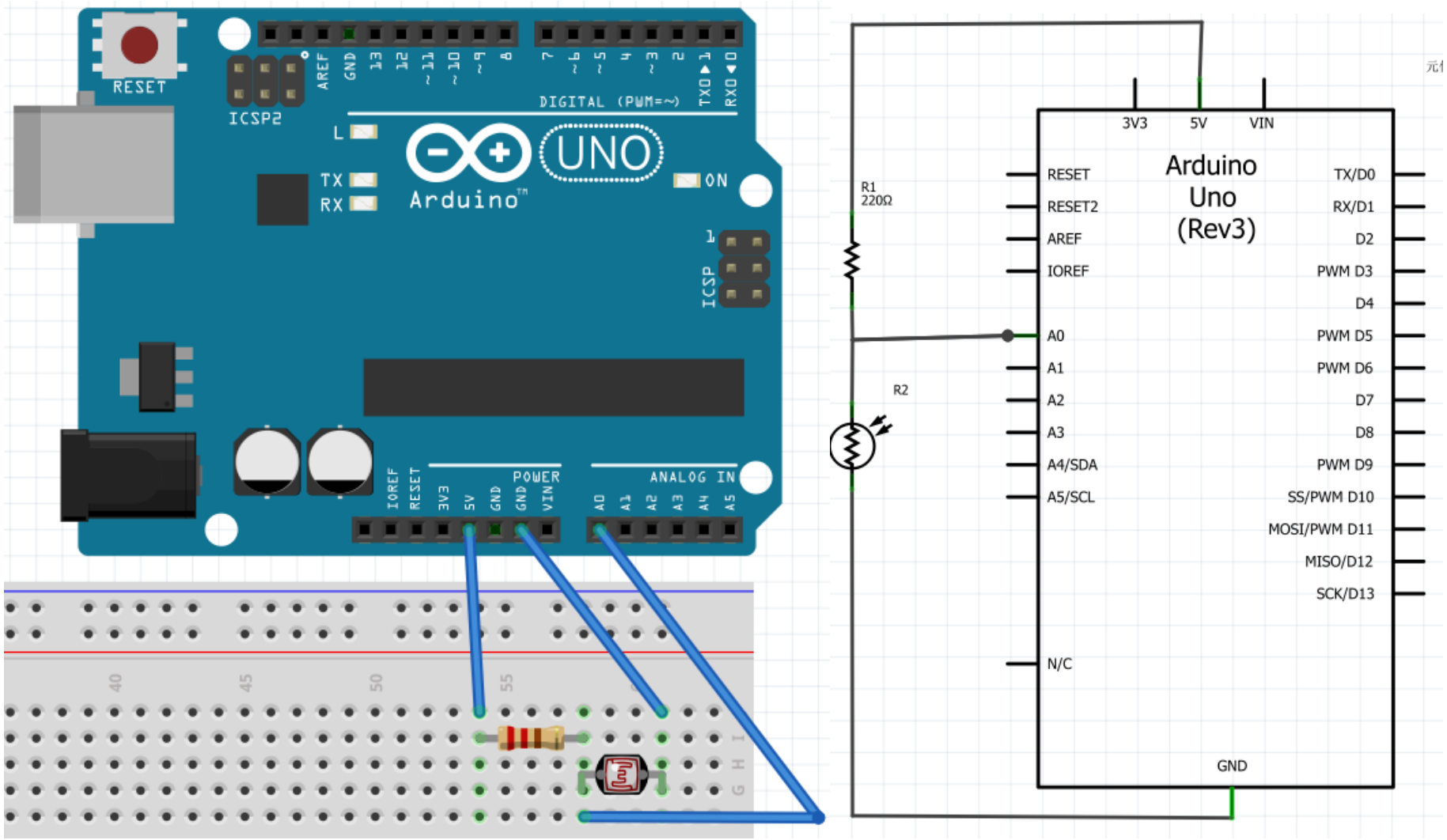
Color, weight, size, etc.



Light Dependent **Sensor**/Photoresistor (Resistance changed by light)

- Photoresistor gives a high resistance in darkness. When it is exposed in light, its resistance drops and become a good conductor.

Connecting a light sensor to Arduino

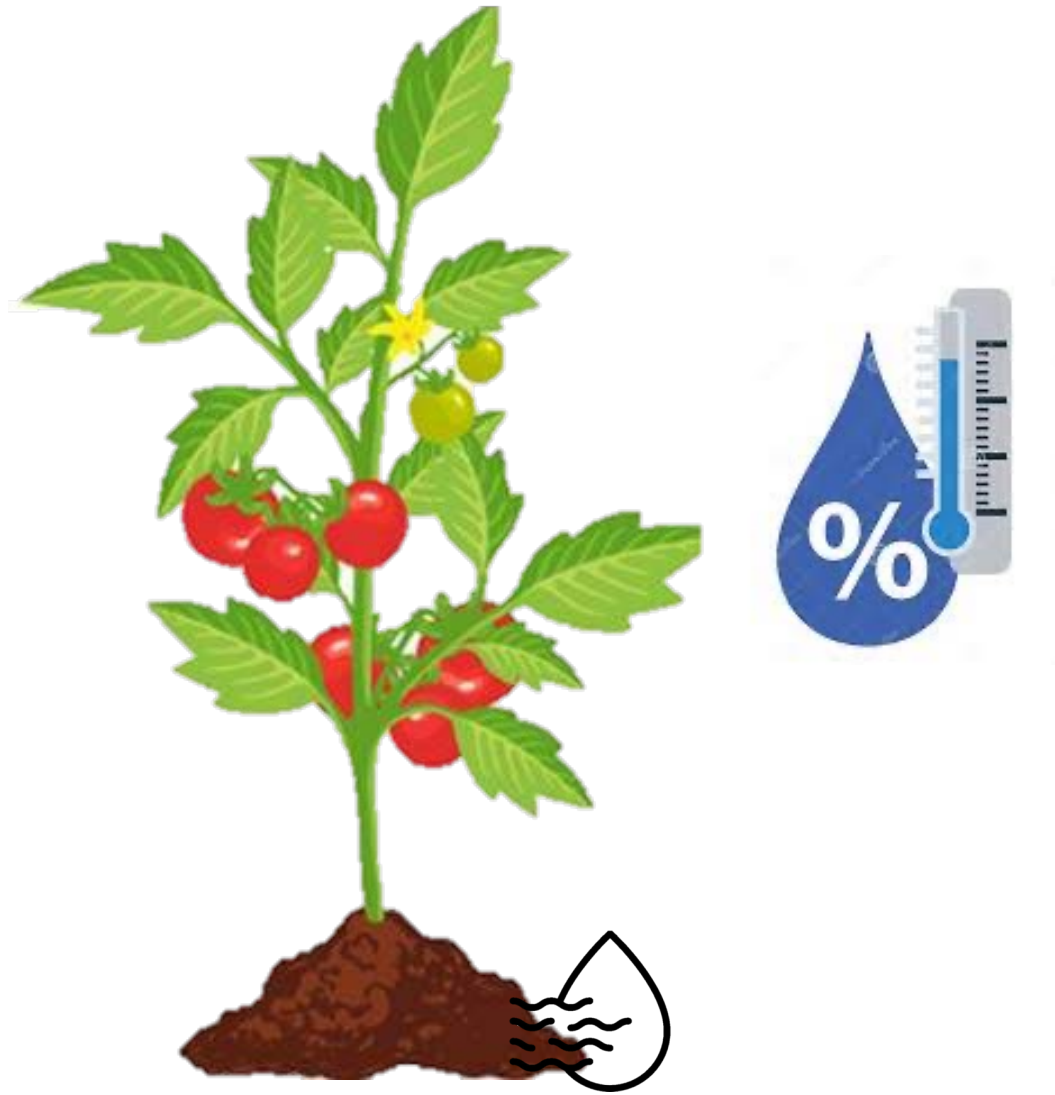


Code to watch the input value

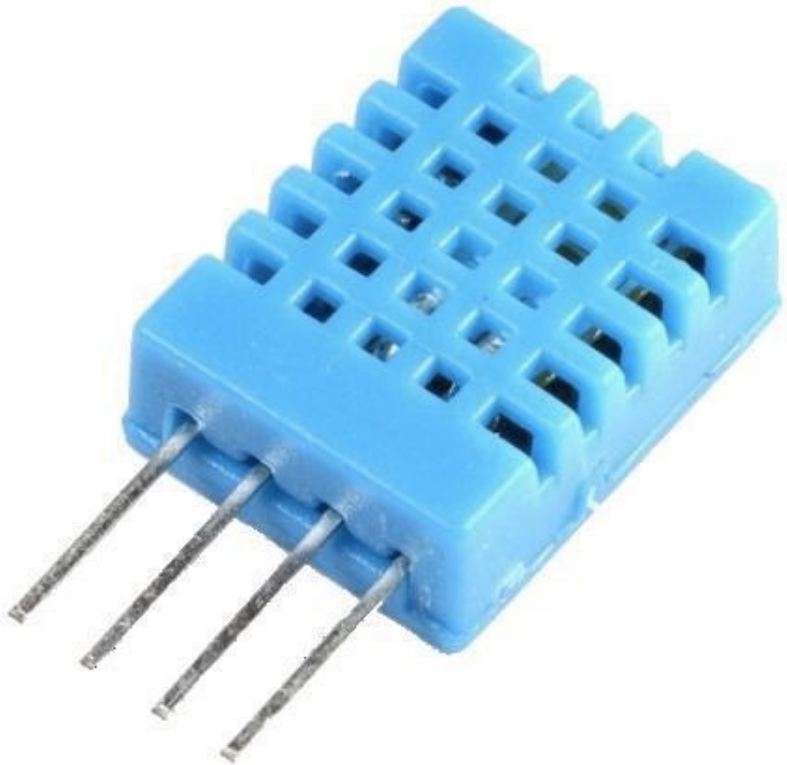
```
int analogPin_0 = 0;

void setup() {
  Serial.begin(9600);
}

void loop() {
  int value = analogRead(analogPin_0);

  Serial.println(value);

  delay(100);
}
```

