PHYSICAL INTERACTION, SENSORS & ACTUATORS
物理交互、传感器&驱动器

Week04_2.1

PHYSICAL INTERACTION
物理交互

PHYSICAL INTERACTION｜物理交互

Keyboard and mouse interaction are intrinsically physical, however they require little in the way of actual body movement or agility.

When we talk about physical interaction, we are speaking about interactions that require more of the body, depend more on movement, and may require a greater level of agility.

We might also be more concerned with the body's relationship to it's environment.

PHOTO BY JON WILEY

PHYSICAL INTERACTION｜物理交互

键盘和鼠标交互也属于physical interaction，然而参与者的（大部分）身体却并没有参与到互动中。当我们提及physical interaction的时候，指的是更多的身体移动，更敏捷的动作参与到互动中，并更多的考虑到人和环境的关系

PHOTO BY JON WILEY

HOW OUR BRAINS SENSE OUR BODIES

Our primary motor cortex, the parts of our brain responsible for our body's movement, can be represented as a Cortical Homunculus. Notice how disproportionately larger some parts of the Homunculus are, such as the tongue, and fingers. We need more processing power for those functions in order to maintain our fine motor skills.
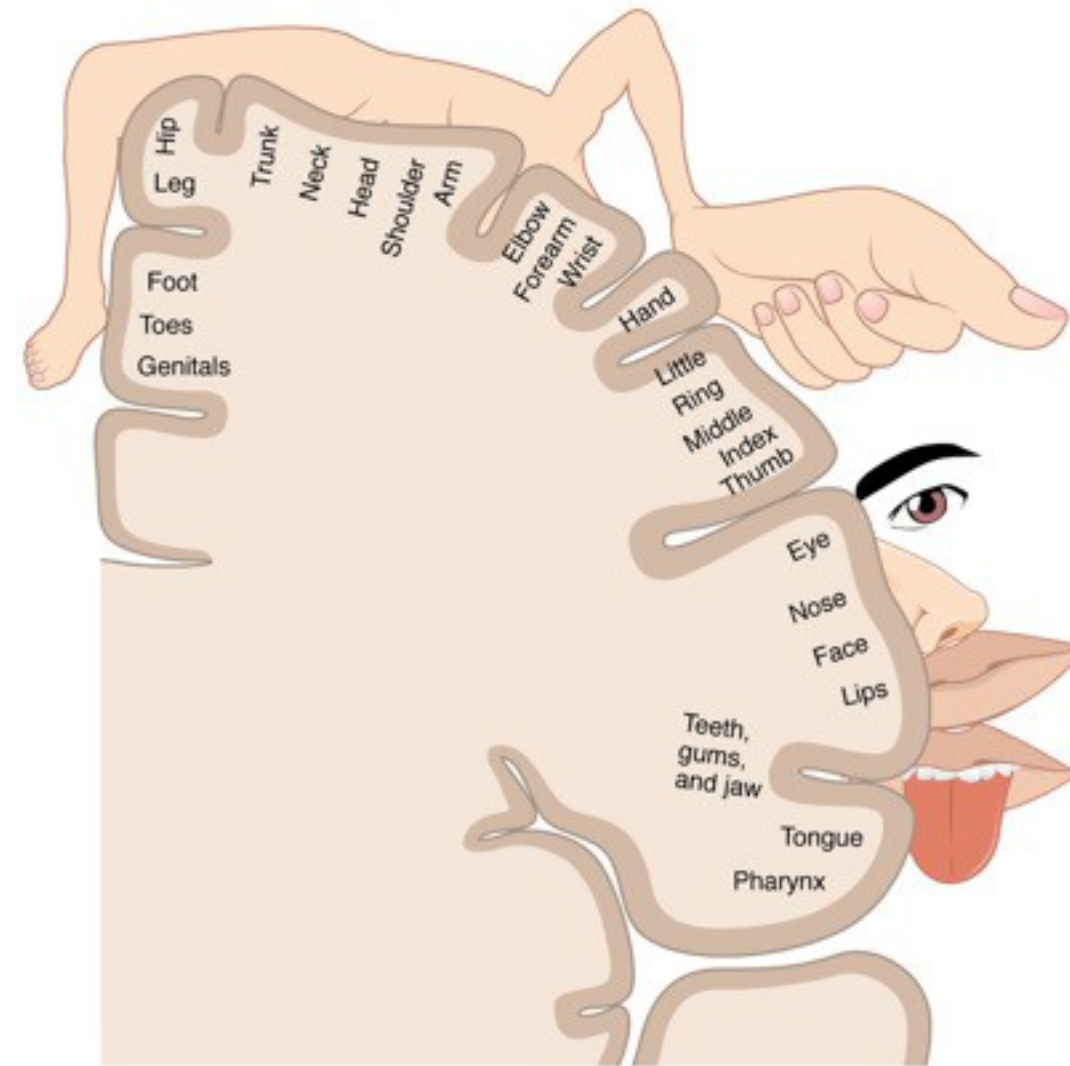
大脑皮质层对应控制省体部位图－－不同身体部位动作的复杂程度亦不同

WHAT COMPUTERS THINK OF HUMANS
计算机眼中的人类

Researchers and ITP professors Dan O'Sullivan and Tom Igoe created this drawing to illustrate what computers think of humans based on how we interact with them.
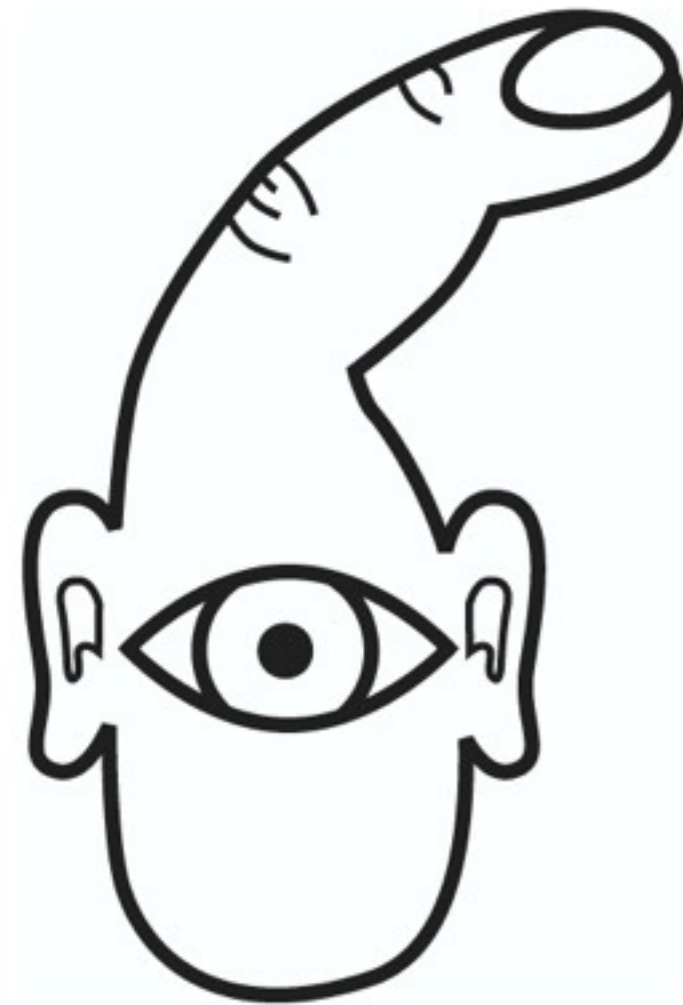
基于人和计算机的交互方式产生的结果：
计算机理解的人类

WOODEN MIRROR｜木镜

Daniel Rozin's Wooden Mirror is a mechanical mirror made from 830 blocks of wood. A camera embedded in the work of art captures whatever may be in front of the mirror. A computer analyzes each frame of video, and then controls motors which shift the direction of the attached blocks causing them to reflect more or less light.

Daniel Rozin 的作品木镜由930块木块儿组成，整个装置作品通过一个摄像头捕捉前方的图像，计算机分析图像并控制单个木块的转动，形成明暗变化表达像素点的灰度

SHORT++

Short++ is a pair of robotic platform shoes worn by artist Adi Marom.
The height of the wearer can be adjusted in real-time by using an iPhone App.
The artist created the shoes so that she could investigate how height plays a role in the interaction of people.

Short＋＋：Iphone控制的穿戴机器人，实时调整其身高，从而可以改变穿戴者和环境互动中自身的高度。

SENSORS
传感器

SENSORS｜传感器

Sensors are a range of input circuits capable of measuring a physical quality.
A sensor acts to convert this physical quality into an electrical signal that is understandable to a microcontroller.

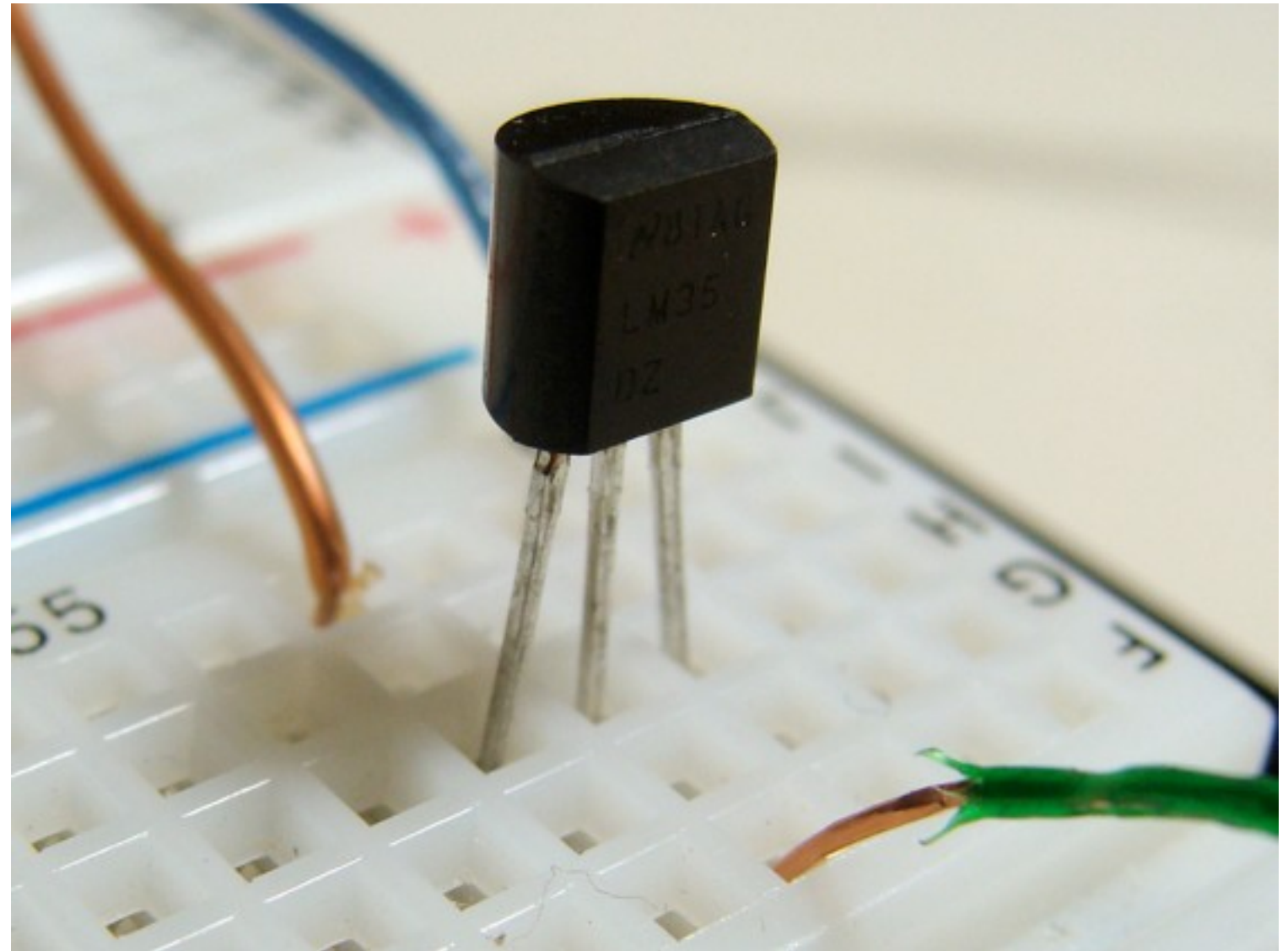传感器：一类能将测量物理信号的电路，将物理信号转化成电子信号并被微控制器读取

PHOTO BY DANIEL SPILLERE ANDRADE

SENSOR CATEGORIES｜分类

Some general sensor categories

- Sound & Vibration
- Light & Radiation
- Temperature
- Position & Proximity
- Speed & Acceleration
- Pressure & Force
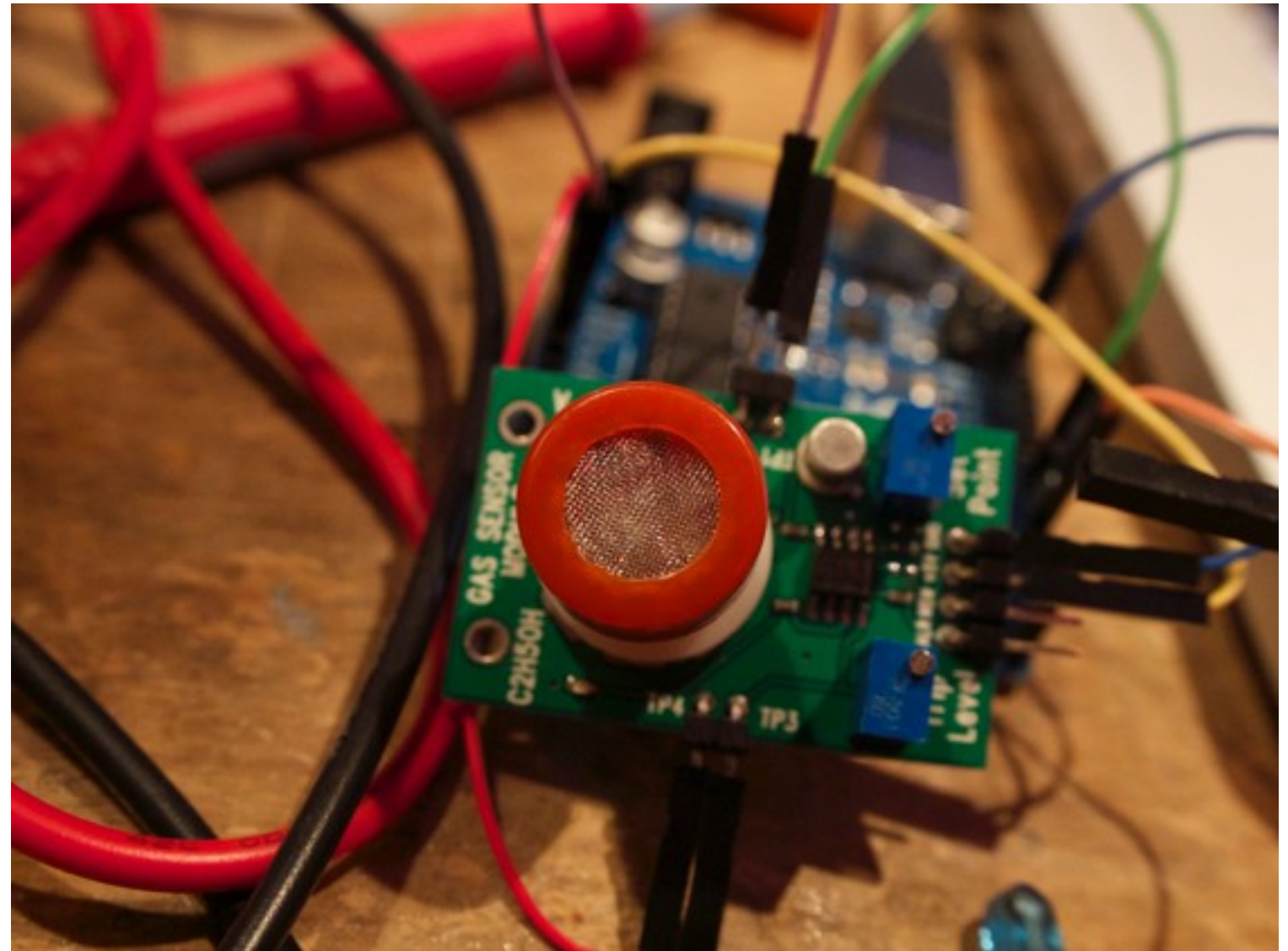- Gas & Chemical
- Electrical & Magnetic