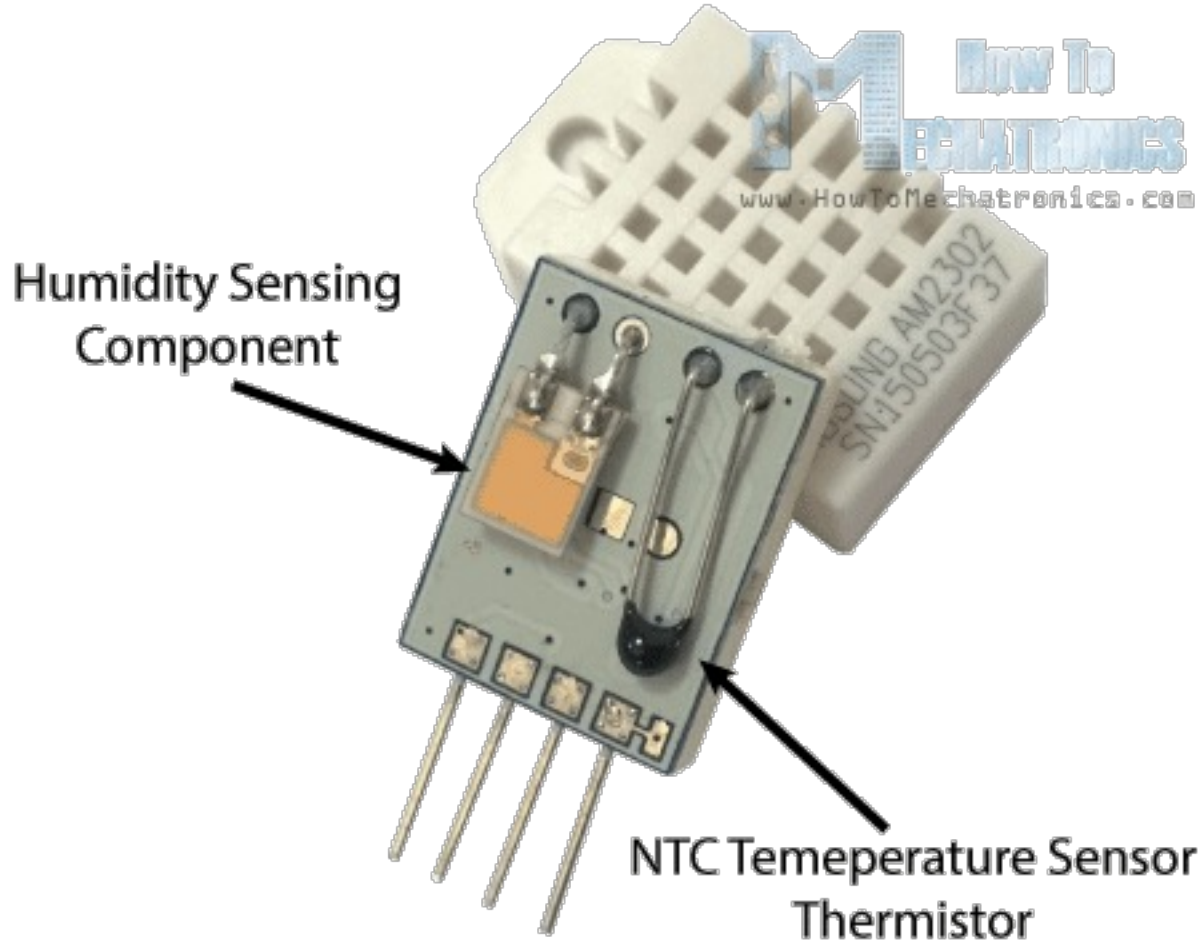
With plant

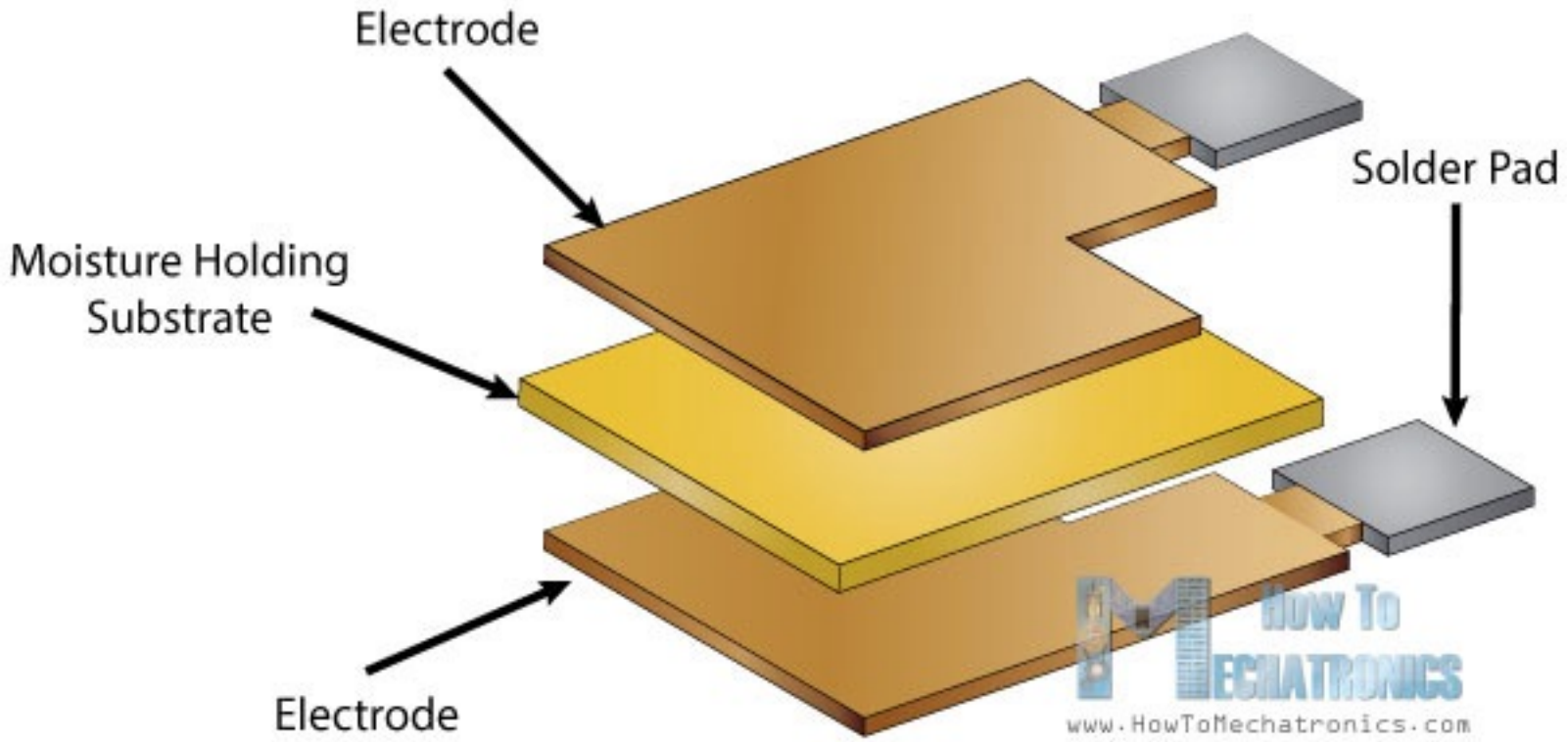
- You can put the light sensor near the leaf to record the lighting condition through out the day.



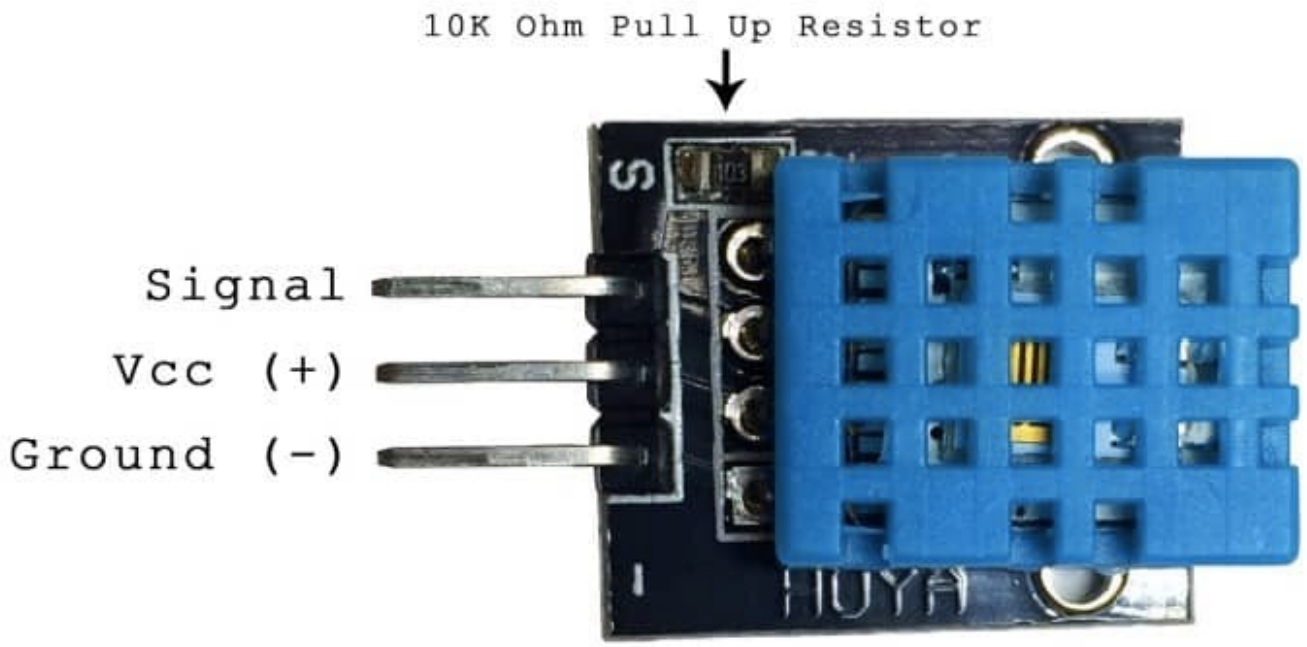
Air Moisture/Humidity Sensor (DHT11)

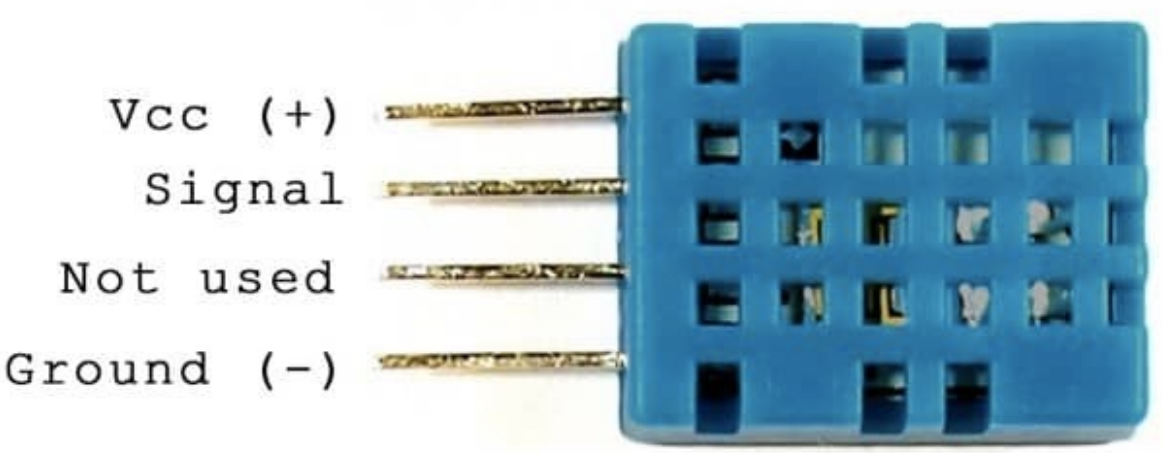


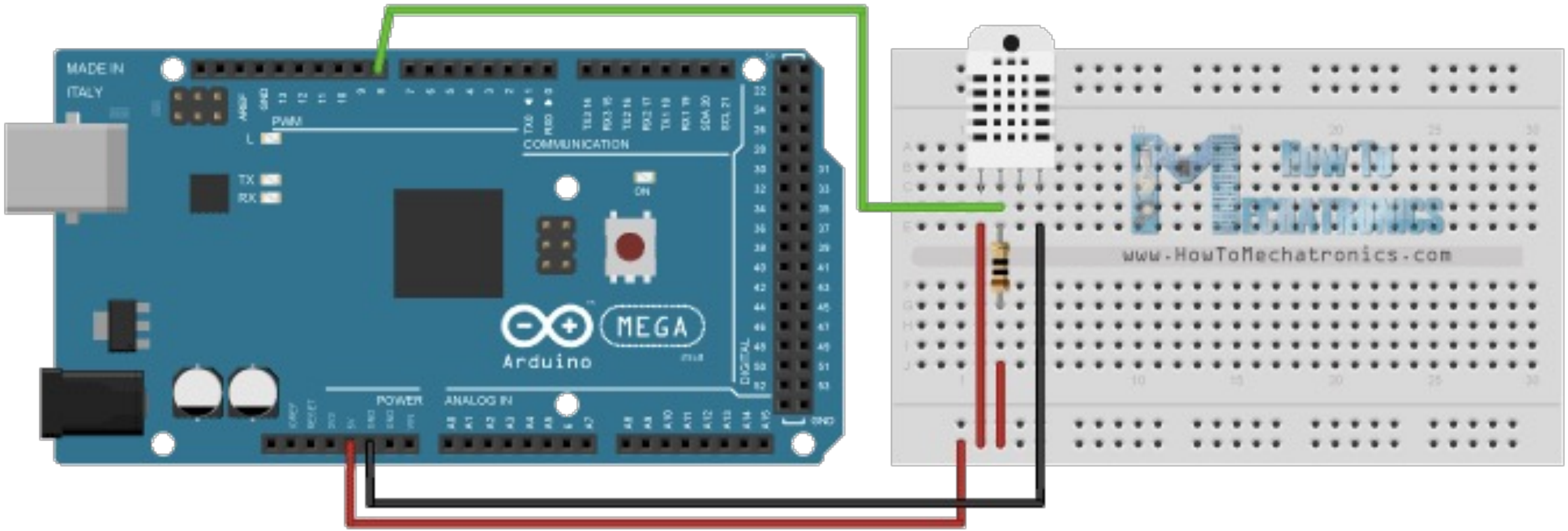




For measuring humidity they use the humidity sensing component which has two electrodes with moisture holding substrate between them. So as the humidity changes, the conductivity of the substrate changes or the resistance between these electrodes changes. This change in resistance is measured and processed by the IC which makes it ready to be read by a microcontroller.


10K Ohm Pull Up Resistor
Signal
Vcc (+)
Ground (-)
S
HUYA


Vcc (+)
Signal
Not used
Ground (-)



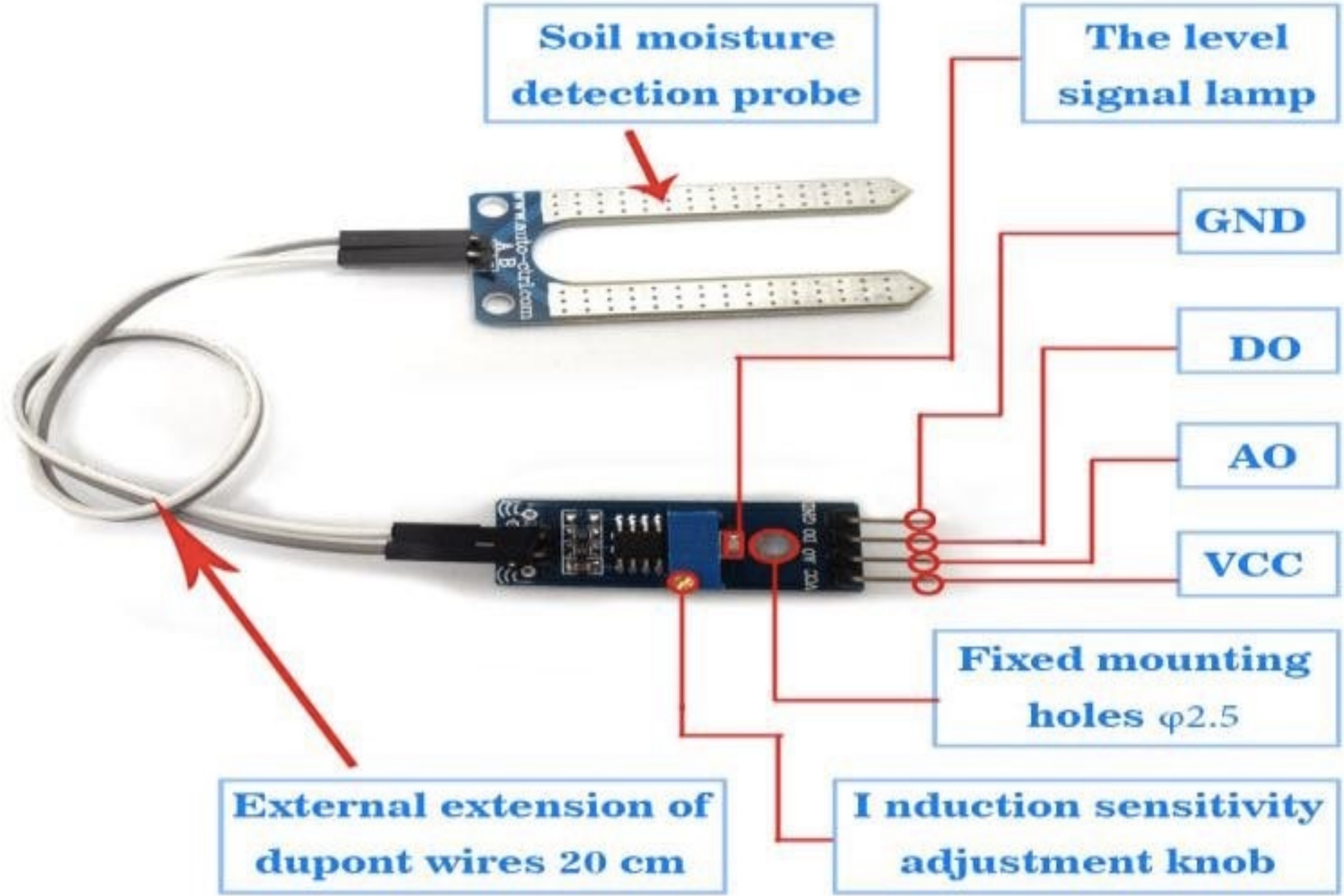
https://www.circuitbasics.com/how-to-set-up-the-dht11-humidity-sensor-on-an-arduino/

Soil Moisture Sensor

The Soil Moisture Sensor uses capacitance to measure dielectric permittivity of the surrounding medium. In soil, dielectric permittivity is a function of the water content.