PHOTO BY MRIAGRUNICK

SENSOR CATEGORIES｜分类

Some general sensor categories

- 声音和震动
- 光
- 温度
- 位置
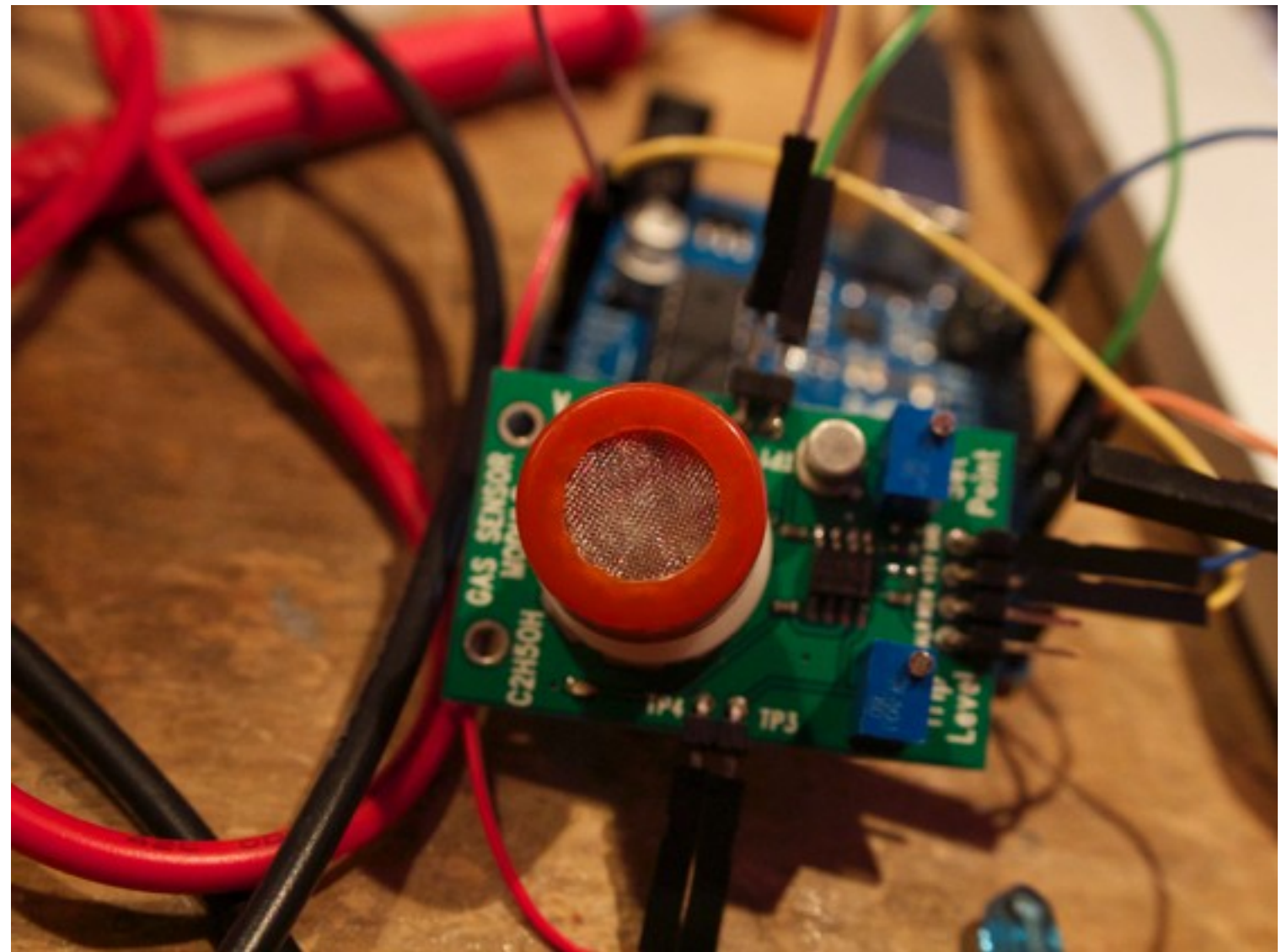- 速度和加速度
- 压力
- 化学品和气体
- 电和磁

PHOTO BY MRIAGRUNICK

SOUND & VIBRATION｜声音和震动

Sound & vibration sensors often rely on the piezoelectric effect.

The piezoelectric effect is the tendency of an electric charge to build up in certain materials when physical pressure is applied

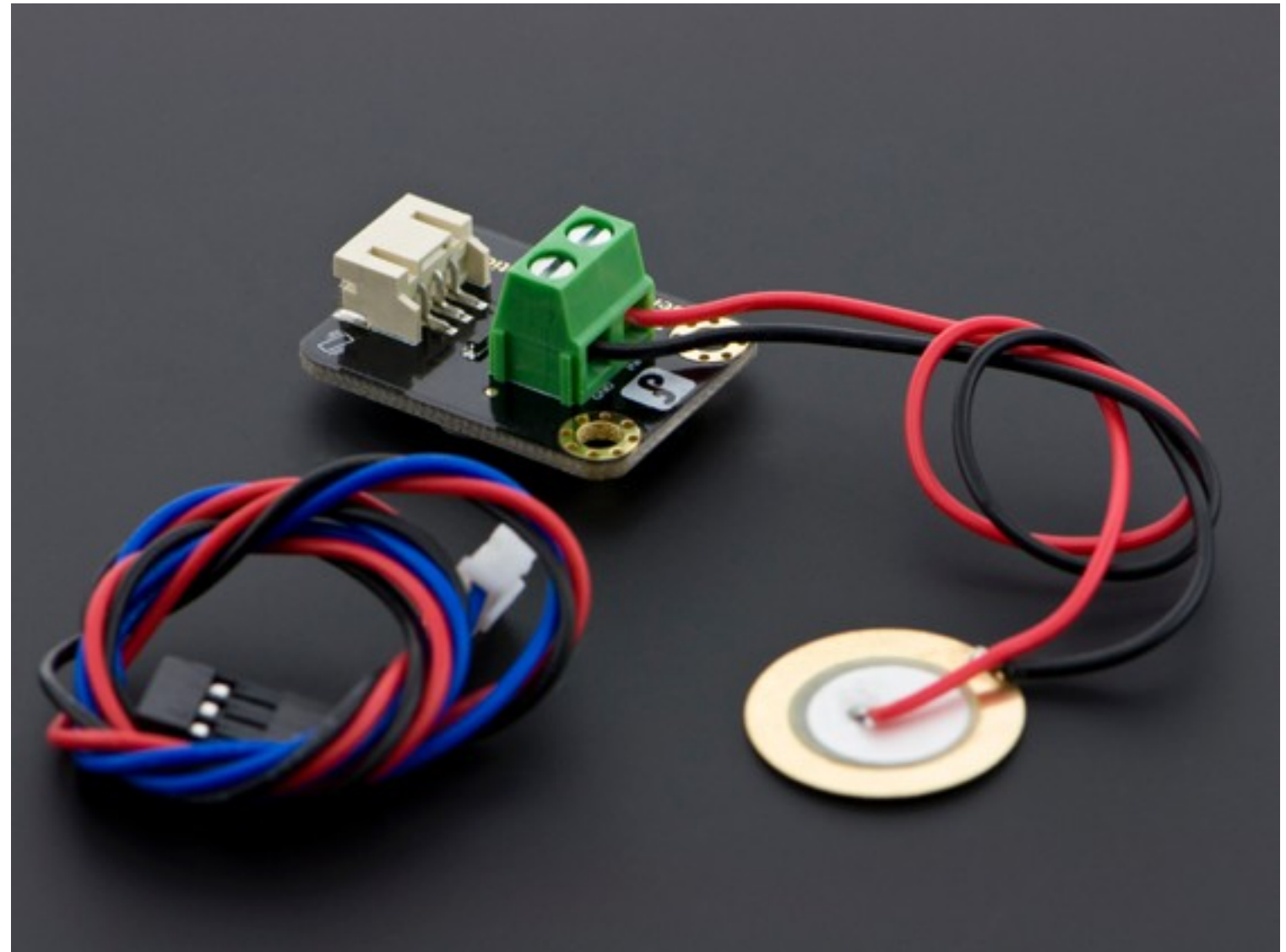声音和震动相关的感应器多是依靠压电效应工作
压电效应指电介质中机械能和电能的相互转化，当有压力施加时，电荷会发生变化

PHOTO BY DFROBOT

LIGHT & RADIATION ｜ 光和辐射

One type of light sensor, photoresistors (sometimes called photocells), are a light sensitive variable resistor that rely on Photoconductivity.
Photoconductivity is the quality of certain materials to become more or less electrically conductive with exposure to electromagnetic radiation.
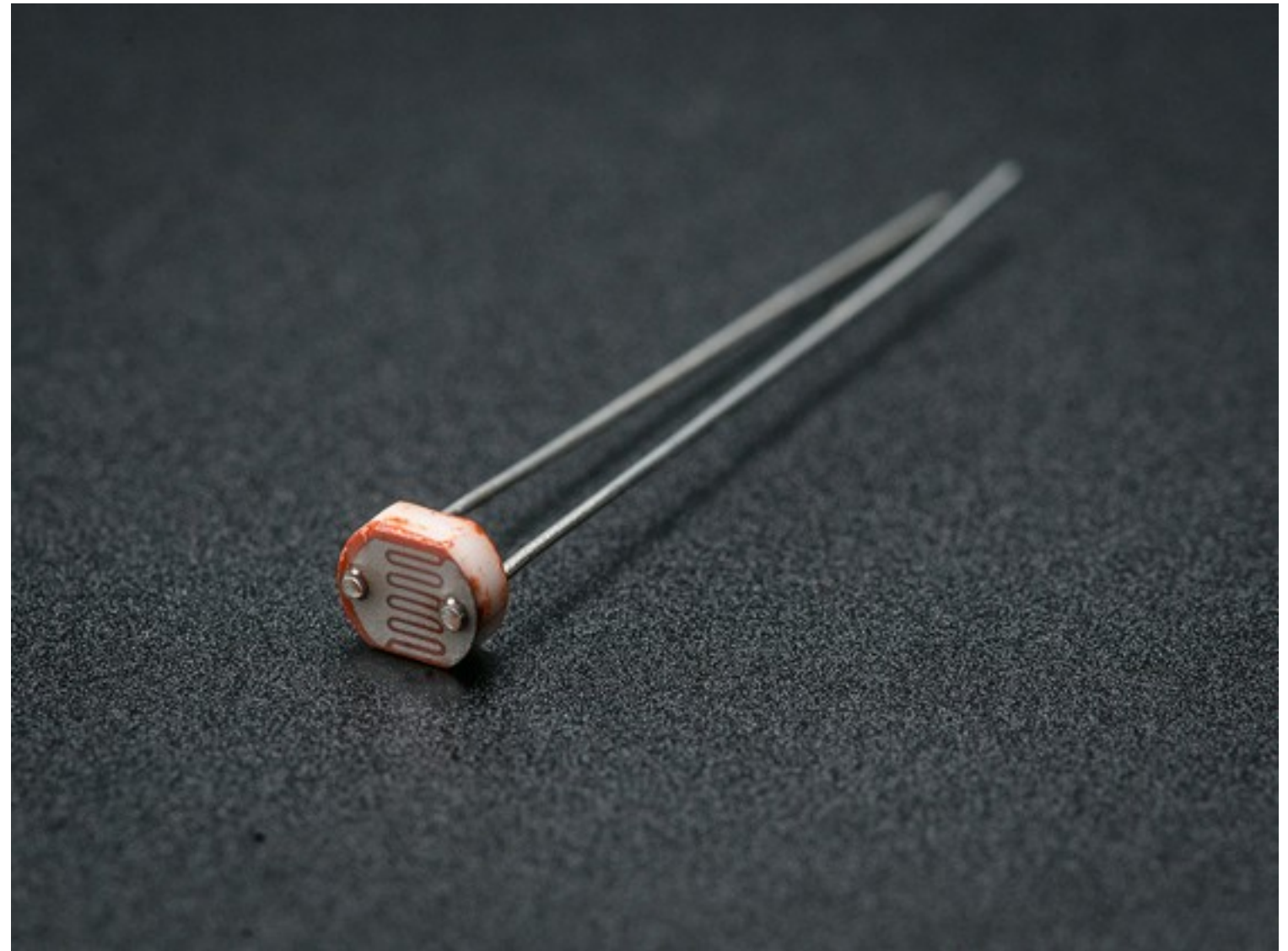光线传感器利用特殊材料在不同光线条件下导电性会发生变化的原理来检测光线，最简单的光线感应器就是光敏电阻