The sensor creates a voltage proportional to the dielectric permittivity, and therefore the water content of the soil. The sensor averages the water content over the entire length of the sensor. There is a 2 cm zone of influence with respect to the flat surface of the sensor, but it has little or no sensitivity at the extreme edges.

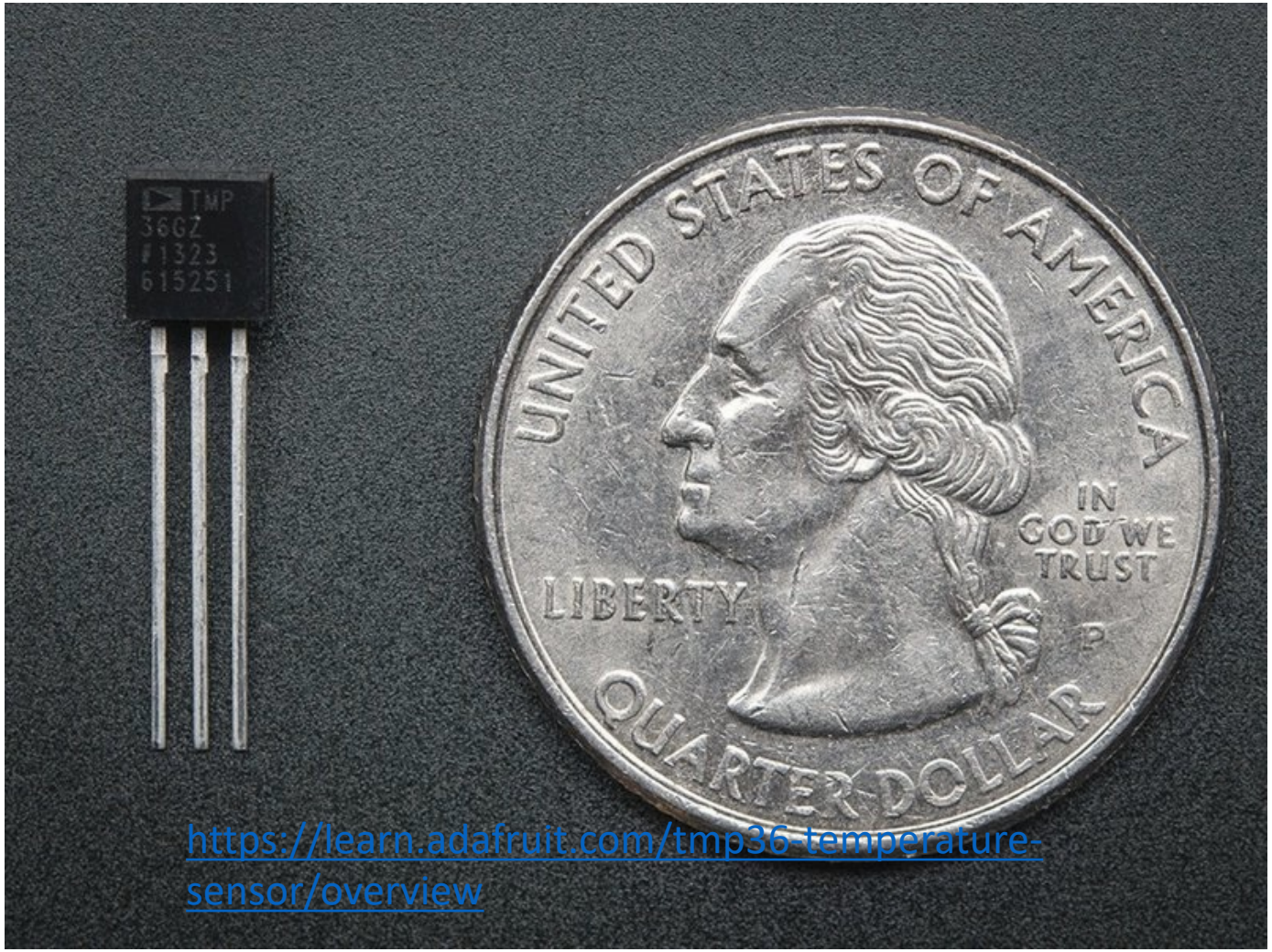
The Soil Moisture Sensor is used to measure the loss of moisture over time due to evaporation and plant uptake,evaluate optimum soil moisture contents for various species of plants,monitor soil moisture content to control irrigation in greenhouses and enhance bottle biology experiments.


Soil moisture detection probe
The level signal lamp
GND
DO
AO
VCC
Fixed mounting holes φ2.5
External extension of dupont wires 20 cm
I nduction sensitivity adjustment knob

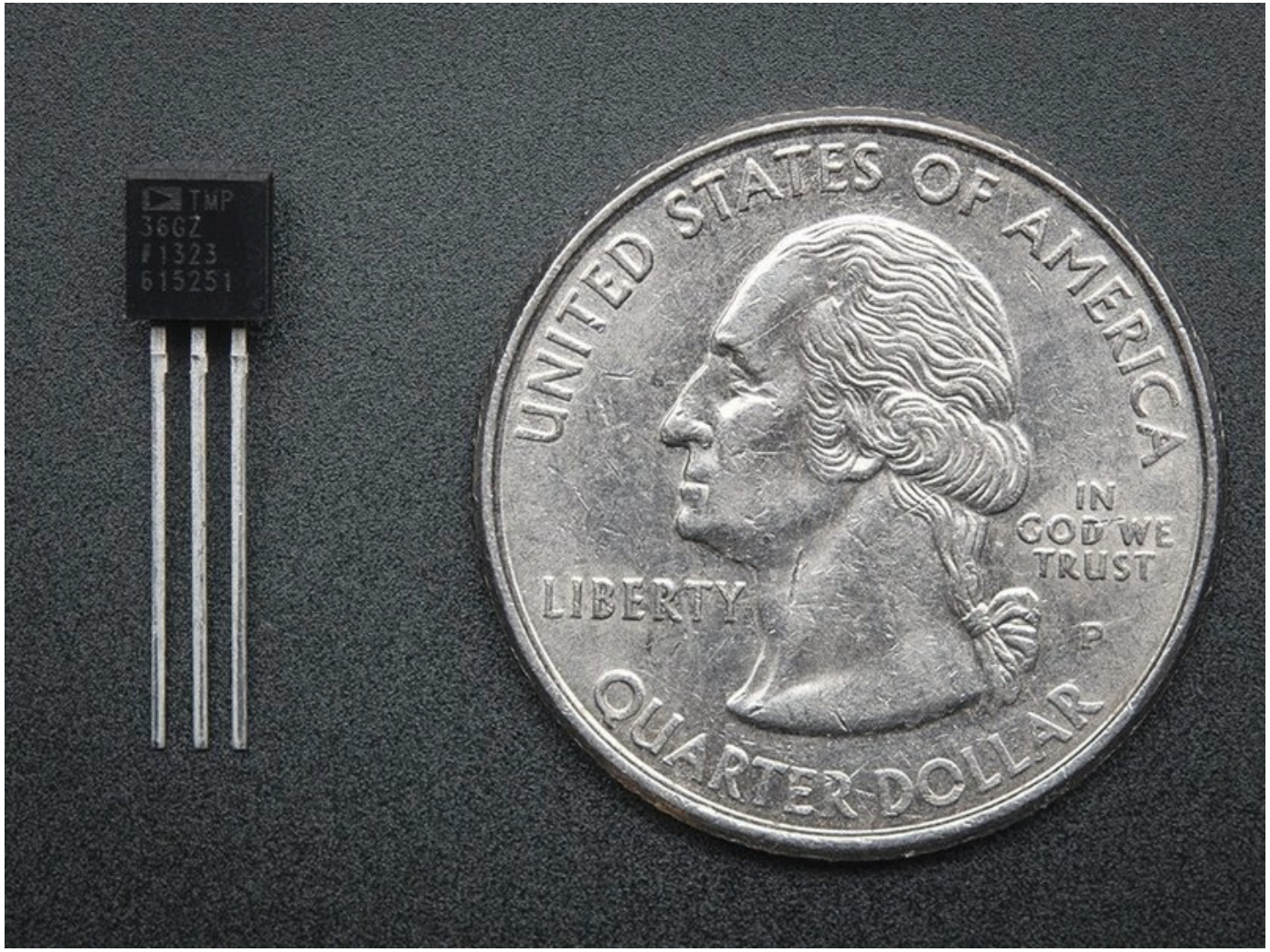
Analog Temperature Sensor (TMP36)

- A chip that tells you what the ambient temperature is.
- It uses the fact as temperature increases, the voltage across a diode increases at a known rate.
- By precisely amplifying the voltage change, it is easy to generate an analog signal that is directly proportional to temperature.

Sounds complicated eh?



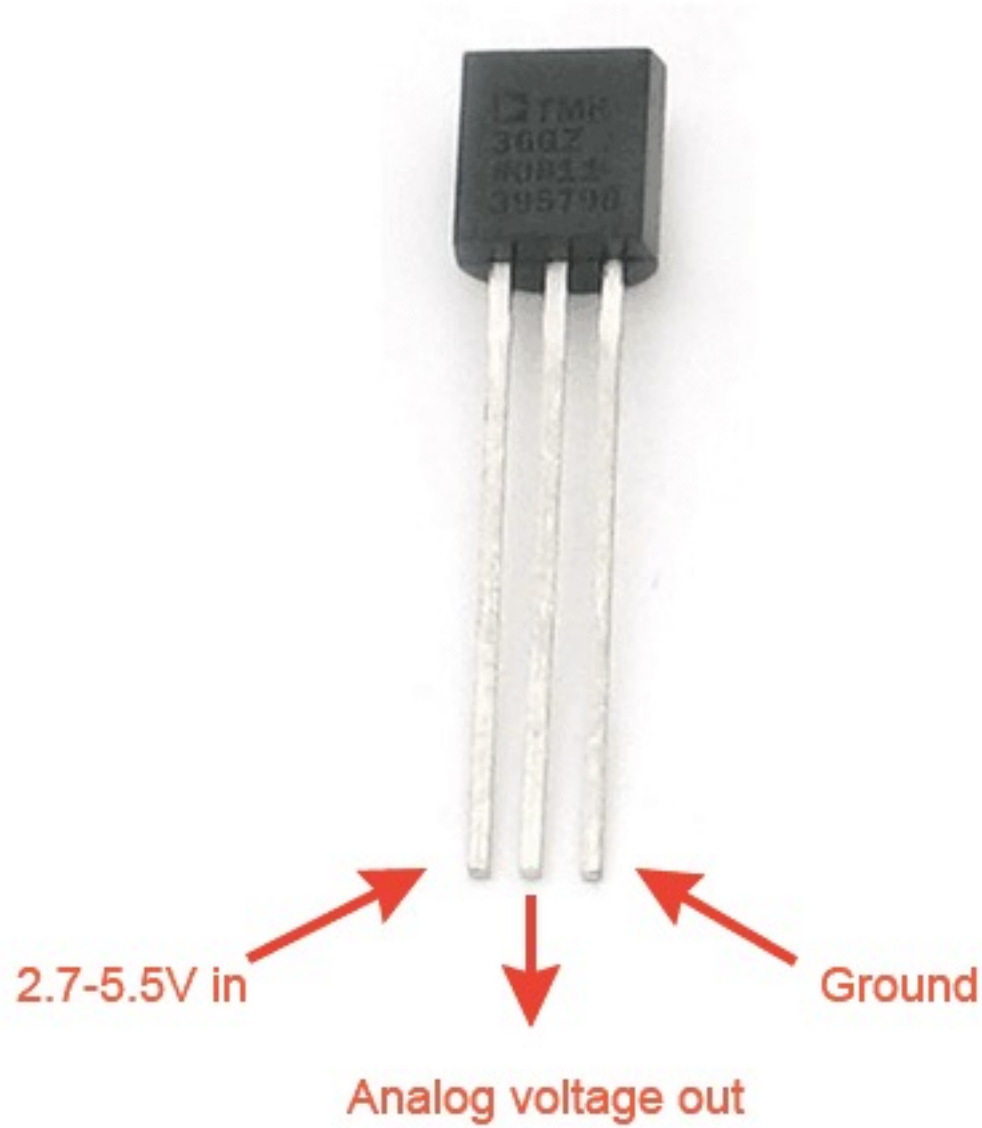
https://learn.adafruit.com/tmp36-temperature-sensor/overview



The good news is all that complex calculation is done inside the chip - it just spits out the temperature, ready for you to use!

Technical Characteristics of TMP36

- **Size:** TO-92 package (about 0.2" x 0.2" x 0.2") with three leads
- **Price:** $1.50 at the Adafruit shop
- **Temperature range:** -40°C to 150°C / -40°F to 302°F
- **Output range:** 0.1V (-40°C) to 2.0V (150°C) but accuracy decreases after 125°C
- **Power supply:** 2.7V to 5.5V only, 0.05 mA current draw
- **Datasheet**


2.7-5.5V in
Ground
Analog voltage out

Linear Mapping from Signal to Temperature

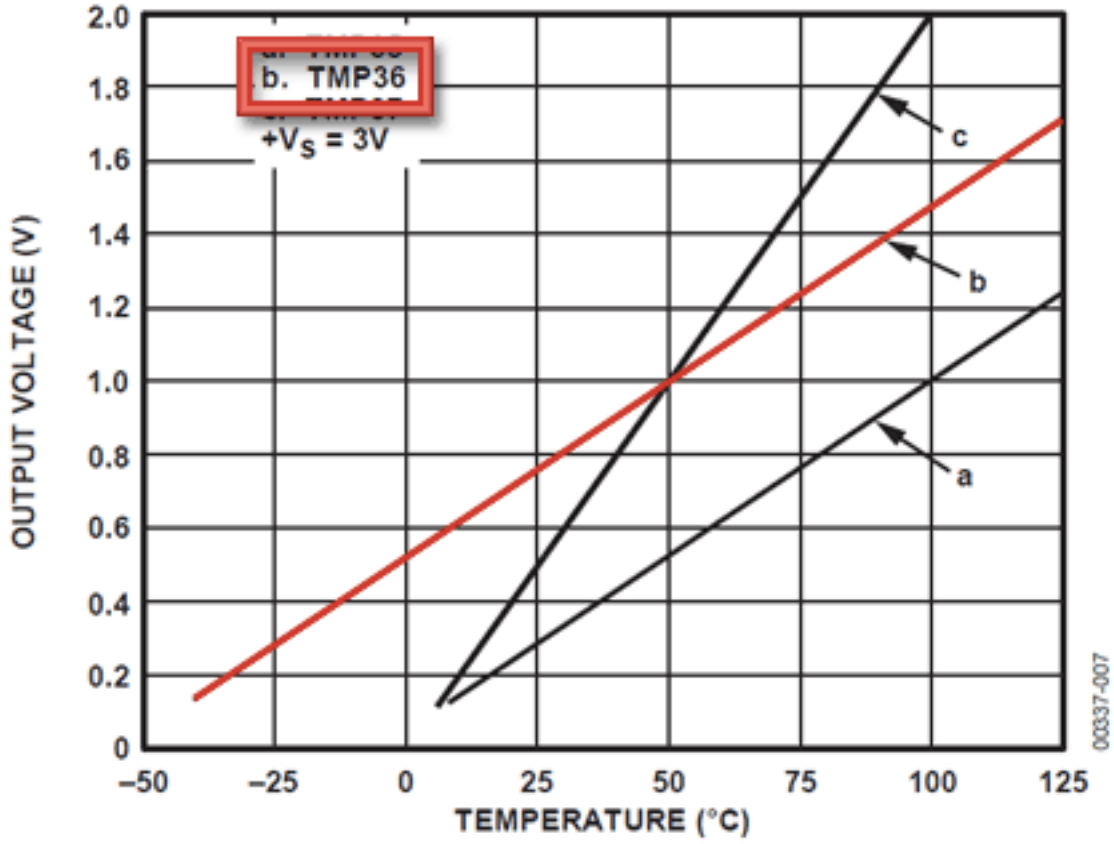
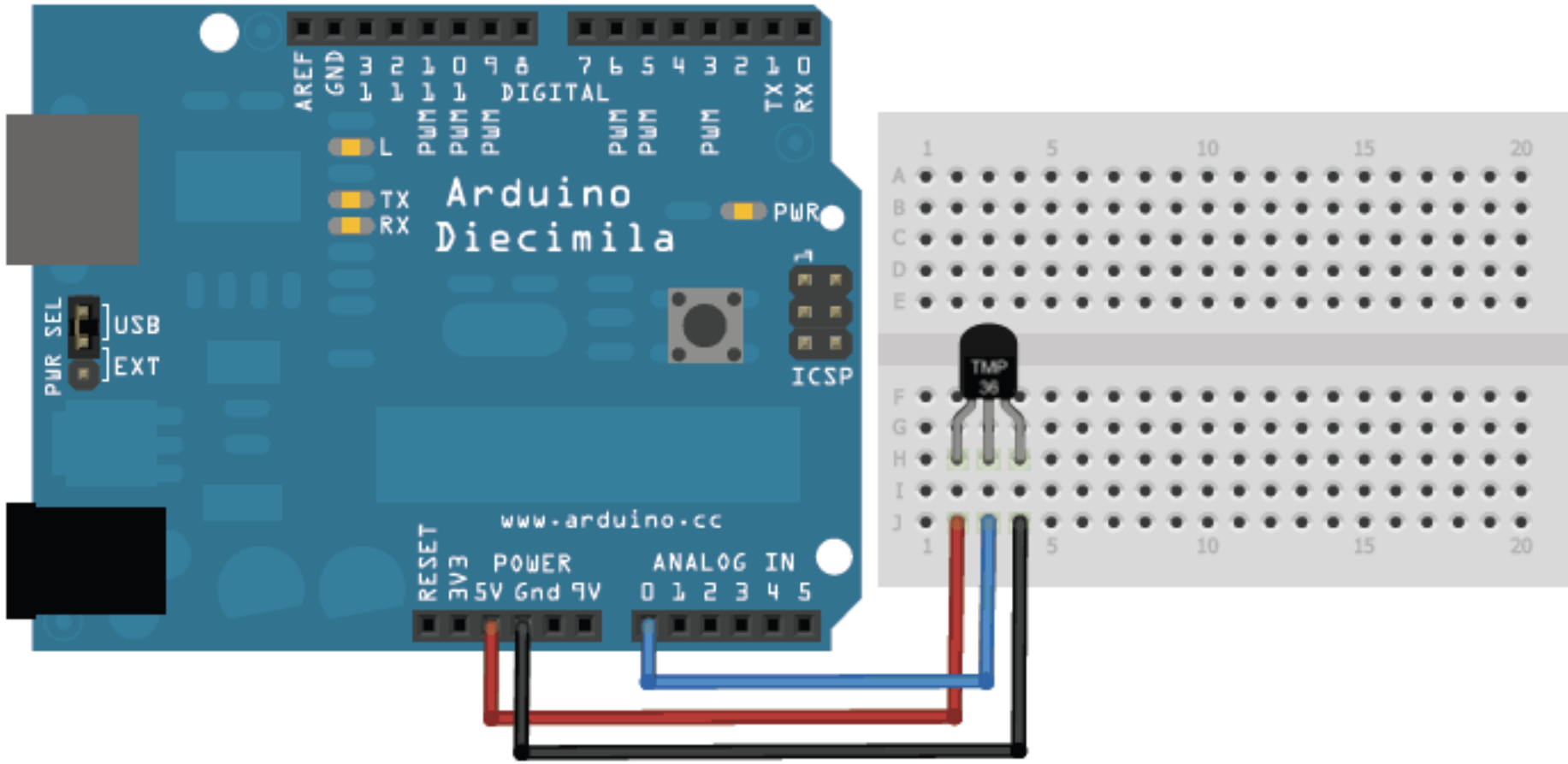


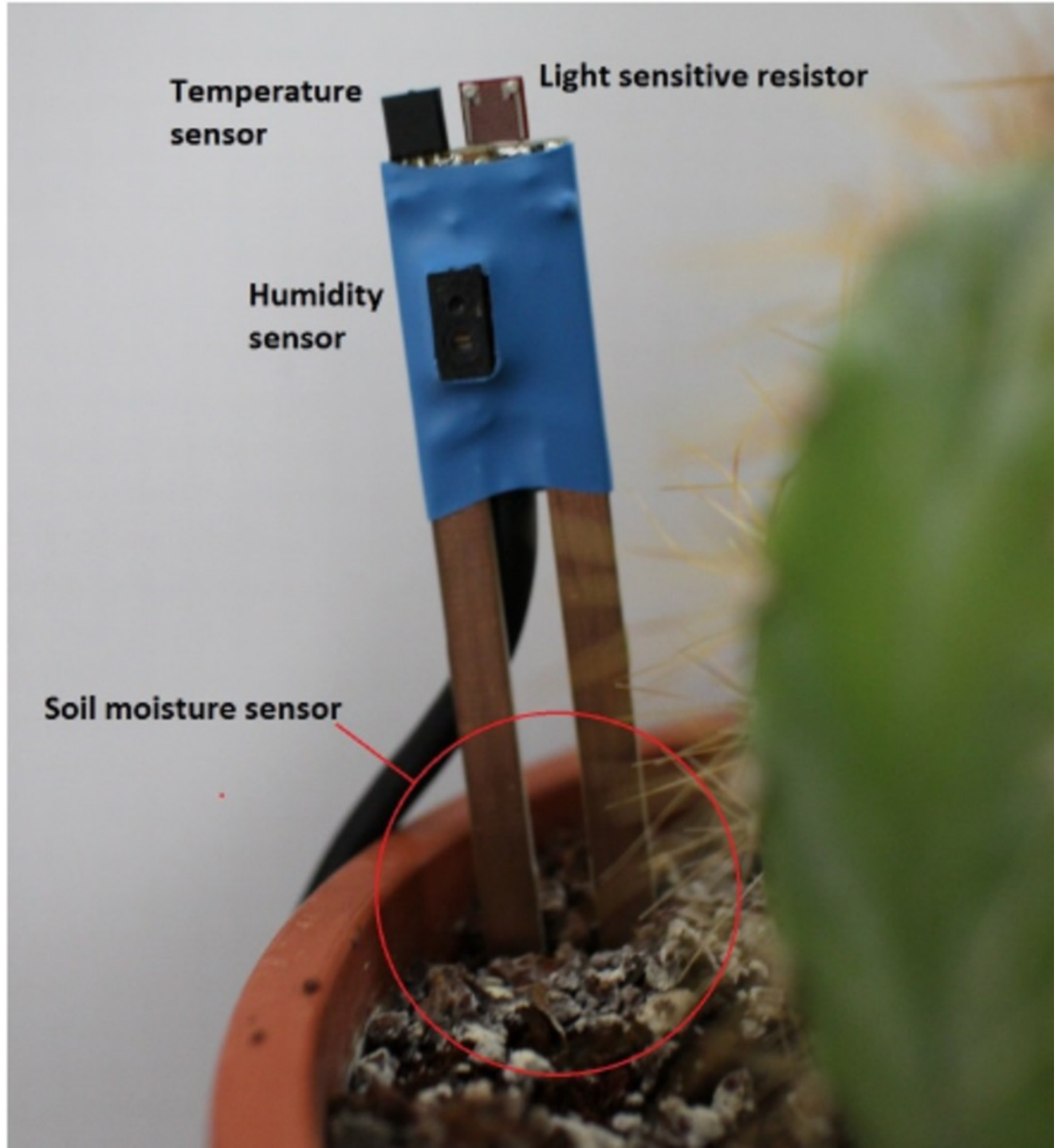
Figure 6. Output Voltage vs. Temperature

Temp in °C = [(Vout in mV) - 500] / 10

Testing TMP36



https://www.tinkercad.com/things/f6mYEXg0T0d


Temperature sensor
Light sensitive resistor
Humidity sensor
Soil moisture sensor

Example: Grow It Yourself

Dima ALBOT

Grow It Yourself

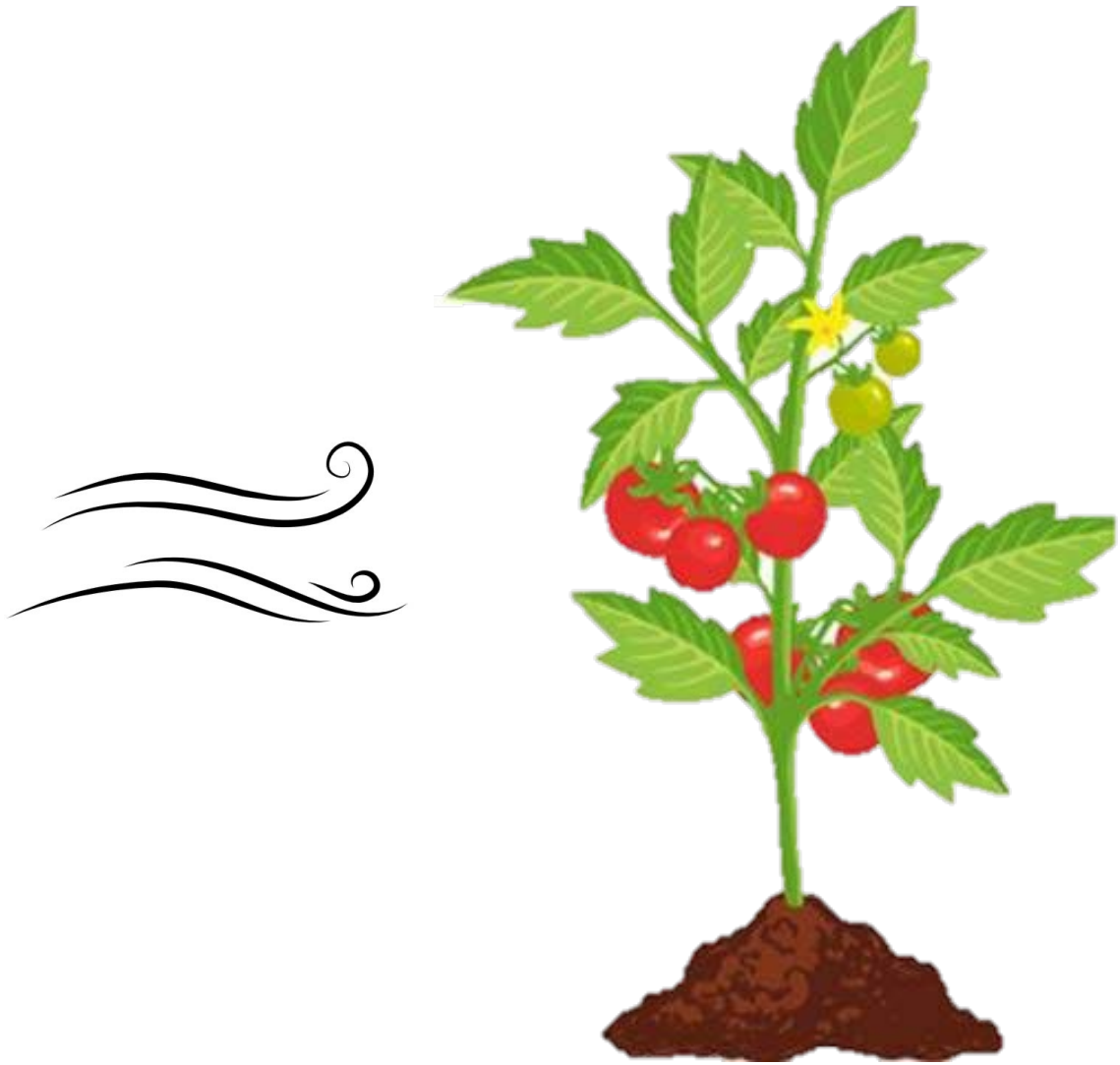
GIY - a self contained growing system that cultivates plants from seed to maturity. The system allows the monitoring and control of the en-viroment for the plants in a completely autonomous fashion.