PHOTO BY ADAFRUIT

TEMPERATURE｜温度

A thermistor is a type of temperature sensor that relies on a change in the conductance of some materials at varying temperatures.
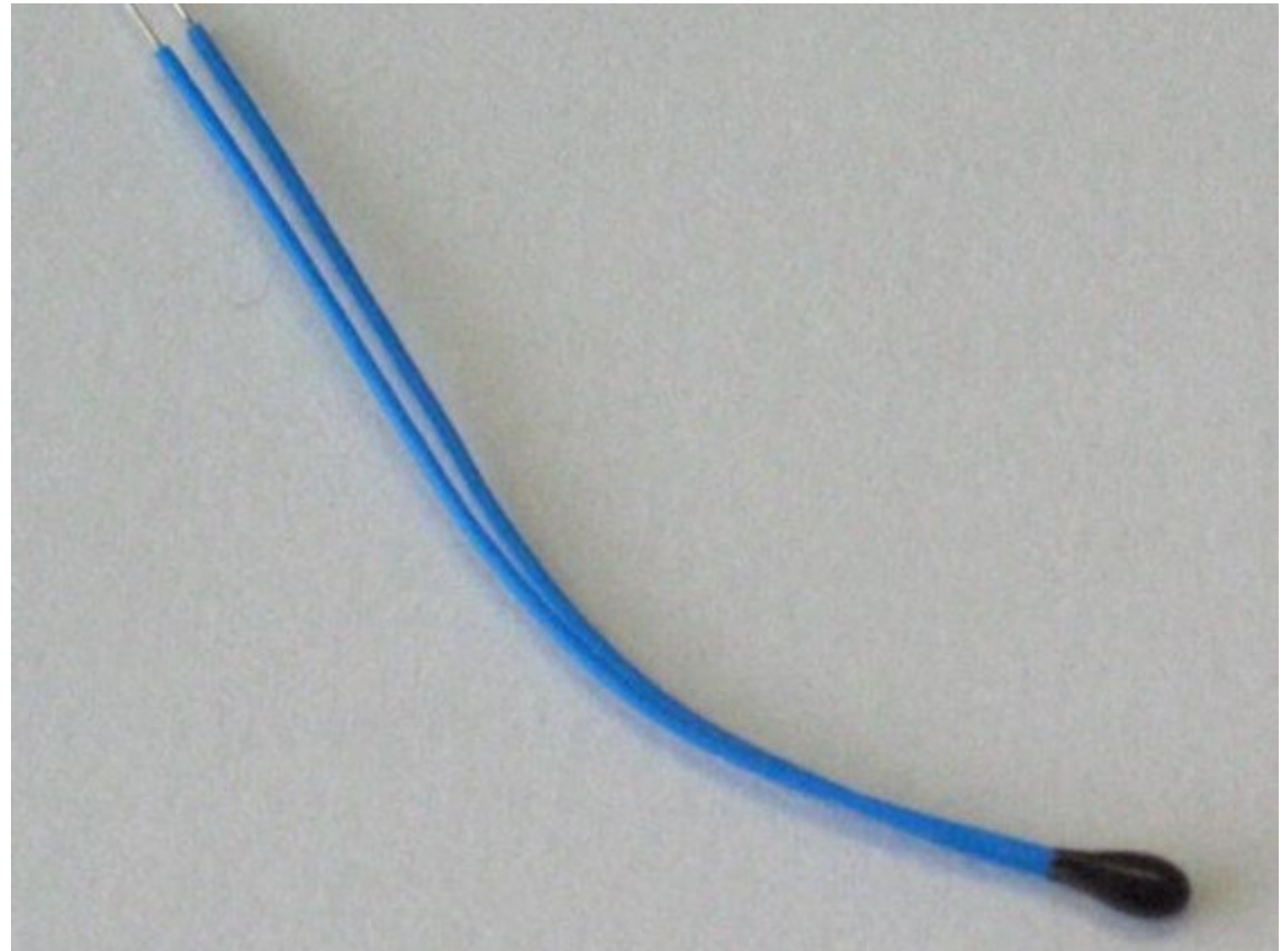
材料导电性随温度变化改变，温度相关传感器，最简单的即是热敏电阻

POSITION & PROXIMITY | 位置

Ultrasonic sensors or rangefinders use the principles of radar. These devices interpret the time it takes an echo produced by sound or radio waves to return to determine distance.
Another way to determine position is to use computer vision, a technique of programmatically analyzing digital images or video.

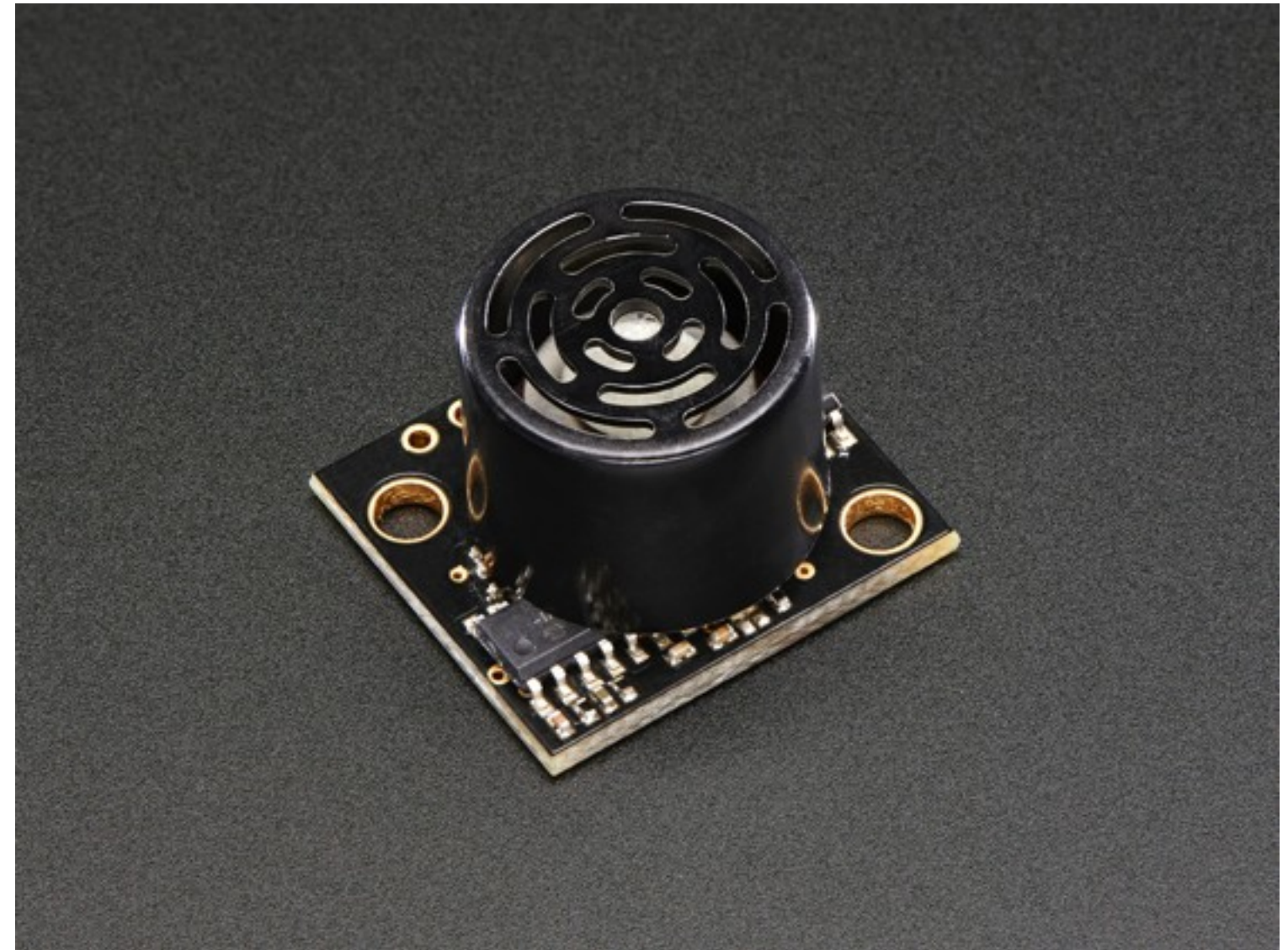超声波感应器使用雷达的原理，根据（超）声波返回时间来判断距离。而另外常用的探测位置的方式即是计算机可视化，computer vision，基于对图像和视频的分析获取位置

PHOTO BY ADAFRUIT

SPEED & ACCELERATION｜速度和加速度

Accelerometers are a range of devices capable of measuring g-forces felt by objects during movement.
These sensors, which are generally included in smart phones, can be used to determine position, orientation, and velocity in single or multiple axes.

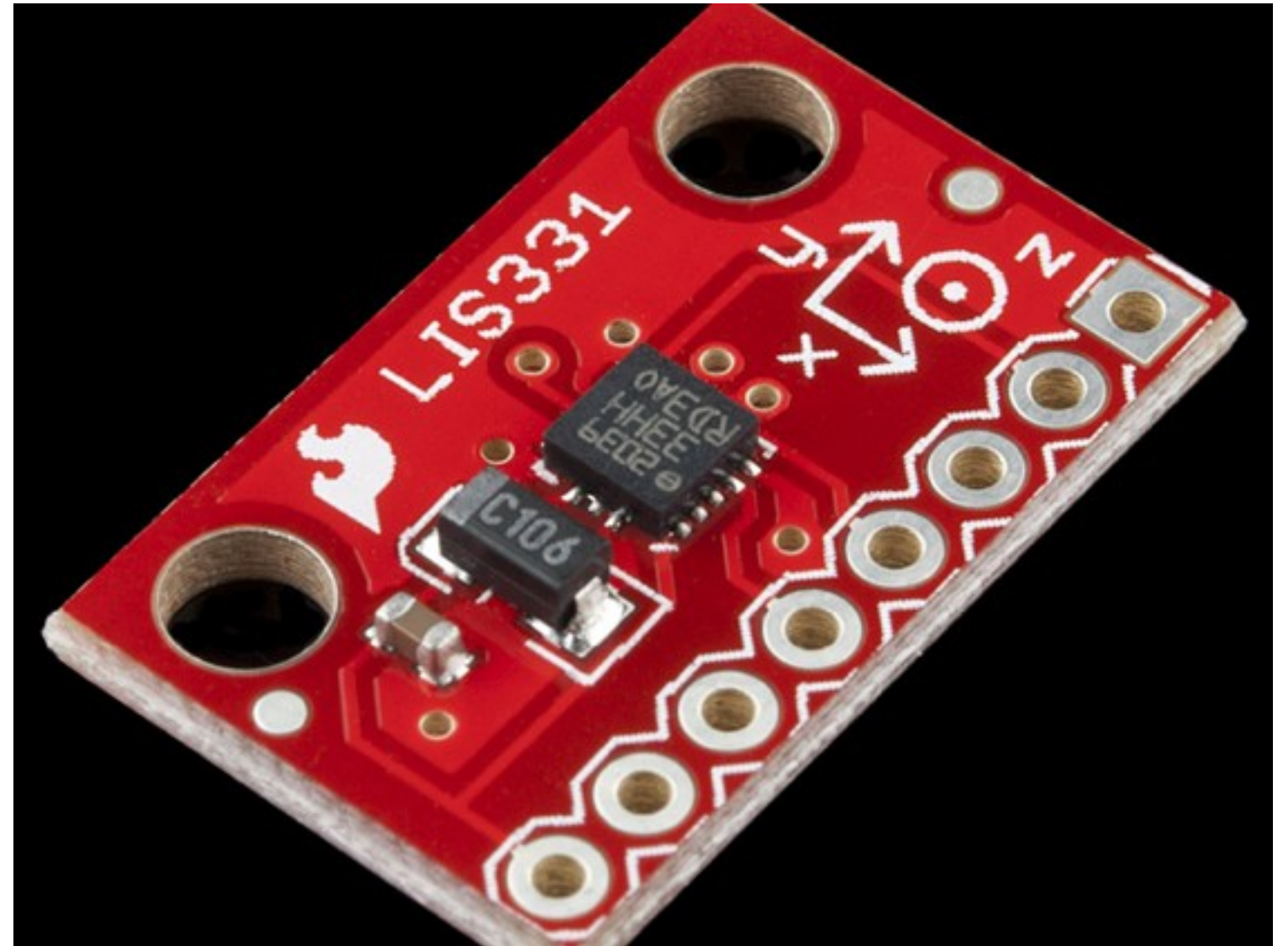加速度计，也被称为陀螺仪，广泛应用于手机中，可以检测位置，各个方向上的速度和加速度

PHOTO BY SPARKFUN

PRESSURE & FORCE ｜压力

Available in many shapes and sizes, force sensitive resistors (FSR) and flex sensors vary their resistance as pressure is applied to them.
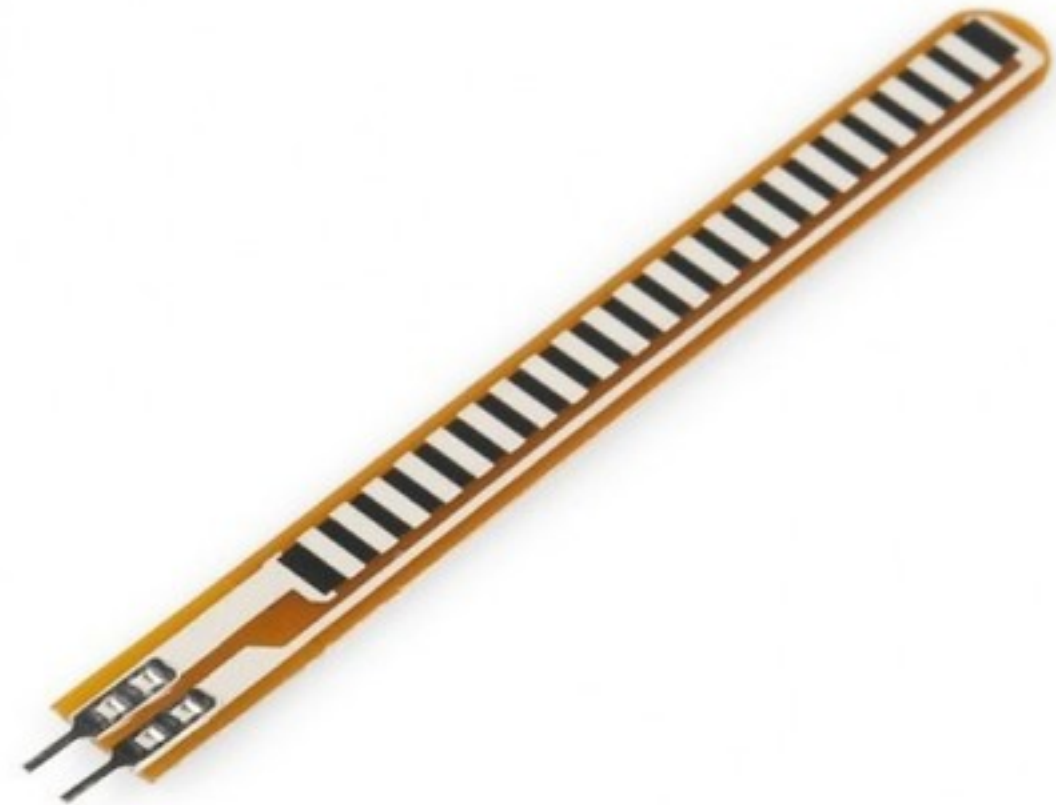
种类繁多且形状各异，常常是电阻值会因压力改变而改变

PHOTO BY DFROBOT

GAS & CHEMICAL｜化学品和气体

Gas and chemical sensors can be sensitive to a range of substances including carbon monoxide, alcohol vapors, and various combustable gasses.

本类感应器可以检测二氧化碳，酒精或者其他各种易燃气体

ELECTRICAL & MAGNETIC ｜ 电和磁

Electrical properties such as current can be measured using various sensors. And magnetic switches can be used for control as well as proximity detection.

电比如电压电流本来就是电路，ARDUINO中不可或缺的部分，我们可以很容易地读取电压电流，而电和磁很容易互相转化

SENSOR COMPONENTS

Sensors are generally available in component form. These components are manufactured in a variety of different packages and mounting formats. Components are often available in multiple forms.
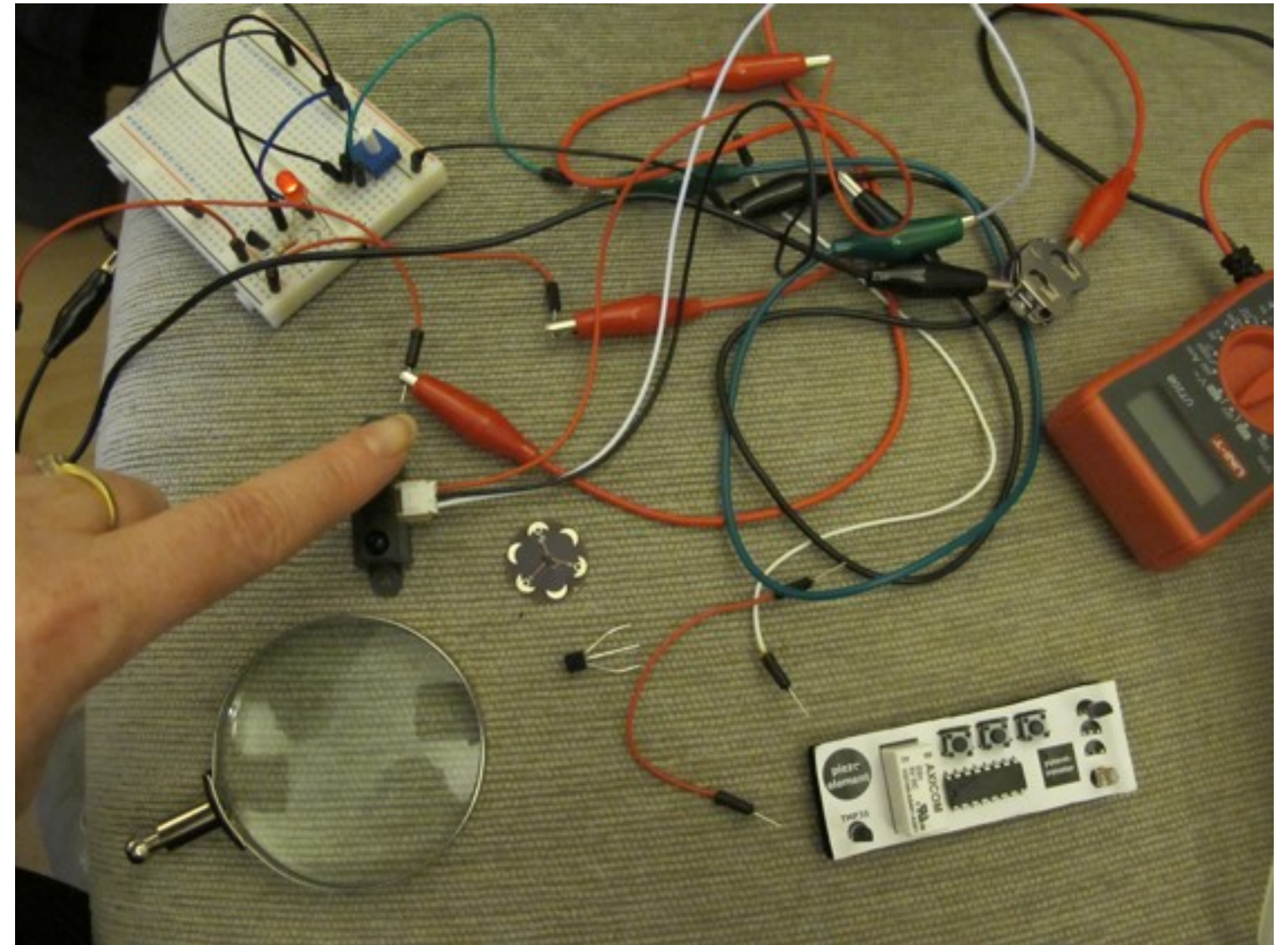
感应器大多电子元件形式出现，根据需要可以选择使用不同形式的封装和接口方式生产的元件

THROUGH HOLE TECHNOLOGY

Through hole technology (THT) refers to a type of electrical component that has long legs, and which is designed to be inserted through and soldered to a hole in a circuit board.
These are the kinds of components that we use with our breadboards too.
Many newer components, however, are not available in this form factor.

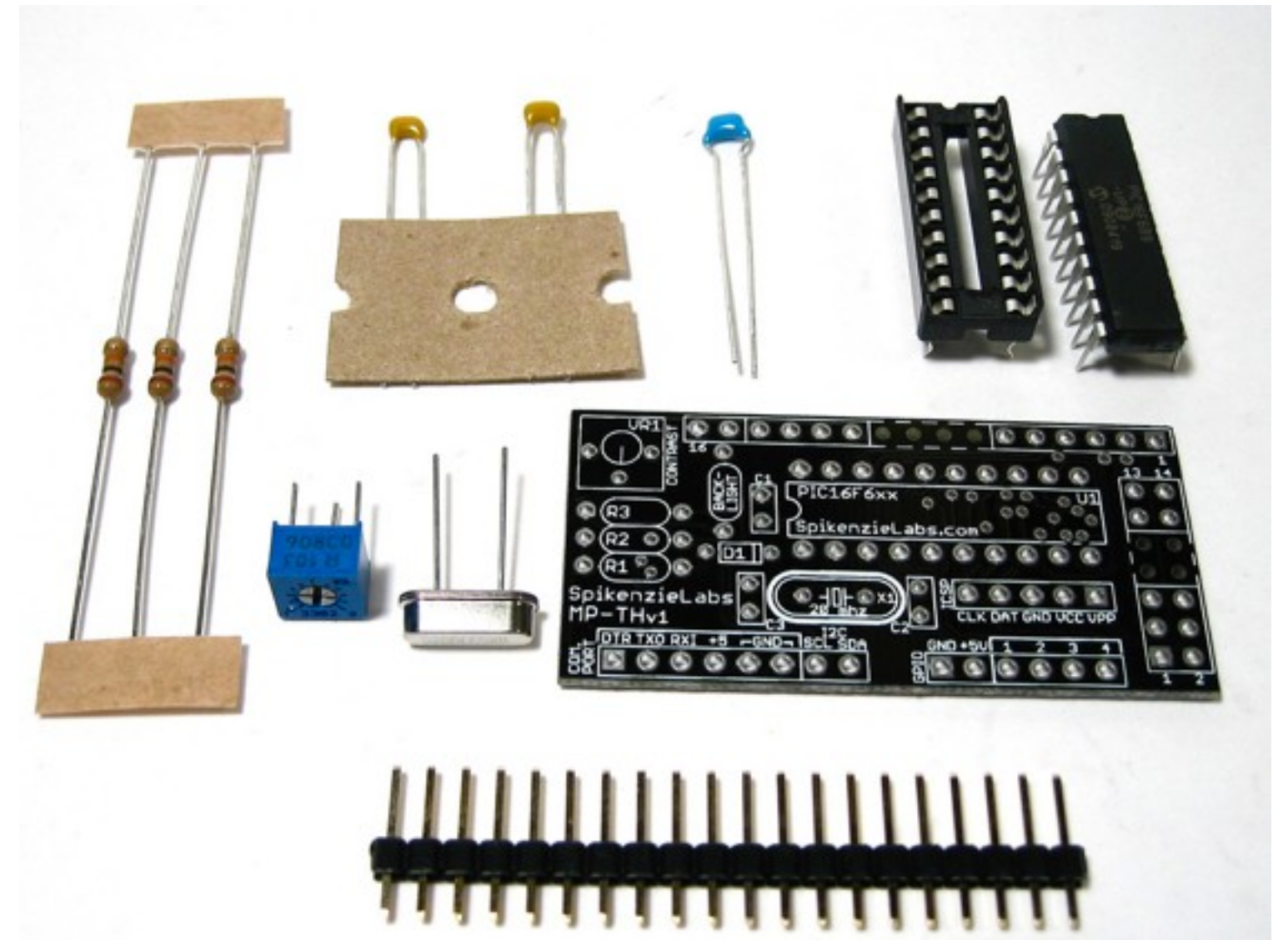THT指一种集成电路封装方式，指有长脚、可以插入并焊上电路板的元件
和面包板一起使用的大多数就是THT类型的元件

DUAL IN-LINE PACKAGES｜双列直插封装

Dual in-line packages (DIP) are a type of integrated circuit package that is designed to be through hole mounted

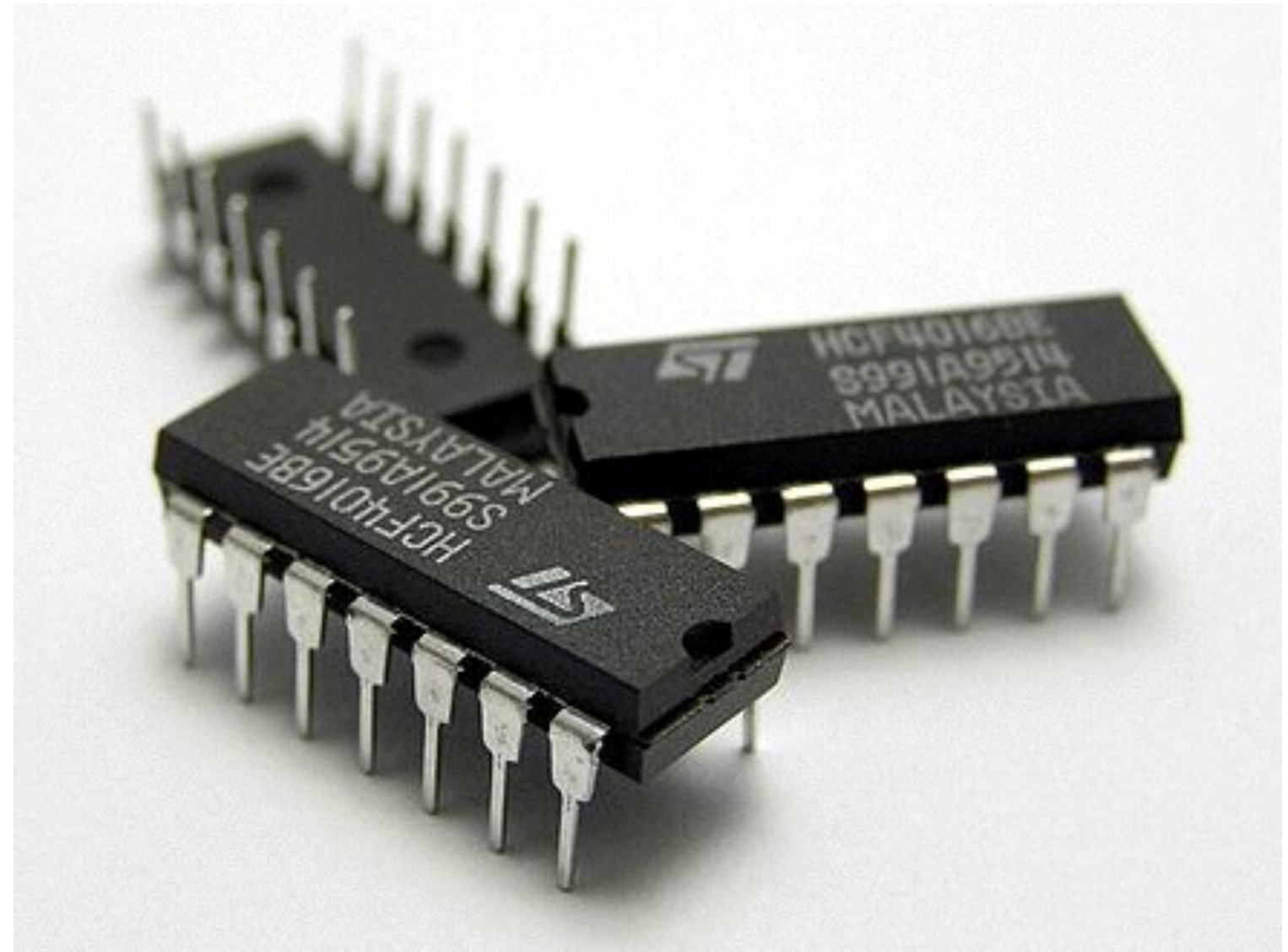DIP集成电路的外形为长方形，在其两侧则有两排平行的金属引脚（称为排针）可以焊接在有金属贯穿孔的电路板上，或者插在DIP插座（socket）上