Skills used in the project:

- cnc
- 3D printing
- electronics design
- electronics production
- embeded programming
- I/O devices
- vacuum moulding

GIY is an innovative planter that grows plants using a new method of irrigation called aeroponics „fog-ponics" that waters the plants through fertilizer infused mist.

http://archive.fabacademy.org/archives/2017/fablabkamplintfort/students/396/final.html

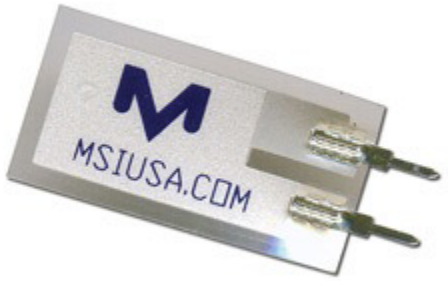


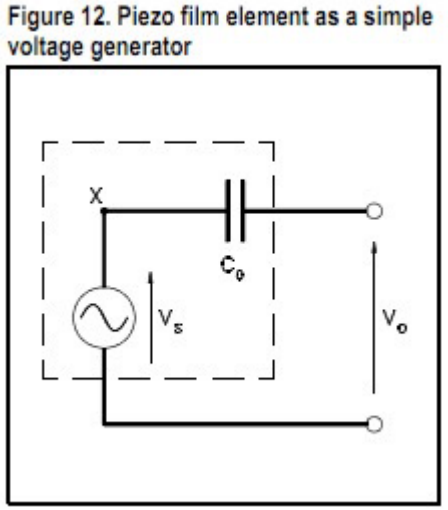
Flexible Vibration Sensor

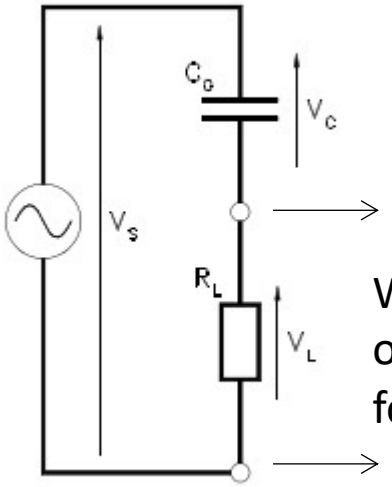
http://www.youtube.com/watch?v=YSwzngiWZWg

Flexible Vibration Sensor (Piezo sensor)

- Piezo sensor is very sensitive to vibration and movement, and generate output signal.
- The voltage range of signal that a piezo sensor can produce can be from a few microvolts to thousands volts, so we need a large value resistor to limit current and reduce the voltage through the circuit.



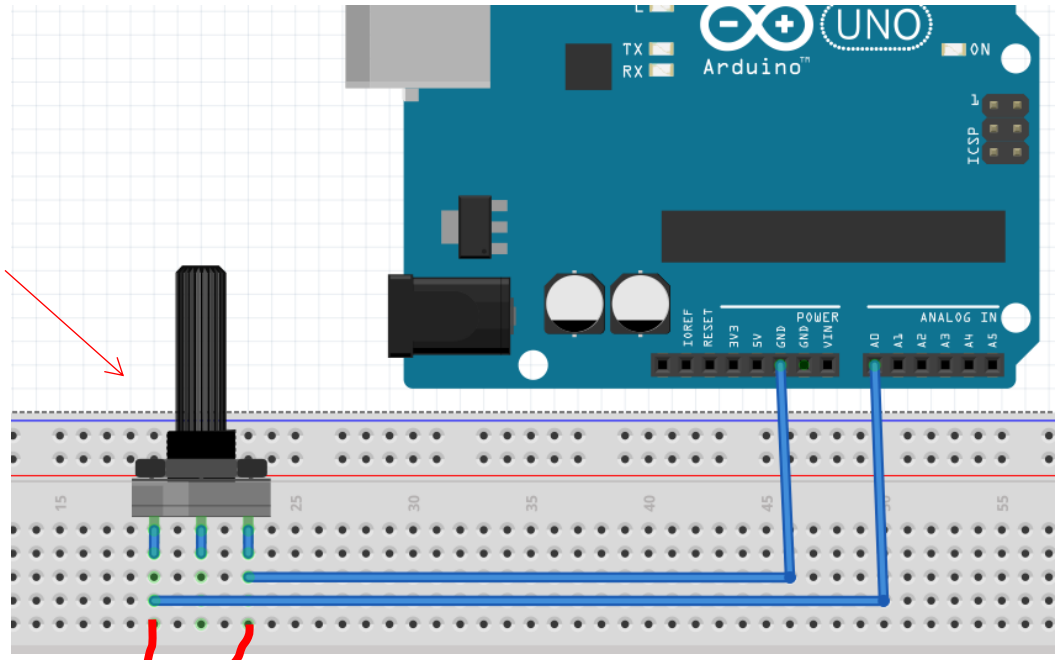


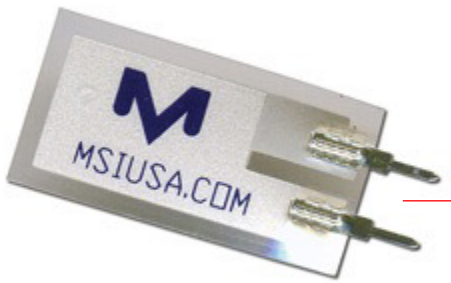


We get the voltage
of these two points
for the input to Arduino

Connect the sensor to Arduino

The value of this potentiometer/resistor should be very big!!
>500k Ohms

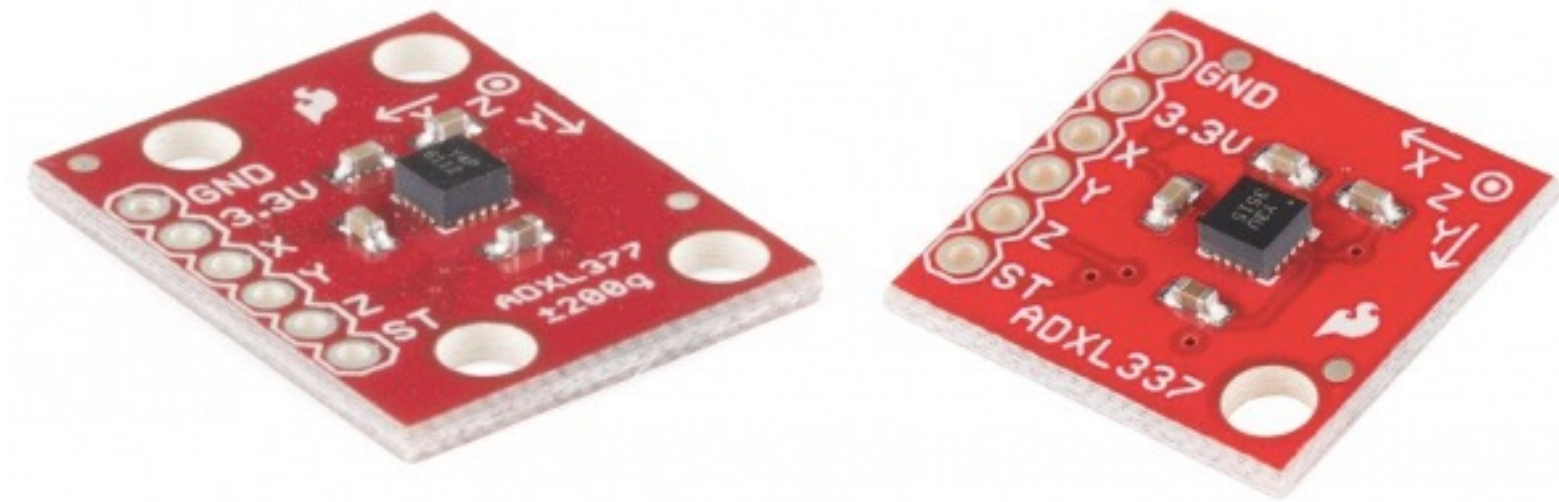




Code

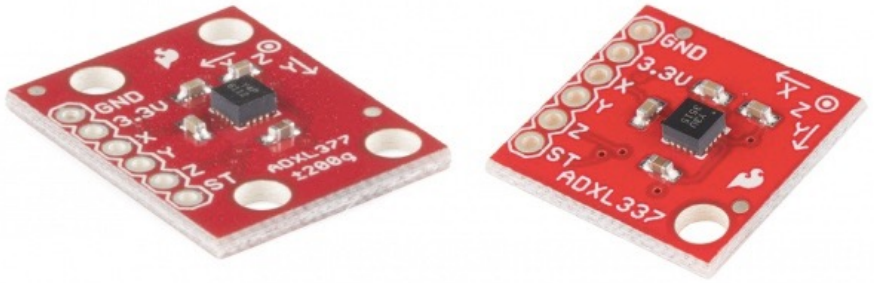
```
void setup()
{
  Serial.begin(9600);
}

void loop()
{
  int value = analogRead(0);

  Serial.println(value);

  delay(100);
}
```