SURFACE MOUNT TECHNOLOGY ｜贴片

By contrast surface mount technology (SMT) components are designed to be placed on and soldered to pads arranged on the top or bottom of a circuit board.
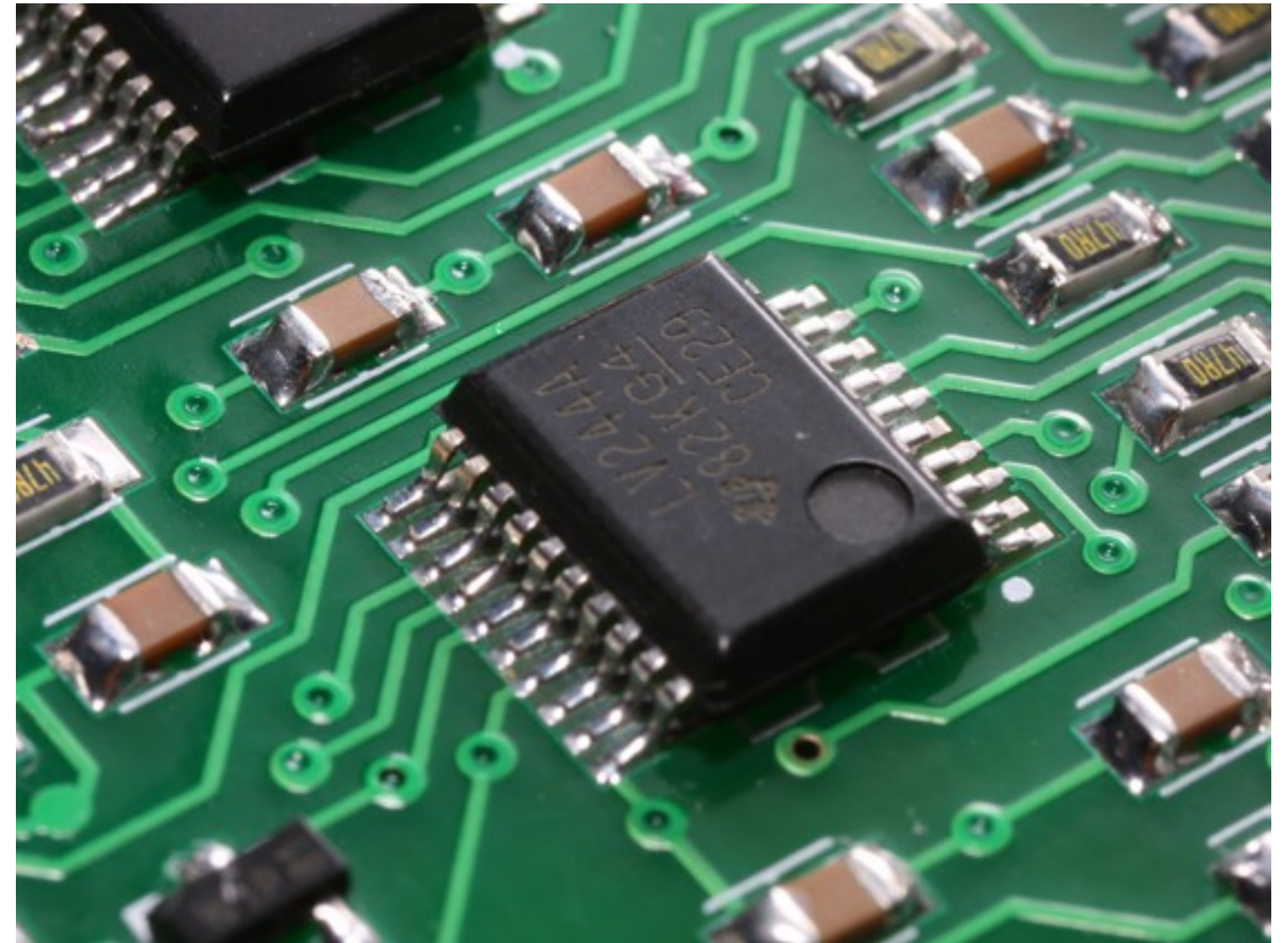
工业级，用于将尺寸微小的元件焊到电路板的正面或者反面

PHOTO BY ANDREW MAGILL

SMALL OUTLINE INTEGRATED CIRCUIT

Small Outline Integrated Circuit (SOIC) is a type of integrated circuit package that is designed to be surface mounted.
There are dozens of other surface mount packages, including Mini Small Outline Package (MSOP) AND Thin Small-Outline Package (TSOP)
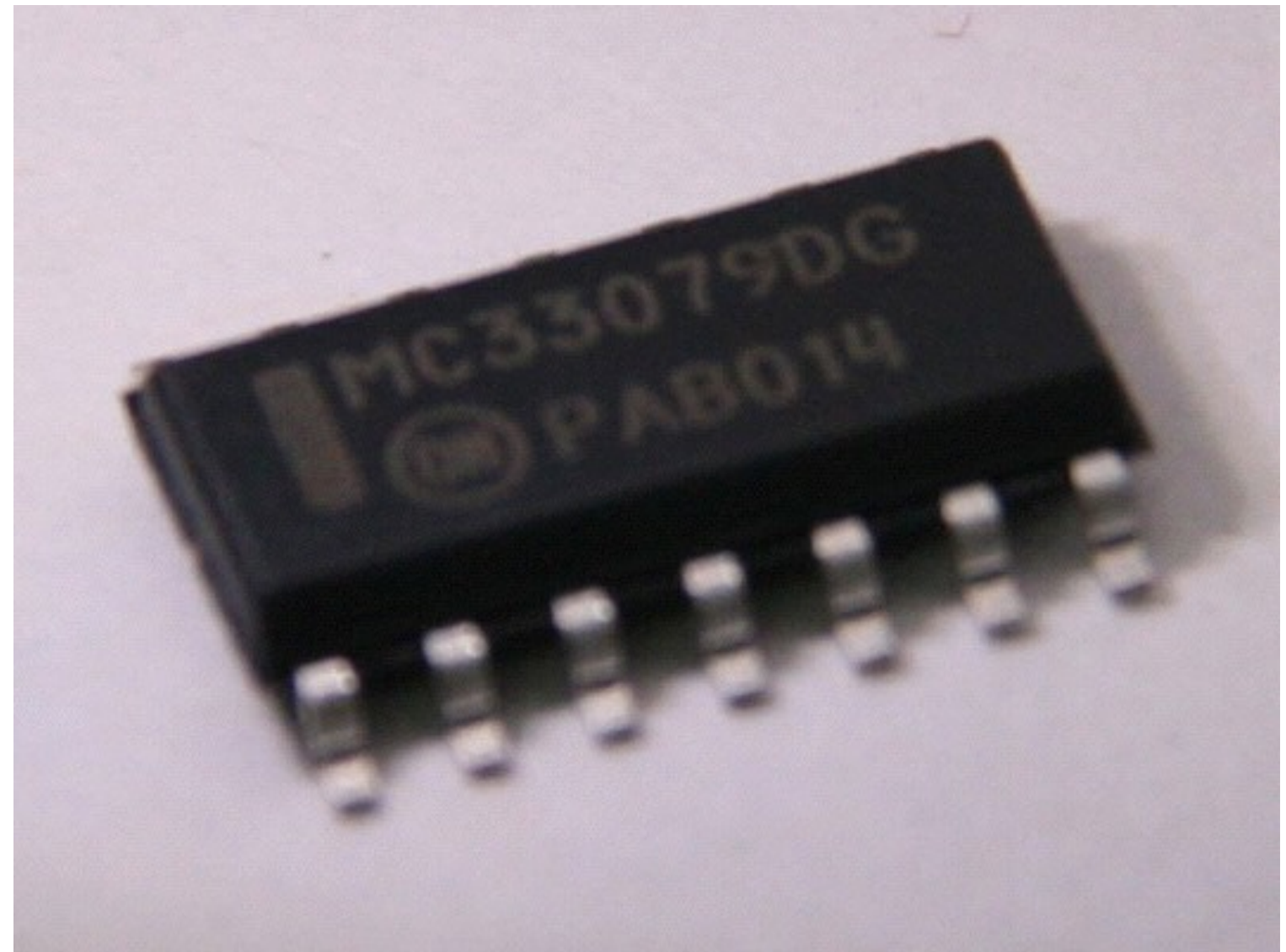
用于贴片的芯片 / chips

USING COMPONENTS｜选择

Generally speaking, THT components are larger, and for that reason easier to use than SMT components.
Sometimes components can be used directly without the need for additional parts such as resistors, capacitors, etc.
Frequently however, there is a need for a more complex circuit.

不同情况下需要选择不同类型的元件，大体上说，THT类型元件尺寸更大并且可以和面包板配合使用，SMT更多在工业生产中被使用，然而更多时候我们需要封装度更高更加复杂的电路
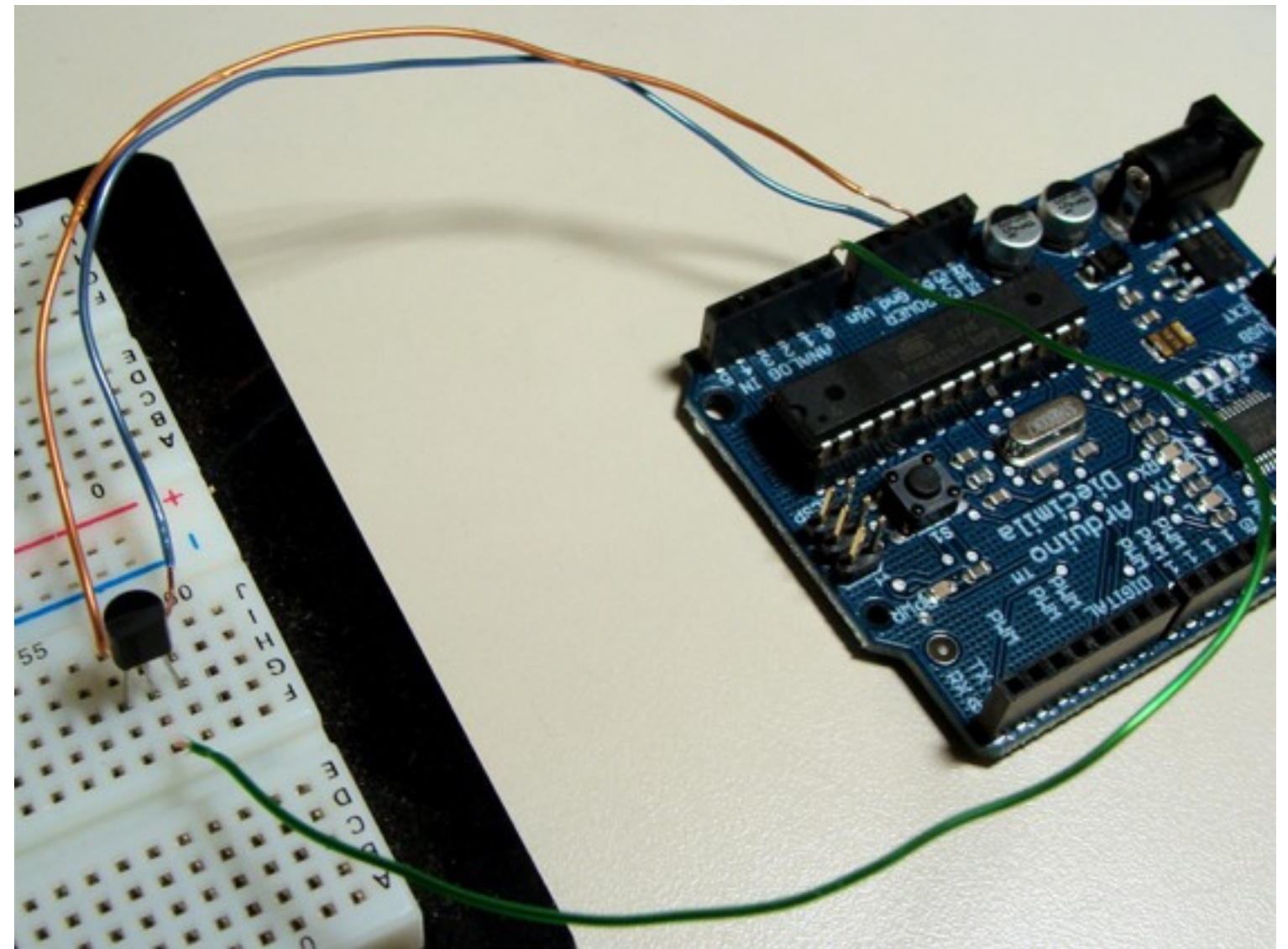

PHOTO BY DANIEL SPILLERE ANDRADE

BREAKOUT BOARDS

Companies such as SparkFun, AdaFruit,DFRobot,
and Seeed Studio have begun manufacturing
breakout boards for many sensor components.
The purpose of the breakout board is to make the
component easier to work with.
These breakout boards are particularly useful when
the sensor components rely on SMT or require
complex supporting circuits.

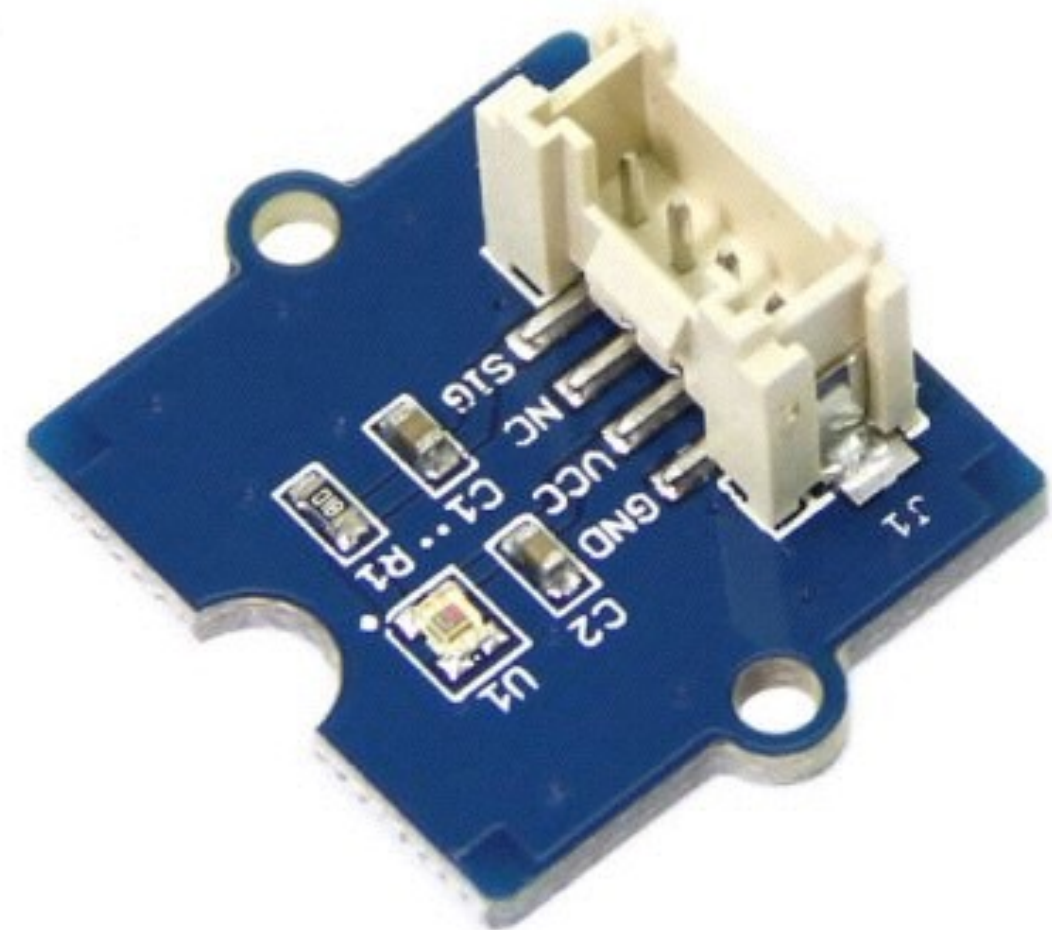传感器组件，意图是让电路连接更加简单，在传感器
要求贴片技术或者电路复杂时，优势明显

DATA SHEETS & DOCUMENTATION

When working with a sensor component or breakout board for the first time, it is important to first familiarize yourself with the data sheet and / or find a good source of documentation. Components can be expensive or difficult to replace, and they are easily ruined by improper use.
Don't just start plugging wires in if you don't know where to connect them.