Open the serial monitor to see the number changing when you shake/flip the film

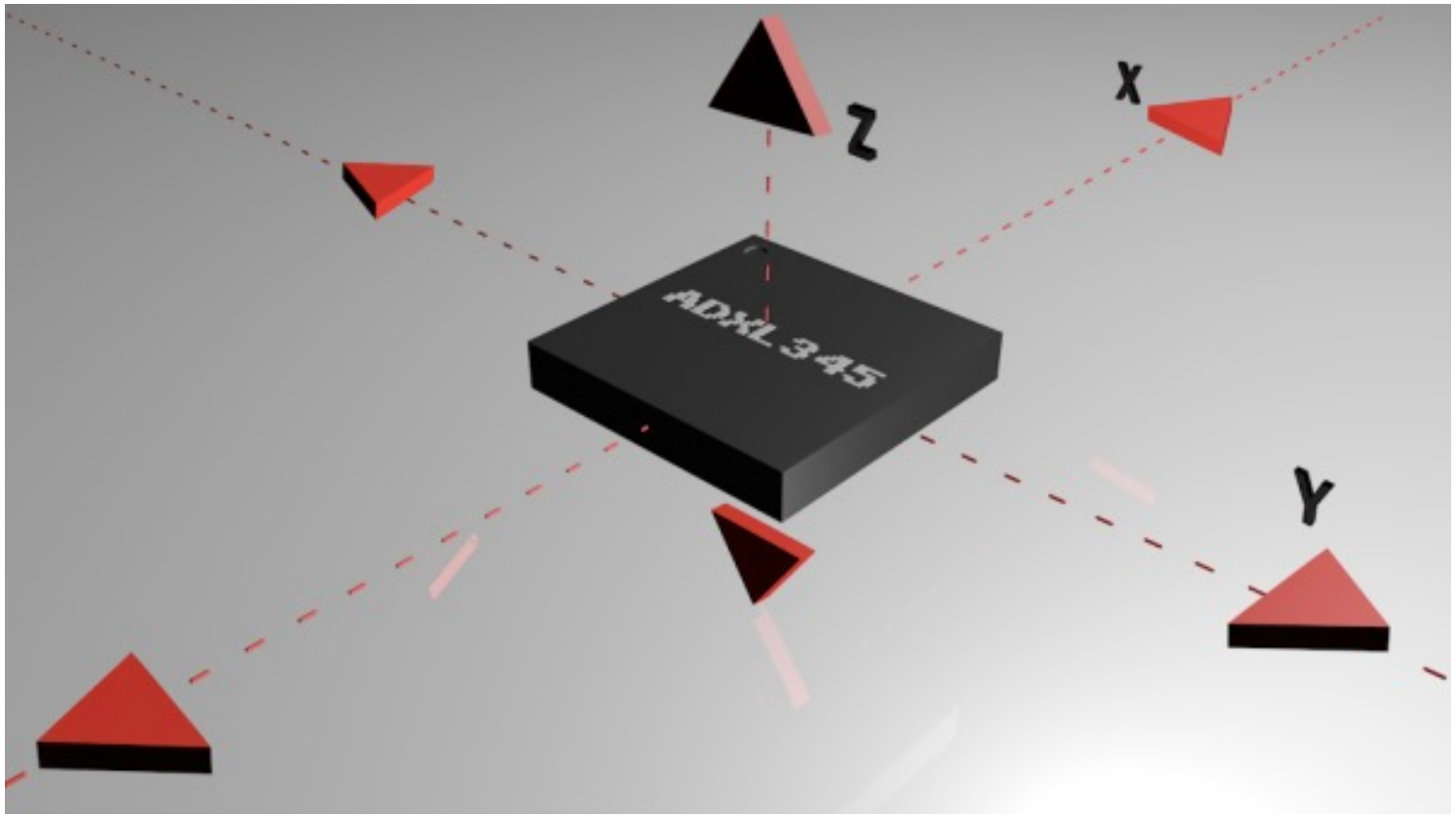

GND
3.3U
X
Y
Z
ST
ADXL377
1200g
GND
3.3U
X
Y
Z
ST
ADXL337

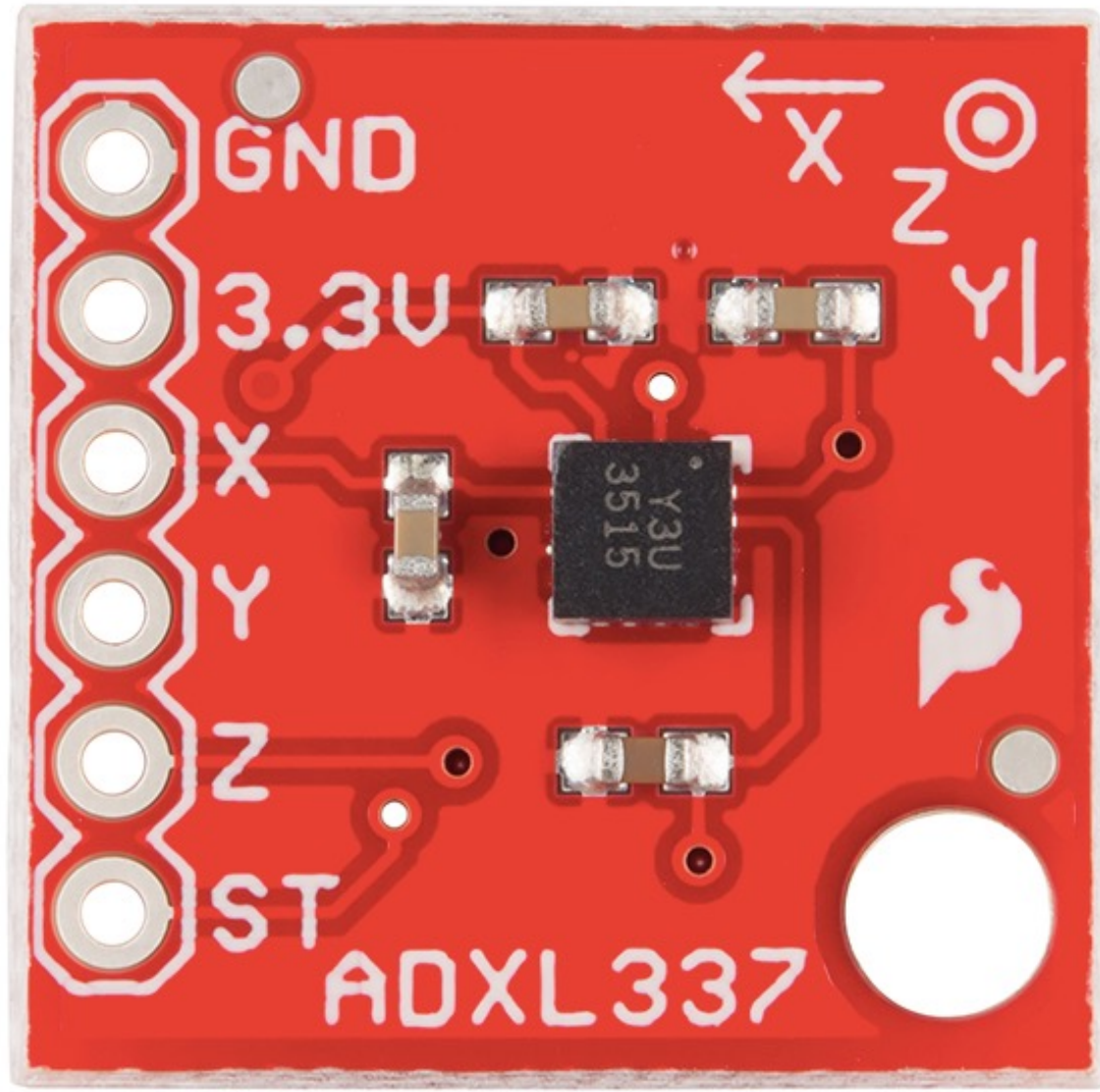
Accelerometer

- Accelerometers are devices that measure acceleration, which is the rate of change of the velocity of an object.
  - They measure in meters per second squared (m/s2) or in G-forces (g).
  - A single G-force for us here on planet Earth is equivalent to 9.8 m/s^2, but this does vary slightly with elevation (and will be a different value on different planets due to variations in gravitational pull).
  - Accelerometers are useful for sensing vibrations in systems or for orientation applications.

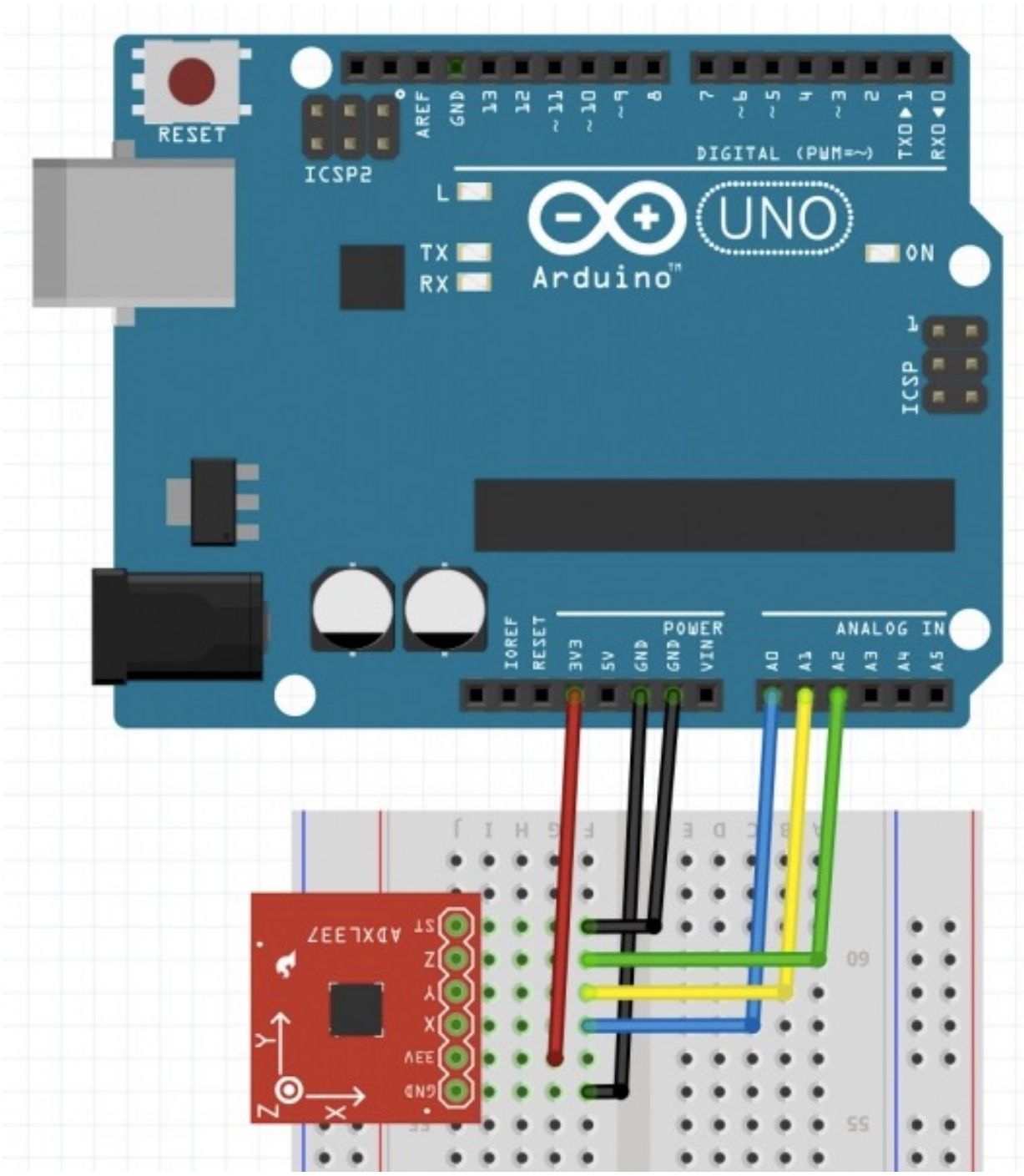


It also measures the XYZ orientation




GND
3.3V
X
Y
Z
ST
X
Z
Y
Y3U
3515
ADXL337

Pin Label	Pin Function	Input/Output	Notes
3.3V	Power Supply	Input	Can be between 1.8 - 3.6V.
X	X axis acceleration	Output	Analog output whose voltage correlates to acceleration measured on the X axis
Y	Y axis acceleration	Output	Analog output whose voltage correlates to acceleration measured on the Y axis
Z	Z axis acceleration	Output	Analog output whose voltage correlates to acceleration measured on the Z axis
ST	Self Test	Input	Used to verify sensor functionality
GND	Ground	Input	0V, common voltage to share with microcontroller circuit

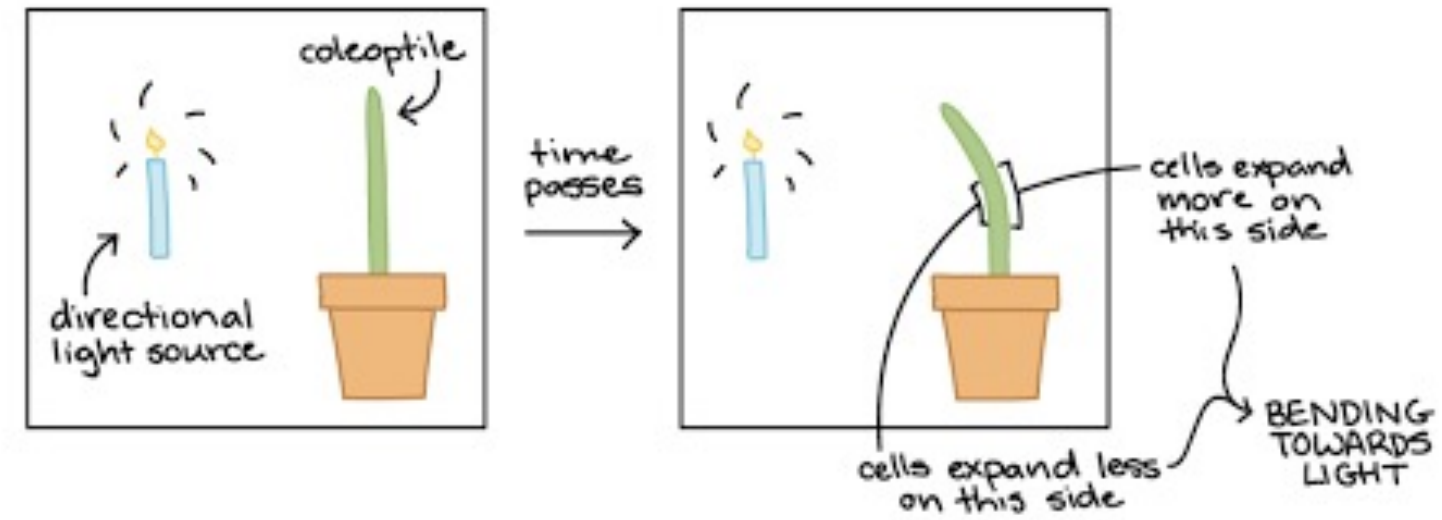

RESET
ICSP2
AREF
GND
13
12
~11
~10
~9
8
7
~6
~5
4
~3
2
TX→1
RX←0
DIGITAL (PWM=~)
L
TX
RX
UNO
Arduino™
ON
ICSP
IOREF
RESET
3V3
5V
GND
GND
VIN
POWER
A0
A1
A2
A3
A4
A5
ANALOG IN
ADXL337
ST
Z
Y
X
3.3V
GND

```ino
void setup() {
  // put your setup code here, to run once:
  Serial.begin(9600);
}

void loop() {
  // put your main code here, to run repeatedly:
  int x = analogRead(A0);
  int y = analogRead(A1);
  int z = analogRead(A2);

  float scaledX = mapf(x, 0, 675, -3, 3);
  float scaledY = mapf(y, 0, 675, -3, 3);
  float scaledZ = mapf(z, 0, 675, -3, 3);

  Serial.print(scaledX);
  Serial.print(" ");
  Serial.print(scaledY);
  Serial.print(" ");
  Serial.println(scaledZ);

  delay(200);
}

float mapf(float x, float in_min, float in_max, float out_min, float out_max)
{
  return (x - in_min) * (out_max - out_min) / (in_max - in_min) + out_min;
}
```

- Attach it on the leaf

The shape/size changes…

The Science Behind…



Plant could be sensitive to human-touch

https://www.youtube.com/watch?v=LTKMCyC5dd0

Or more..

https://www.youtube.com/watch?v=mhasvJW9Nyc

Touché: Enhancing Touch Interaction on Humans, Screens, Liquids, and Everyday Objects

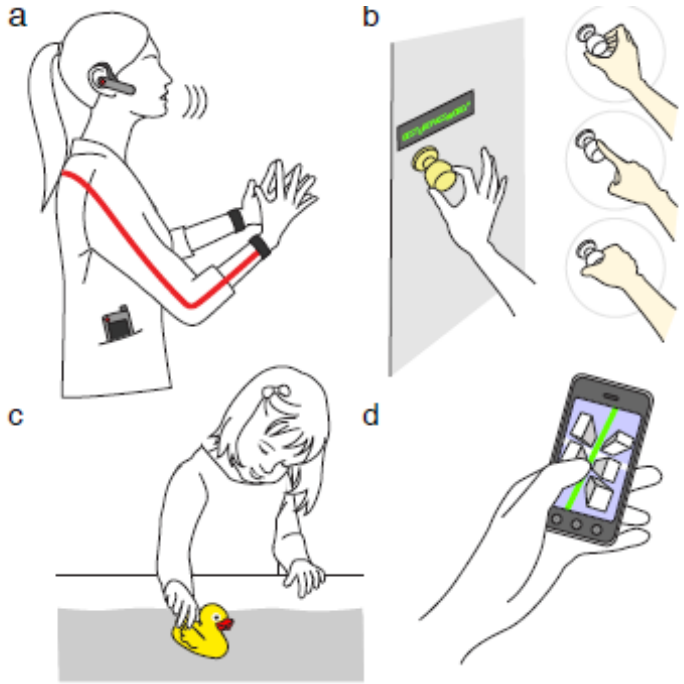


Figure 1: Touché applications: (a) on-body gesture sensing; (b) a smart doorknob with a "gesture password"; (c) interacting with water; (d) hand postures in touch screen interaction.