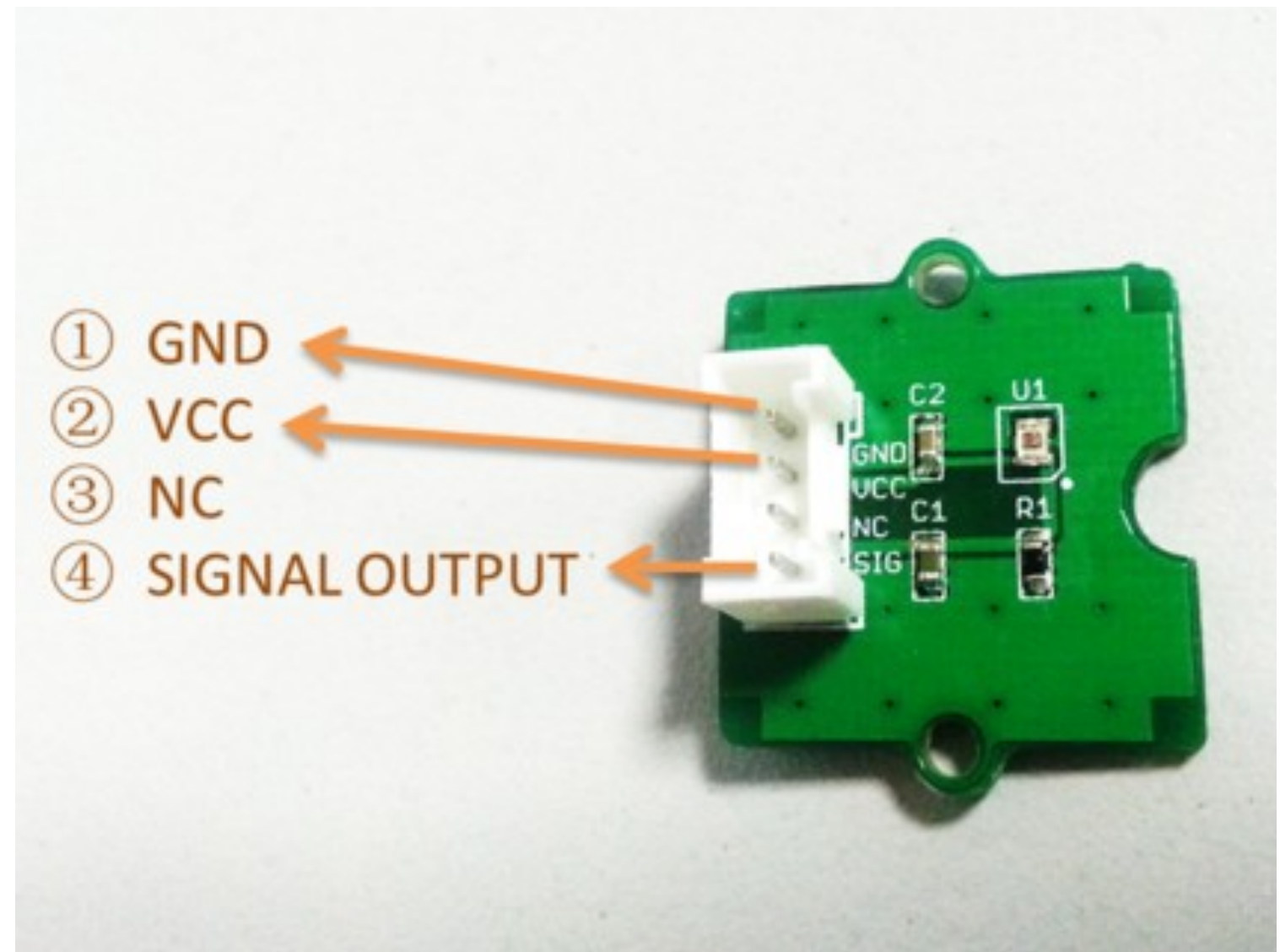使用Component的第一步是找到它的 documentation（如果你第一次使用的话），很多元件极其容易损坏

DATA SHEETS & DOCUMENTATION

Common Acronyms

通常情况下你会在breakout上找到
类似的标记，它们分别对应如下指
示：

GND – Ground 接地
VCC – Power 接正极
NC - Not Connected 不连接
SIG - Signal (output) 信号
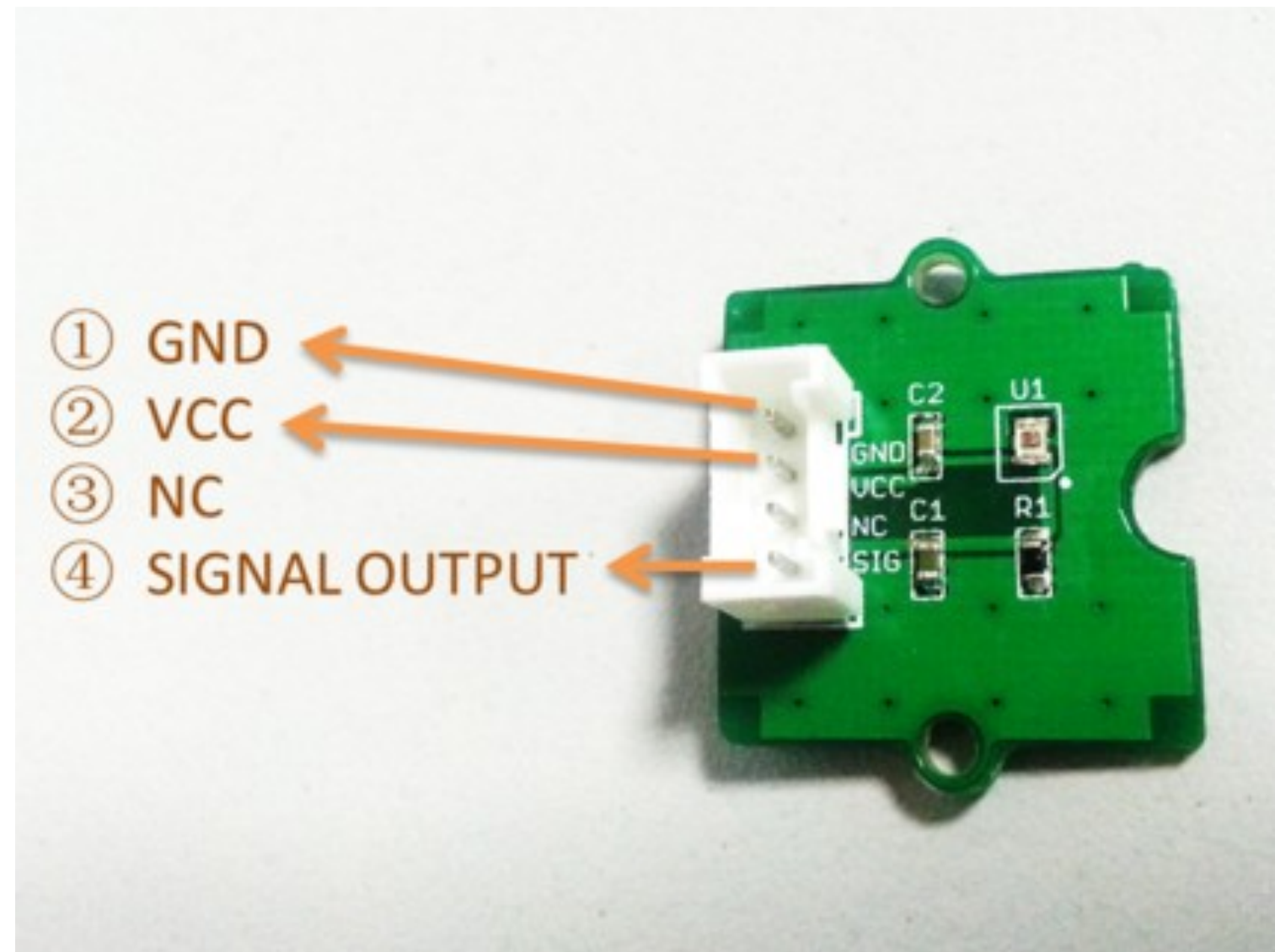

① GND
② VCC
③ NC
④ SIGNAL OUTPUT

SMOOTHING SENSOR VALUES

Sometimes the value from a sensor can be erratic, either because of noise within the circuit or within the environment.
That being the case, It can be desirable to create an average of a sensor's value over time, which will have the effect of smoothing out much of the noise.

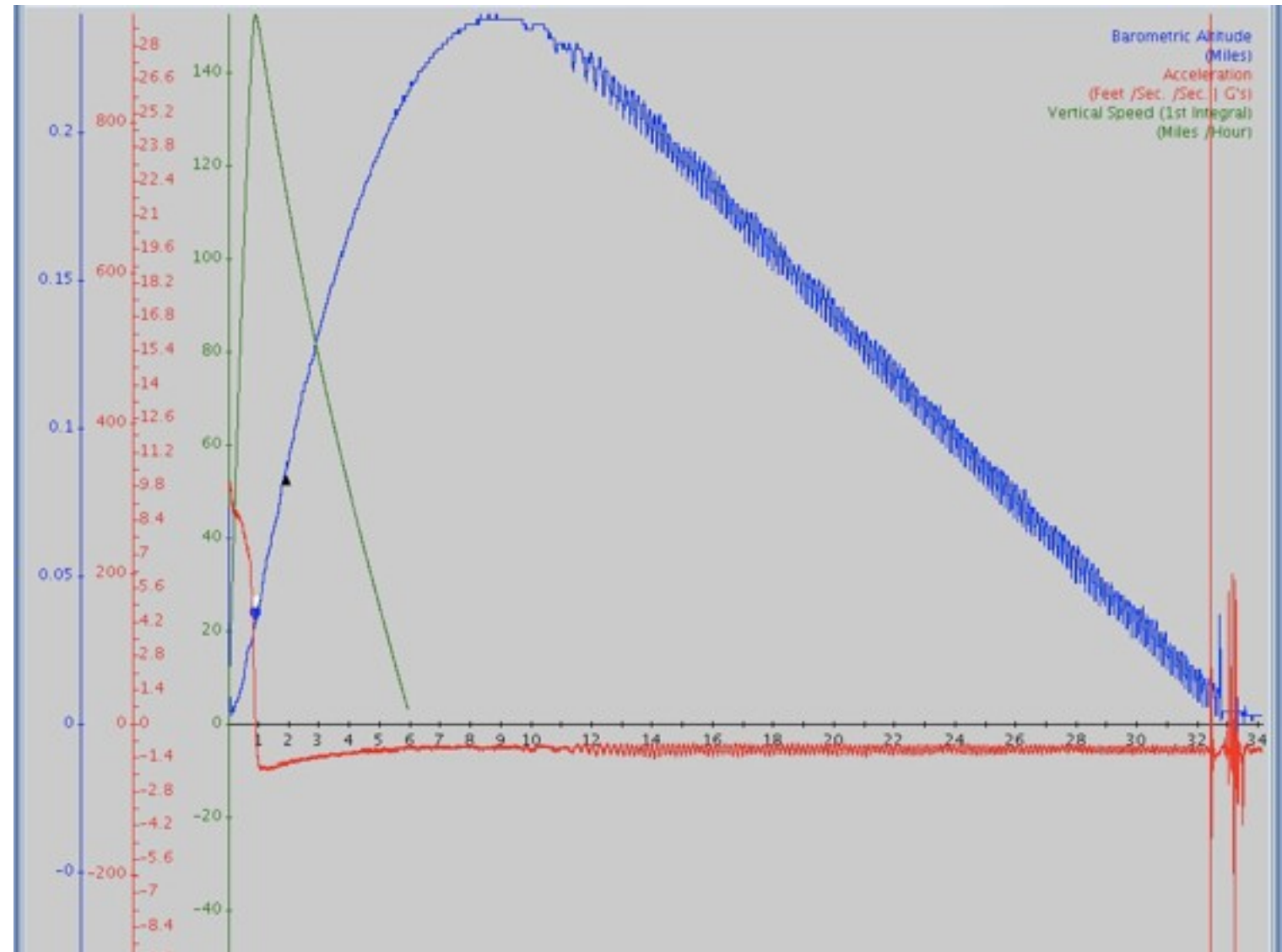传感器读数可能会因为环境干扰或者电路内部干扰出现波动，选择求取一段时间内读数的平均数可以有效地减小读数波动

PHOTO BY STEVE J URVETSON

ACTUATORS
驱动器

ACTUATORS｜驱动器

Actuators are circuits, often a type of motor, that causes something to happen in the physical world, by converting a source of electrical energy into motion.
Actuators allow a machine to operate within the physical world.

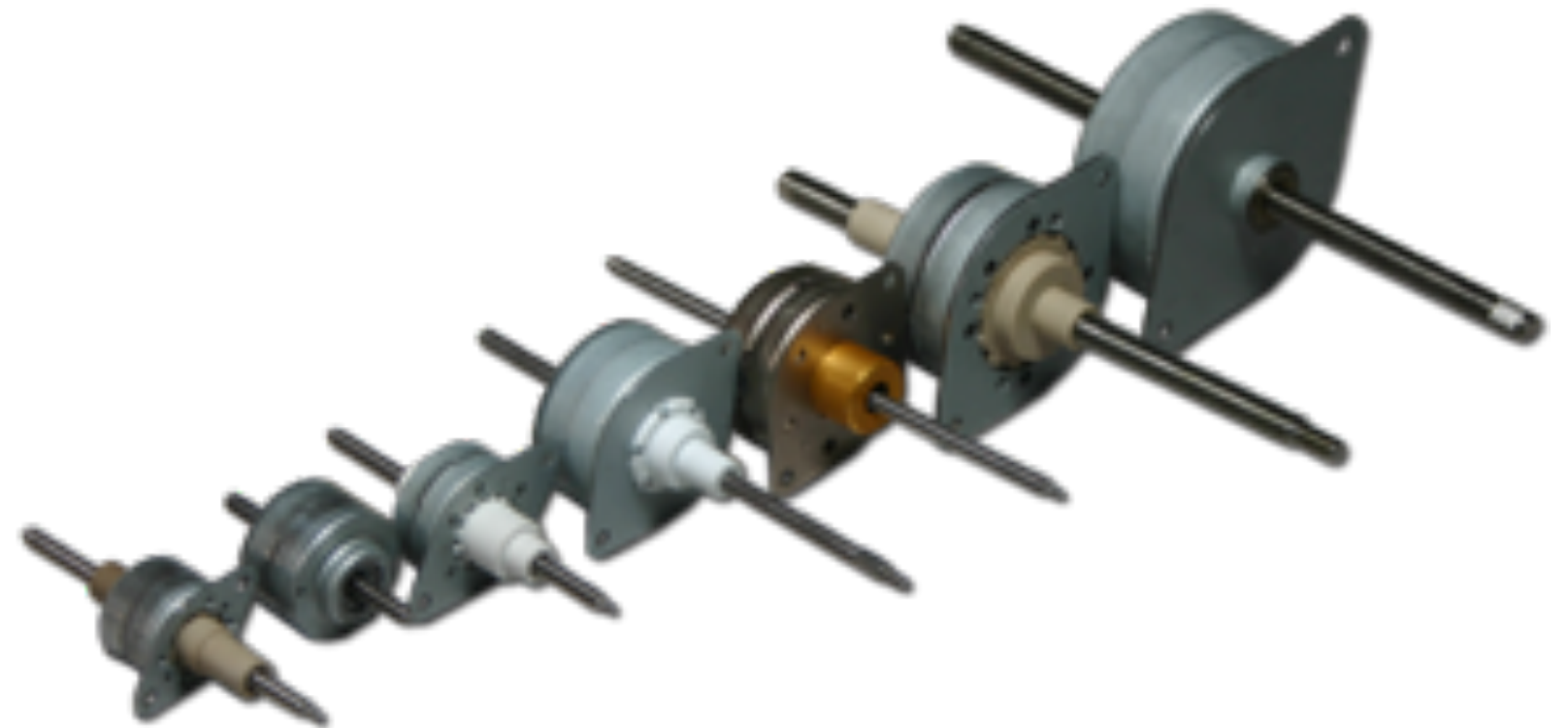Actuator指在物理世界里将电能转化成为动作并引发系列事件的电路，通常是电机

LINEAR ACTUATORS | 线性驱动器

Linear actuators are actuators that produce linear motion, or motion that is constrained to a straight line.
Linear actuators are generally devices that convert rotary motion into linear motion.

线性驱动器指产生线性动作或发生在直线上的动作的驱动器
线性驱动器常常是将旋转的动作转化成现行的动作

ROTARY ACTUATORS｜旋转驱动器

Rotary actuators are actuators that produce rotary motion, in other words spinning. Rotary actuators are generally motors. DC motors produce continuous rotary motion while servo motors and stepper motors produce motion to a specific angle.

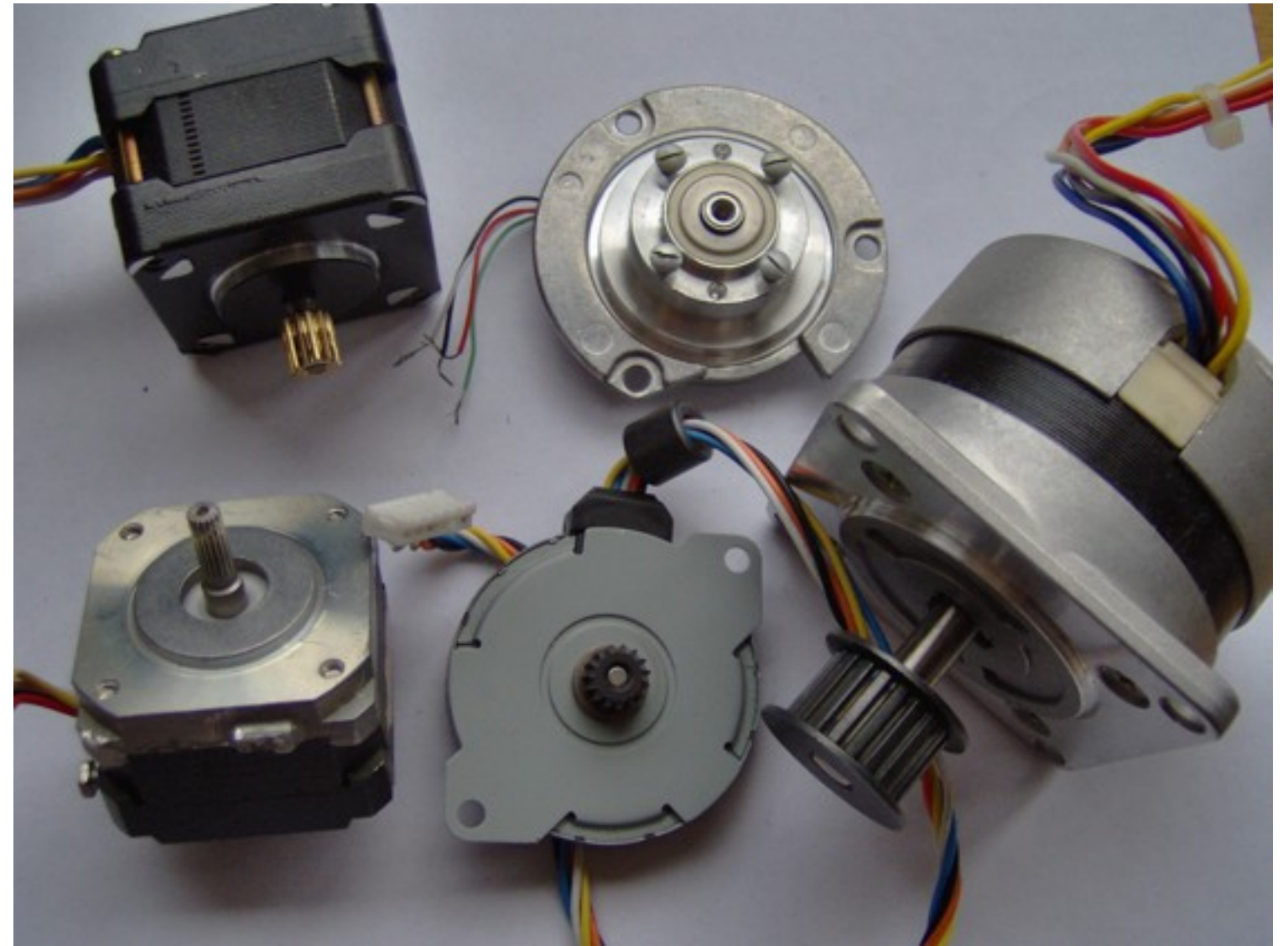旋转actuator指产生旋转动作的actuator，常常是电机。直流电机产生连续的旋转，对应地，舵机和步进电机旋转特定角度

PHOTO FROM WIKIPEDIA

BRUSHLESS STEPPER MOTORS | 无刷步进电机

Brushless stepper motors are a type of motor that operates through the coordinated control of internal fixed electromagnet coils (phases or windings) that cause the motor to turn by an incremental step. Steppers are known for their reliability and precision, but do not have the same continuous rotation quality of a brushed motor.

无刷步进电机：具有齿轮状突起
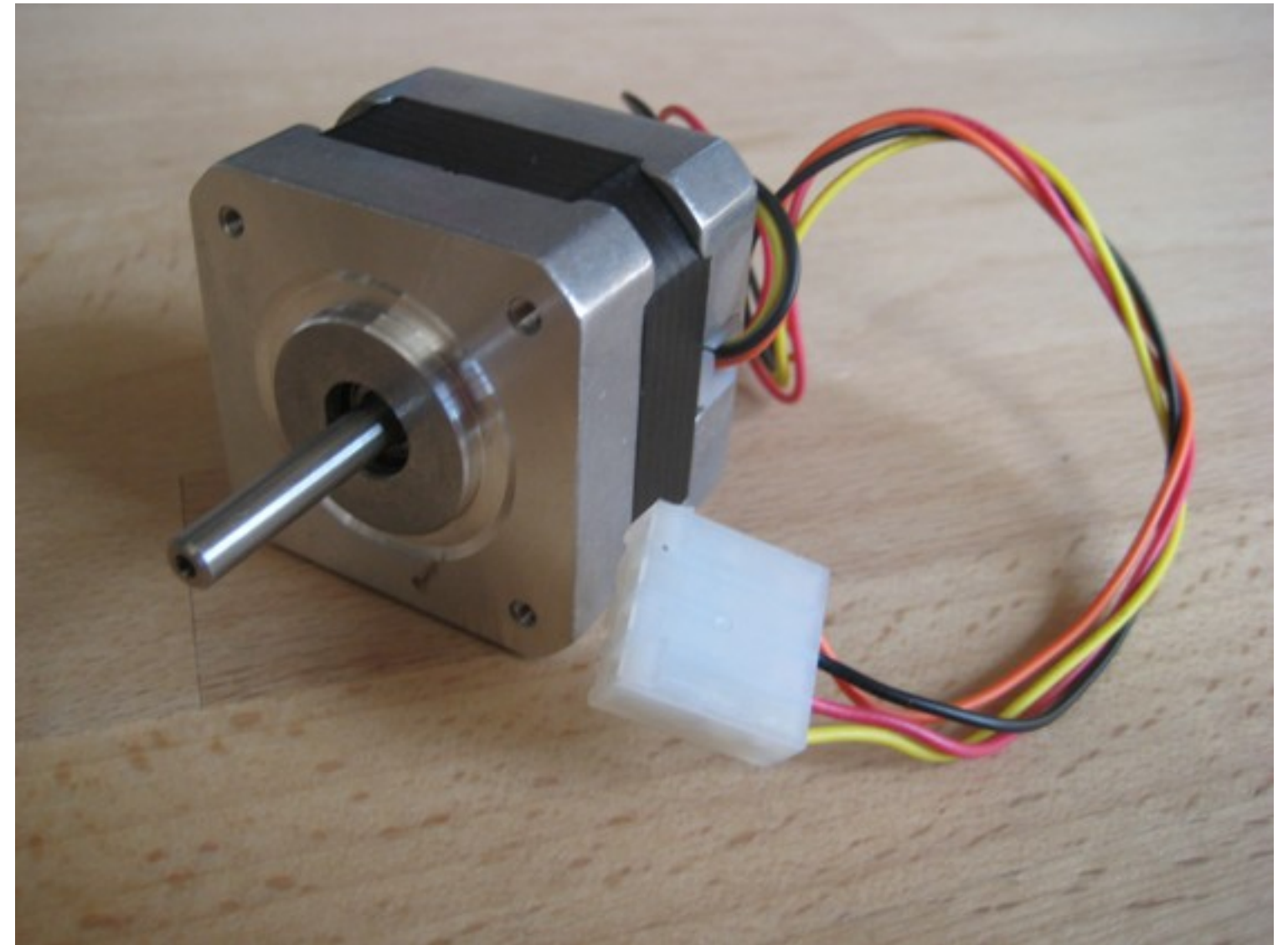具有如齿輪狀突起（小齒）相鍥合的定子和轉子，可藉由切換流向定子線圈中的電流，以一定角度逐步轉動的馬達
能達成精確的位置和速度控制，且穩定性佳

PHOTO BY MAKERBOT

BRUSHED MOTORS | 有刷电机

Brushed motors are a type of motor that operate using DC power to continuously spin an internal commutator.
The commutator is in contact with brushes on the inside of the motor that create an electrical circuit, but do not restrict the movement of the motor. Sometimes a gear is attached to the shaft of the motor to provide greater torque, or twisting force.
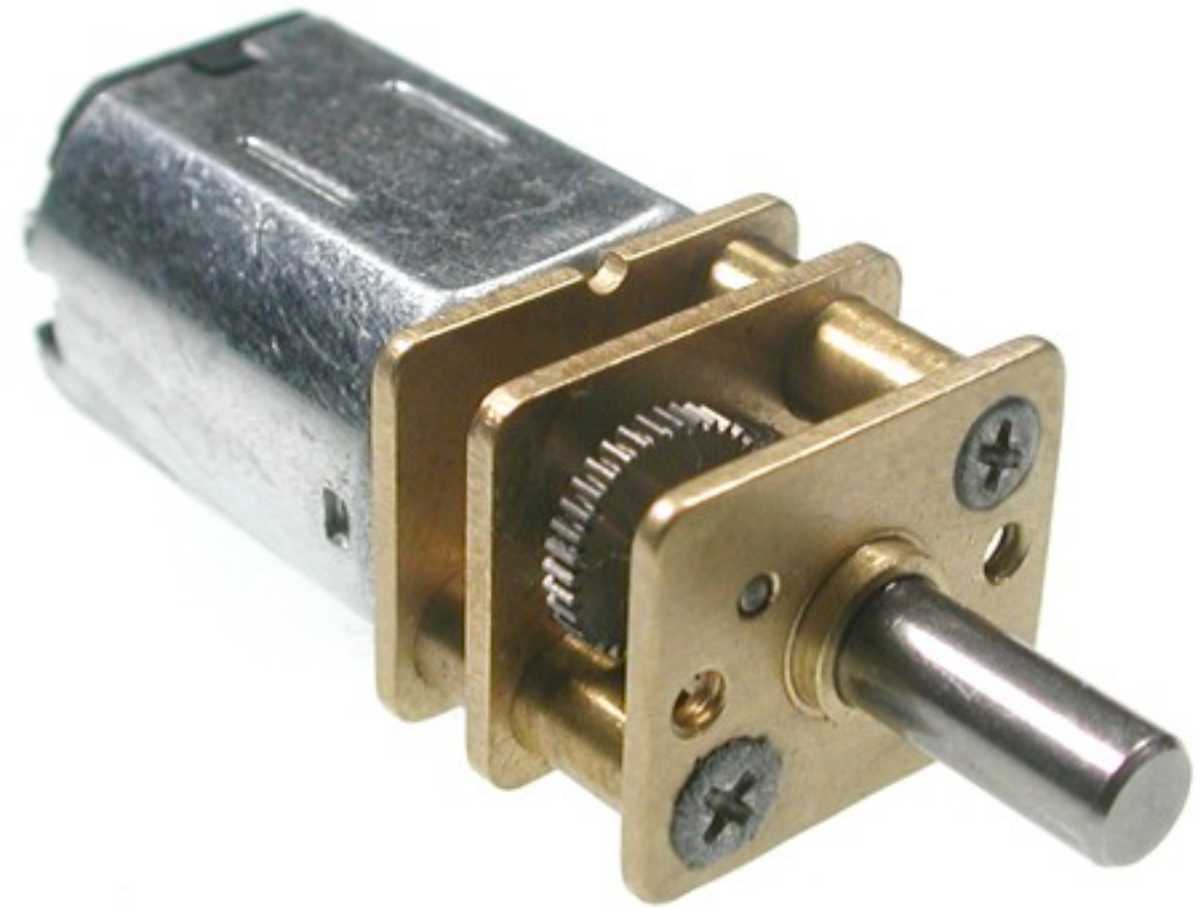
有刷电机指的是直流电驱动内部转子连续旋转的电机，有时候直流电机会配套齿轮。

PHOTO BY SOLARBOTICS

SERVOS ｜舵机

Servos are small motors with integrated gears.
They are frequently used in remote control devices such as toys and robots, but with various mechanical applications. Depending on the servo type, you can control position or speed through the use of pulse-width modulation (PWM).