Touché proposes a novel ***Swept Frequency Capacitive Sensing*** technique that can not only detect a touch event, but also recognize complex configurations of the human hands and body.

Disney Research

https://www.chrisharrison.net/index.php/Research/Touche

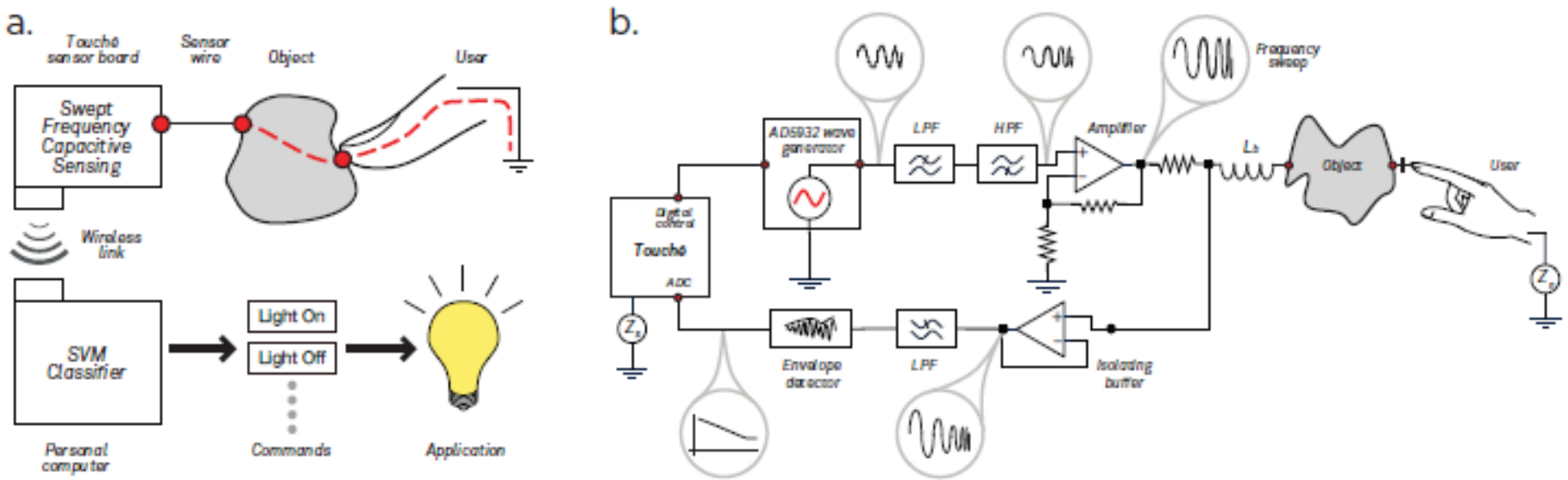


Figure 2: (a) Touché architecture (b) Swept Frequency Capacitive Sensing with Touché.

- A changing signal passing through the circuit between the send and the receive pins.

Touché:

Enhancing Touch Interaction on Humans, Screens, Liquids, and Everyday Objects

Munehiko Sato, Ivan Poupyrev, Chris Harrison

CHI 2012 Paper Video Figure

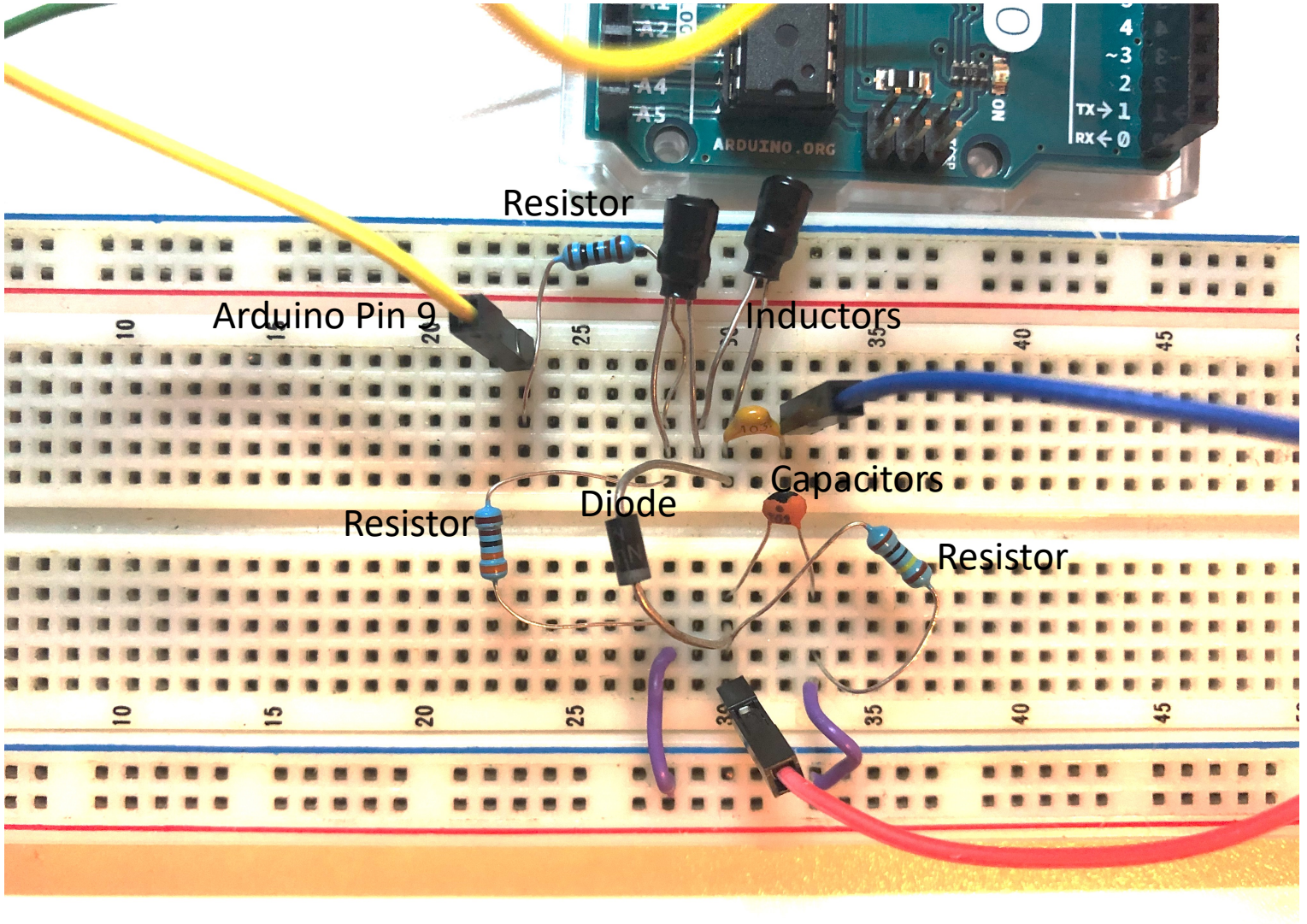
Disney Research Pittsburgh

https://www.youtube.com/watch?v=E4tYpXVTjxA

DIY Touché

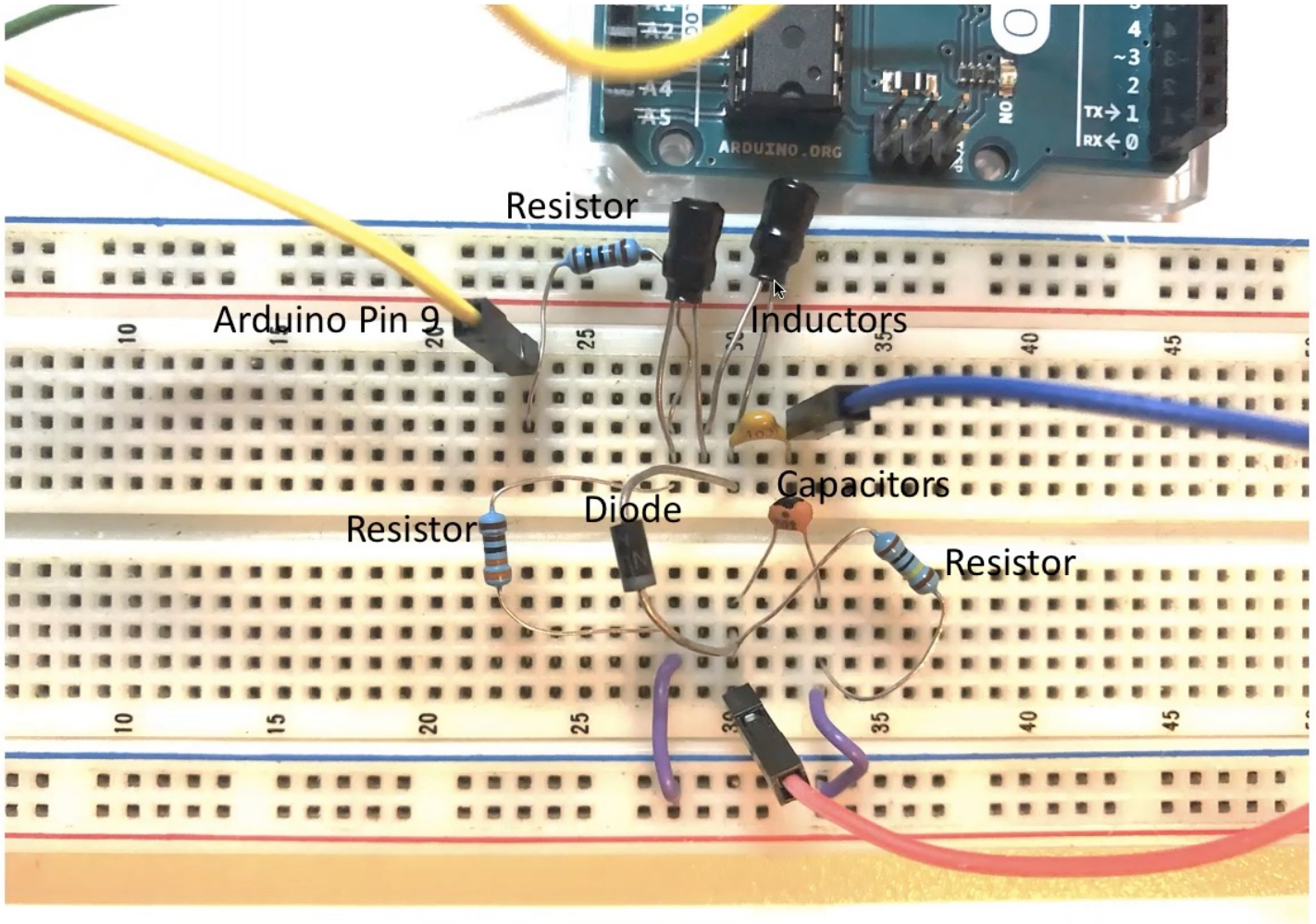
https://www.instructables.com/id/Touche-for-Arduino-Advanced-touch-sensing/