舵机是集成有齿轮的电机，广泛应用在遥控设备中，因种类不同，可分别通过PWM控制舵机的角度或转速

PHOTO BY CAMB416

SERVO WIRE｜舵机接线

Servo motors use three wires, but they often vary in color. Typical colors include:

- Black, Red & Yellow
- Brown, Red & Yellow
- Black, Red & White

Black or brown is ground, Red is power & yellow or white is control.

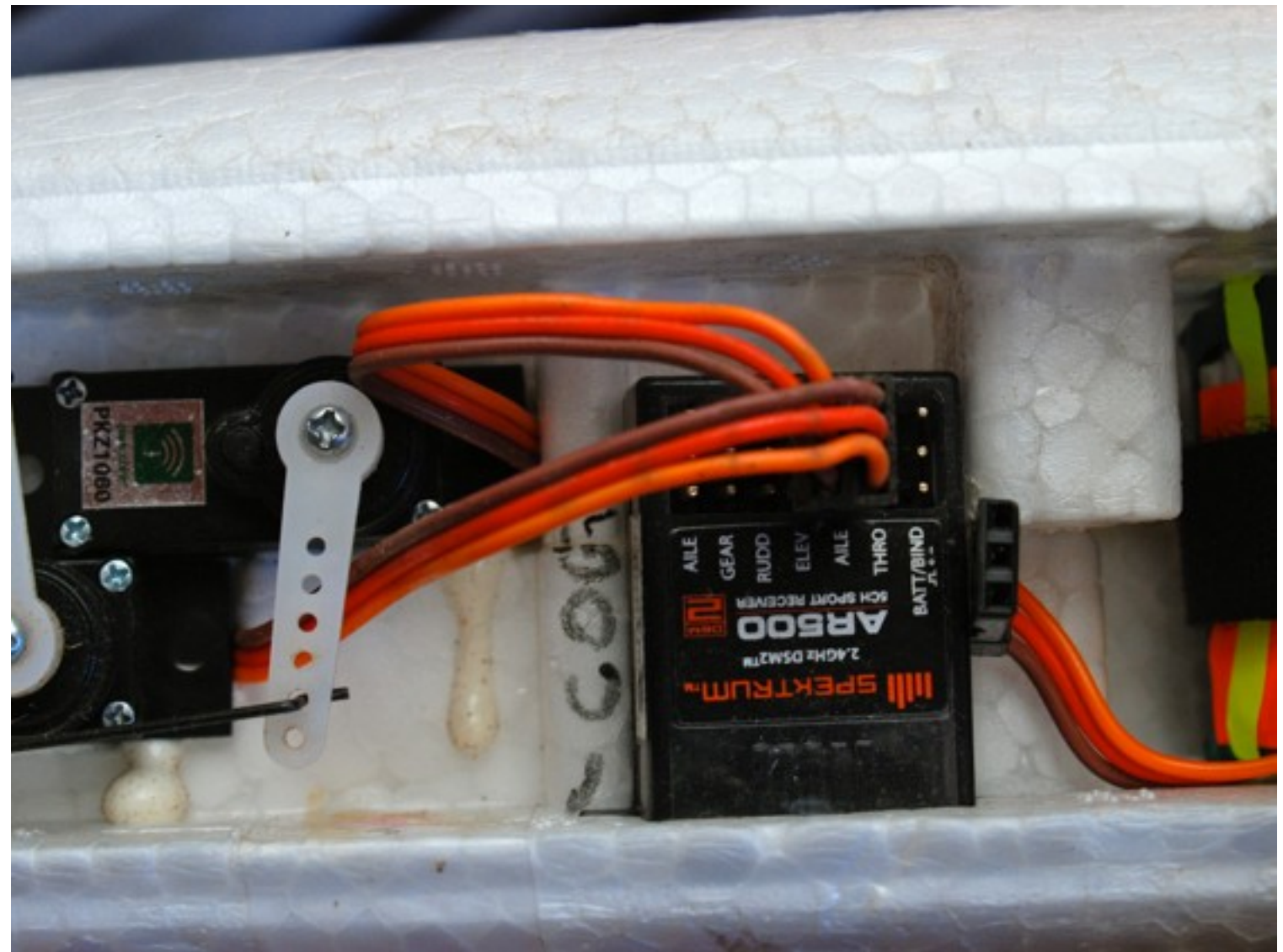舵机连接线有三根线，不同型号线亦不同，通常有如下几种：黑红黄，棕红黄，黑红白，黑红蓝，简单来讲，深色的是接地，红色接正极，彩色是控制线

SERVO LIBRARY | 舵机控制

The Arduino Servo Library is built-in to the Arduino IDE and allows you to easily control up to 12 Servo Motors on most Arduinos and even more on the Arduino Mega.

ARDUINO IDE中已经集成有舵机的 library，能控制至多12个电机，使用 ARDUINO mega还能控制更多

PHOTO BY OSAMU IWASAKI

SERVO LIBRARY FUNCTIONS｜舵机控制

servo.attach()

Attaches the Servo variable to a pin.

servo.detach()

Detaches the servo from its pin.

servo.read()

Reads the current angle of the servo motor shaft.

servo.write()

writes a value to the servo, controlling the motor shaft accordingly.

PHOTO BY SPIKENZIE

SERVO LIBRARY EXAMPLE | 示例

```
#include <Servo.h>
Servo servo; void
setup() {
    servo.attach(9);
}

void loop()
  { servo.write(90);
  delay(500);
  servo.write(0);
  delay(500);
}
```

In-Class Assignment
课堂练习

SERVO EXAMPLE A｜示例A

Use the Servo Library

https://www.arduino.cc/en/Reference/Servo

Connect a Servo to your Arduino and run the Sweep example to run it back and forth. Control it with a potentiometer or a light sensor using the Knob example.
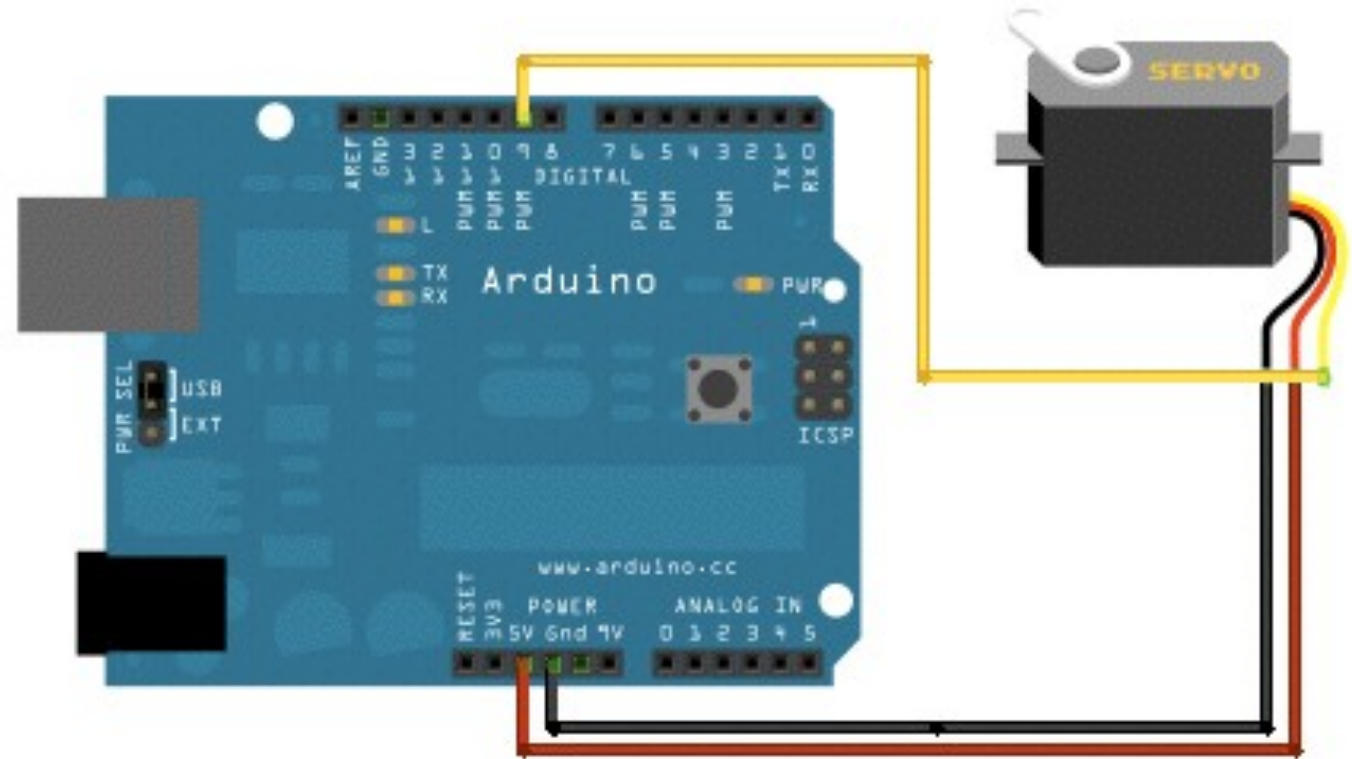

PHOTO FROM ARDUINO.CC

SERVO EXAMPLE B | 示例B

Use the Servo Library

https://www.arduino.cc/en/Reference/ Servo

Connect a Servo to your Arduino and run the Sweep example to run it back and forth. Control it with a potentiometer or a light sensor using the Knob example.
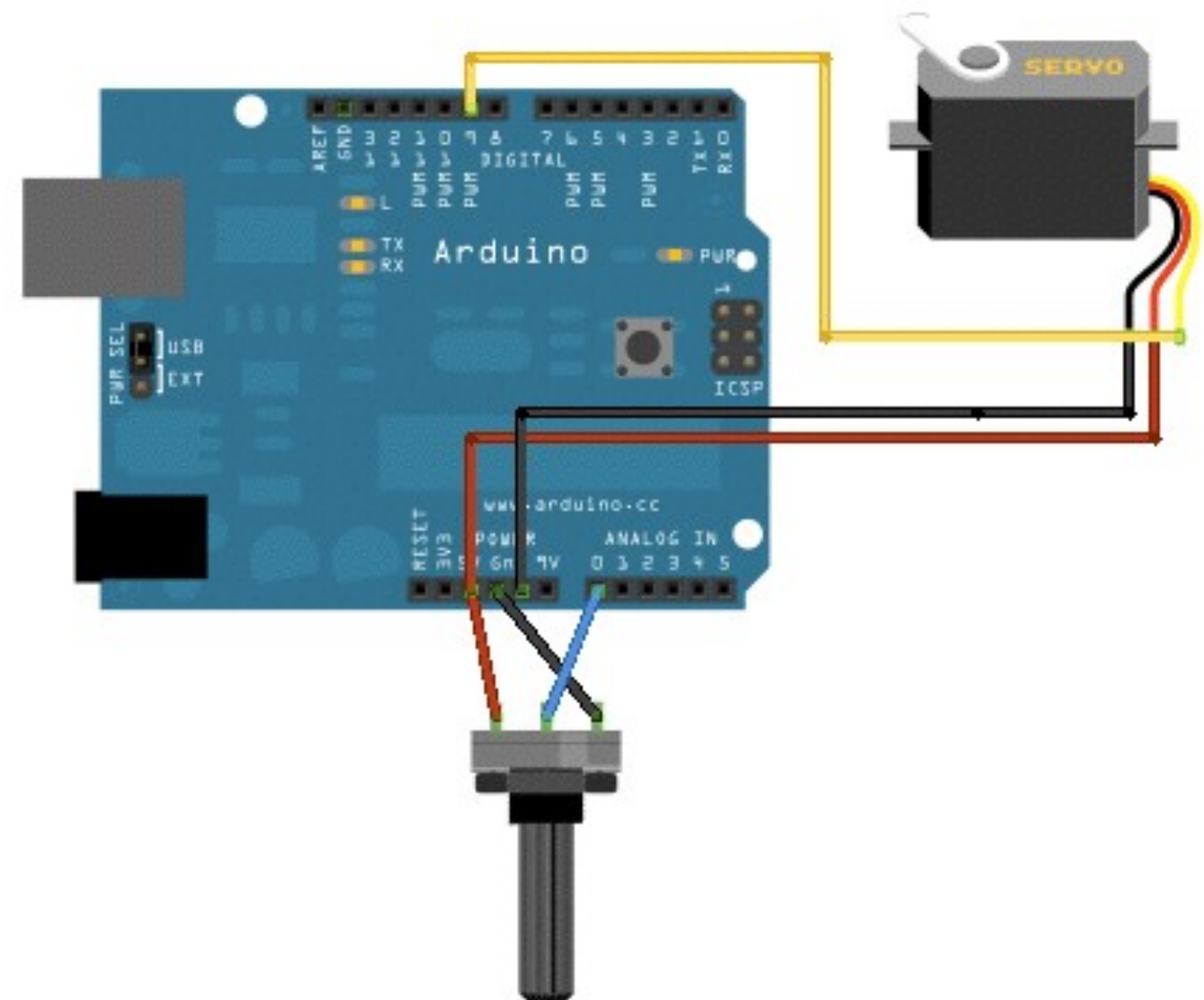

PHOTO FROM ARDUINO.CC