Touché Circuit Photo



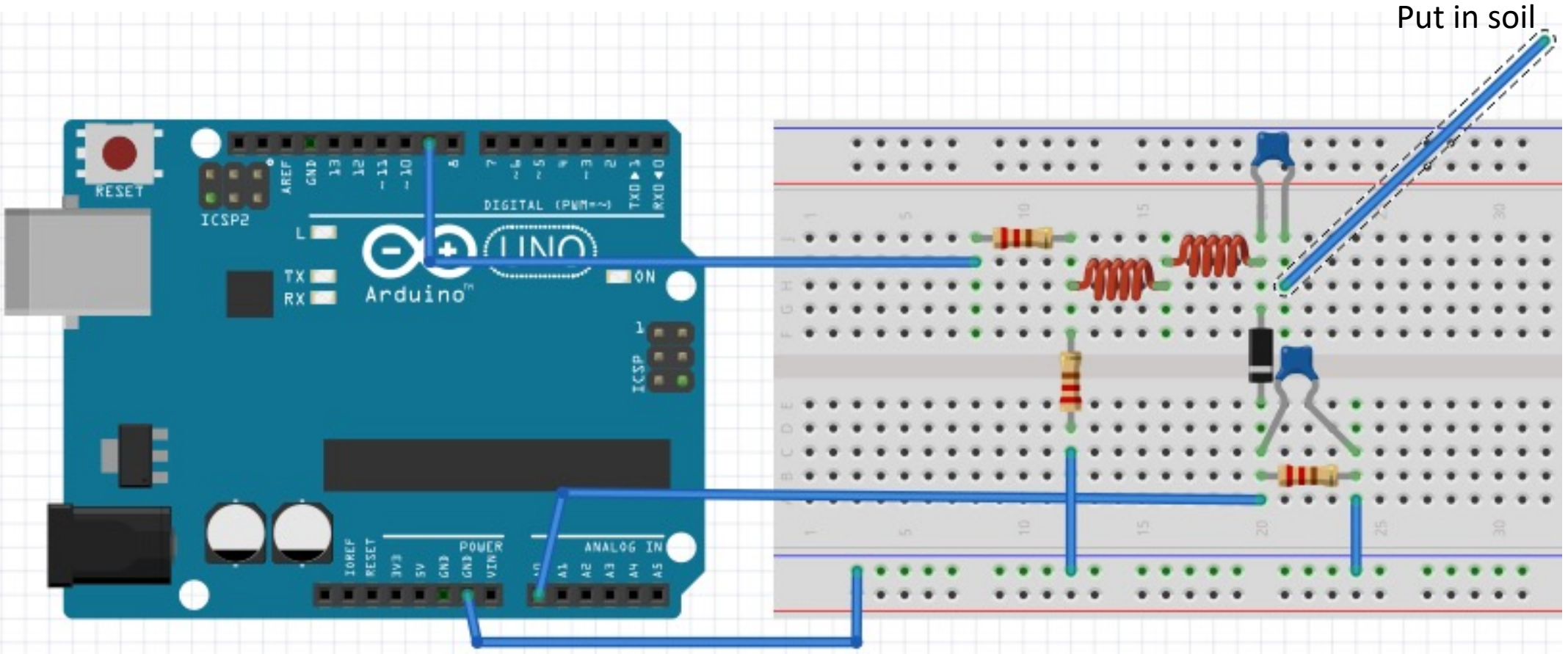
Demo

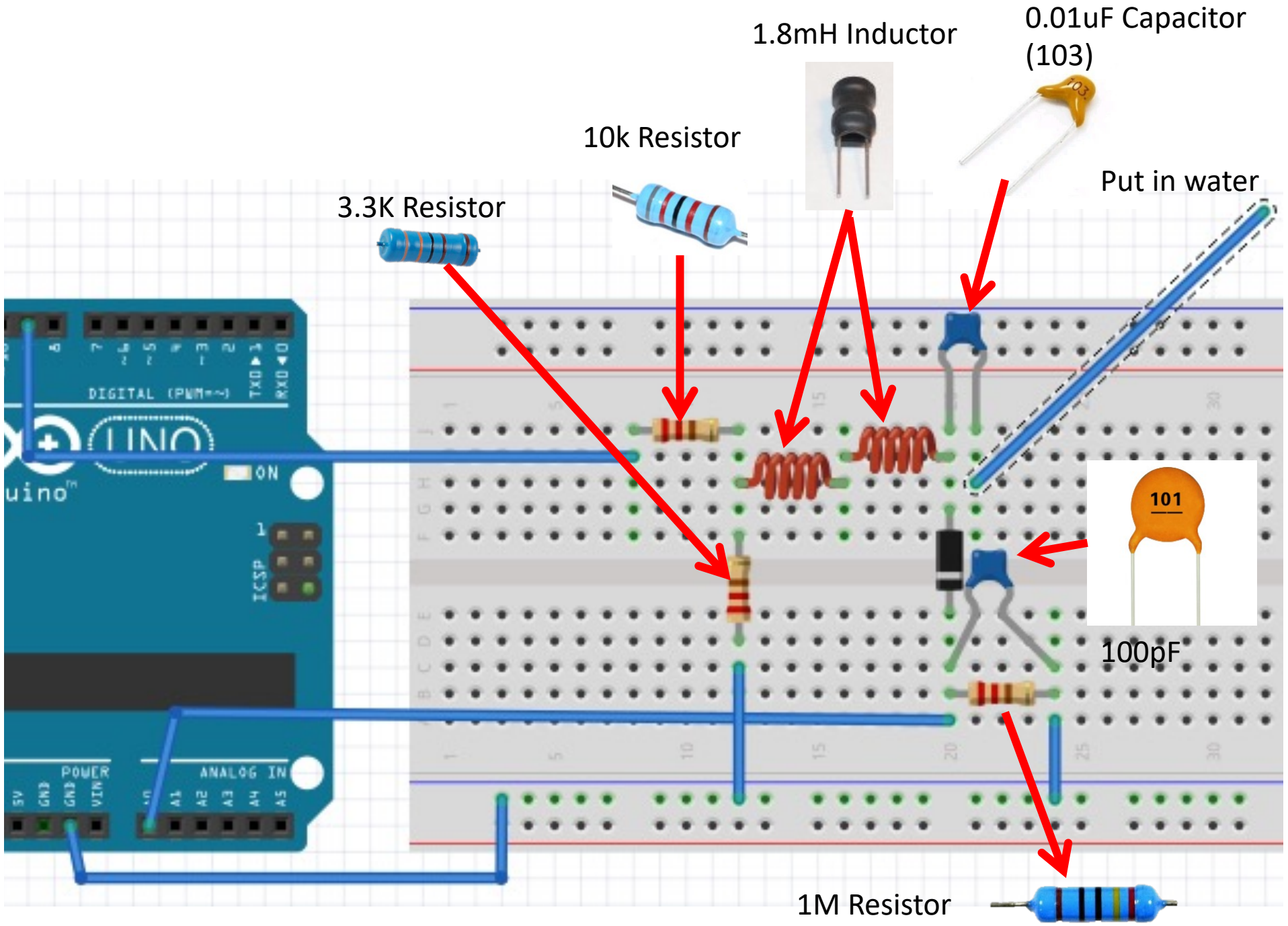
Touché Circuit Photo

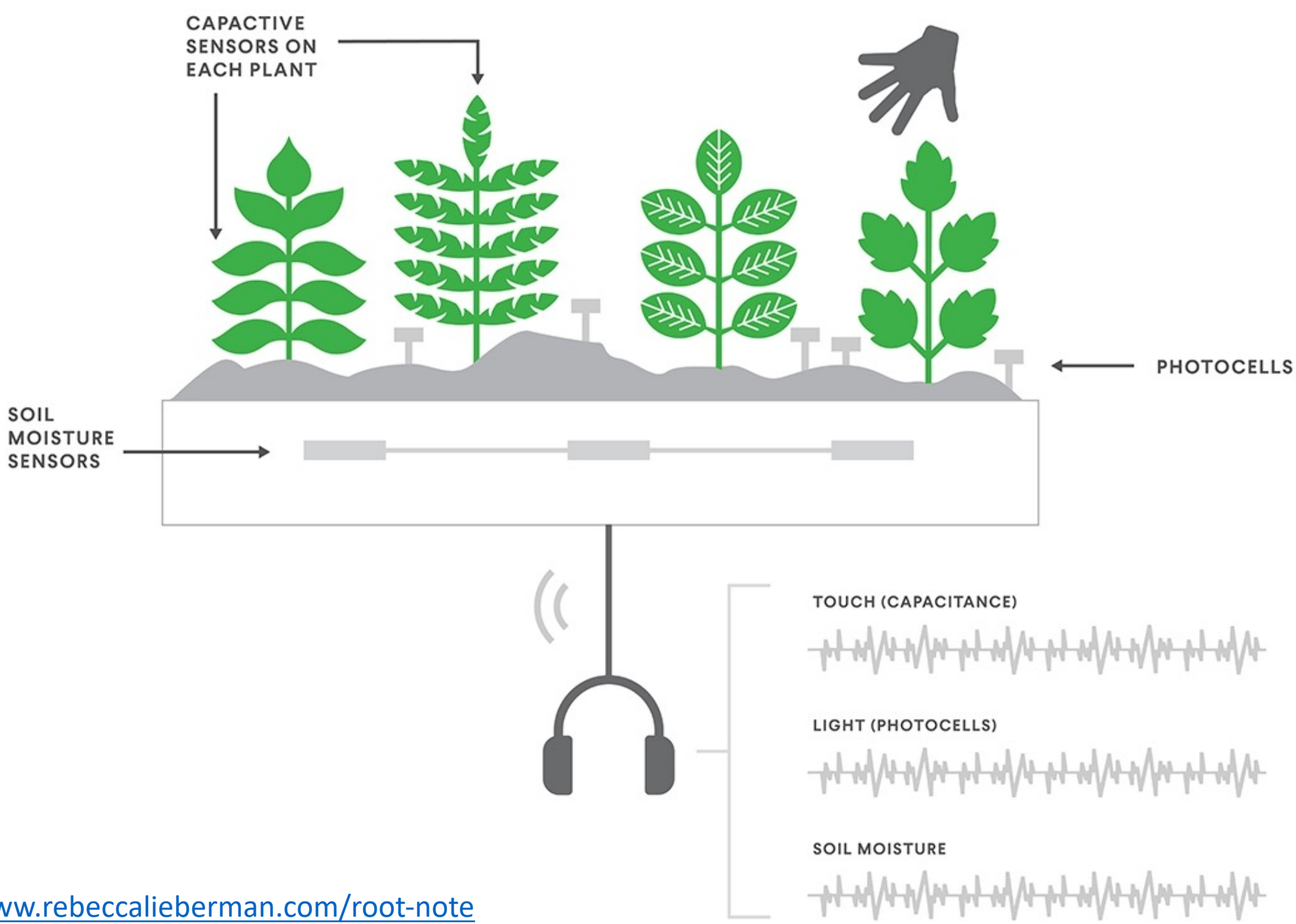


How to make water glass touch-sensitive

- Hardware




1.8mH Inductor
0.01uF Capacitor
(103)
10k Resistor
Put in water
3.3K Resistor
101
100pF
1M Resistor

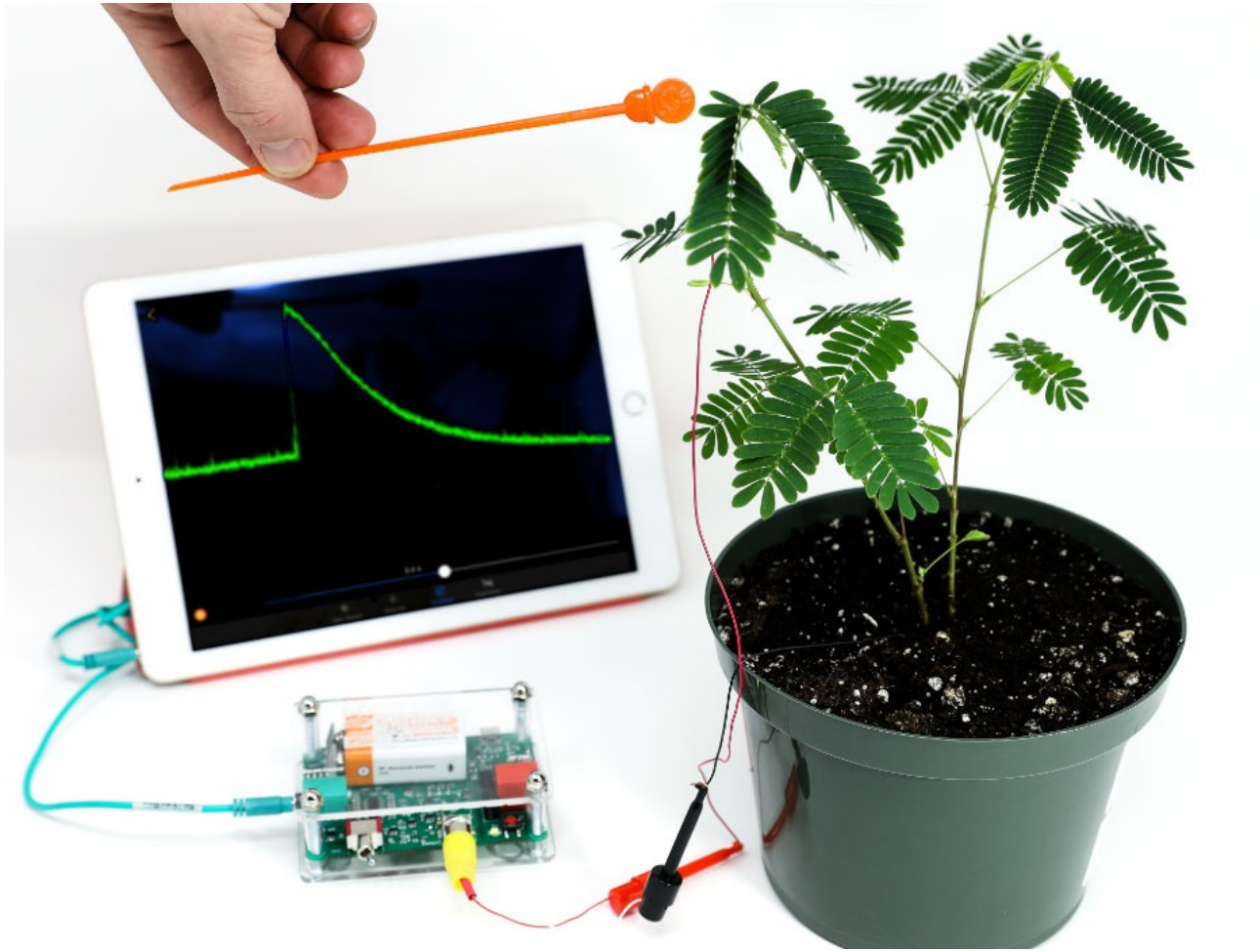


https://www.rebeccalieberman.com/root-note

Talking Plant

https://www.youtube.com/watch?v=ix0QV2_p-bM

Let’s come back to mimosa plant



https://backyardbrains.com/products/plantspikerbox

https://www.youtube.com/watch?v=tzI2rss7q_4

https://backyardbrains.com/experiments/Plants_SensitiveMimosaPudica

Plant-Plant Conversation

https://www.youtube.com/watch?v=Gj1JfgGmKug

How to store this data?

- Arduino to Processing

We will talk about it on Friday!

Simple Visualization

- Excel
- Processing

- How to transfer it to a 3D visualization?

If you want to borrow PlantSpikeBox

- Email keninzhu@cityu.edu.hk

- One group borrows one set at a time.