

# Principles and Applications of Microcontrollers

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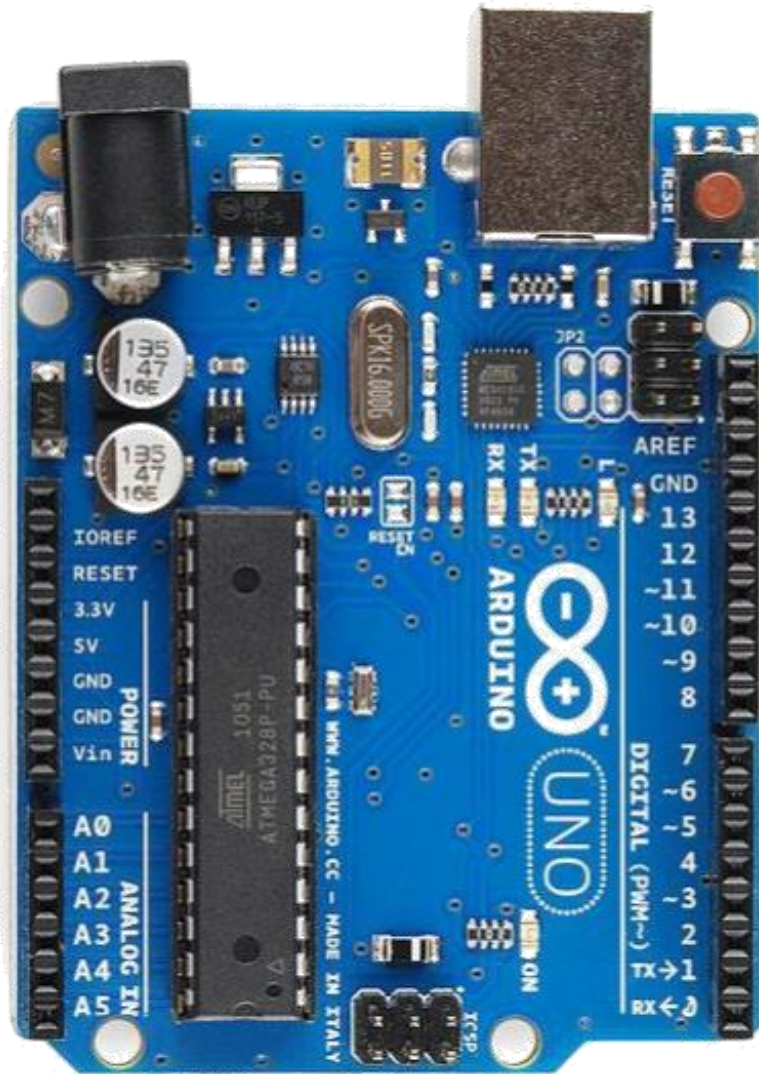
National Taiwan University

Today:

- Arduino analog input
- Infrared sensor



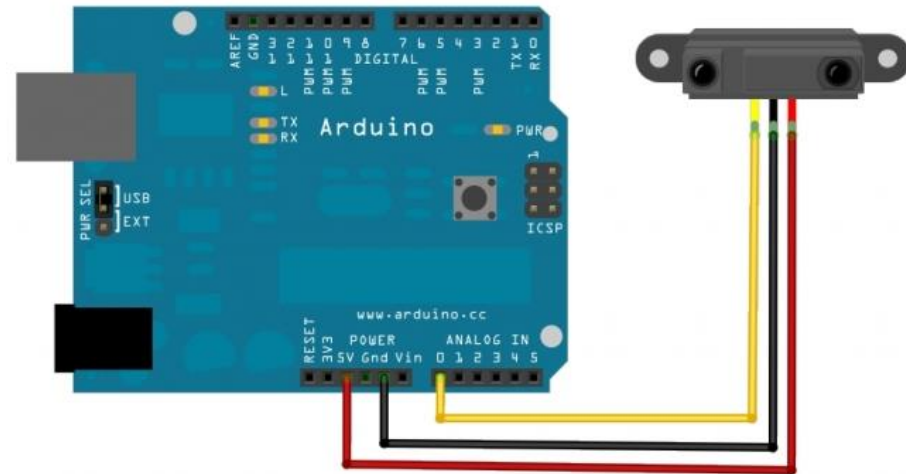
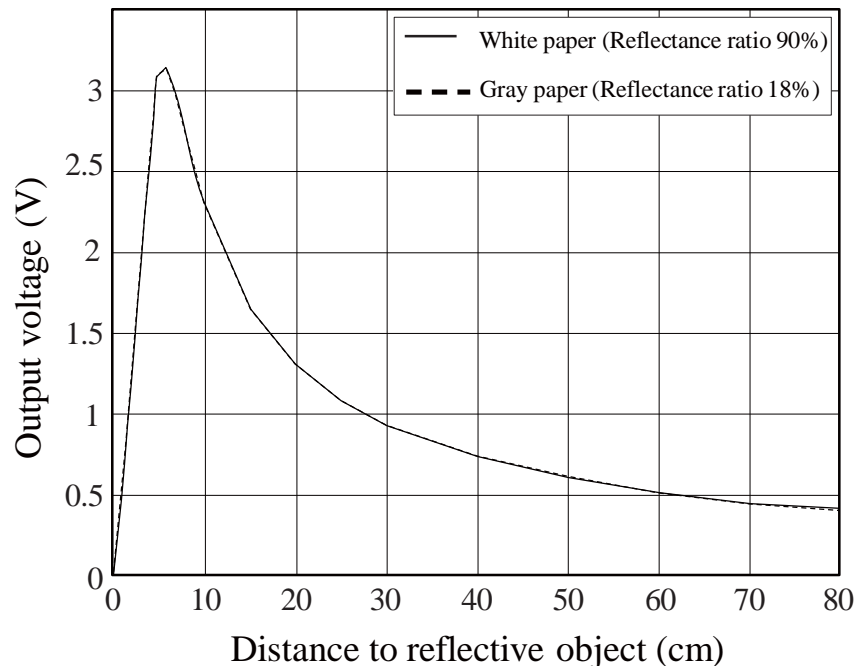
# Arduino I/O



- Digital:
  - `digitalWrite(Pin, Value);`
  - `Value = digitalRead(Pin);`
- Analog:
  - `analogWrite(Pin, Value);`
  - `Value = analogRead(Pin);`

# Example – DMS Sensor

- Read distance from proximity sensor
- It is an analog device
- Insusceptible to object color



# Sketch Code – DMS Sensor

```
void setup() {  
  pinMode(A0, INPUT);  
  Serial.begin(9600); // initialize serial communication at 9600 bits per second  
}  
  
void loop() {  
  int sensorValue = analogRead(A0); // read the input on analog pin 0  
  Serial.println(sensorValue); // print out the value you read  
  delay(100); // wait for 1000 milliseconds  
}
```

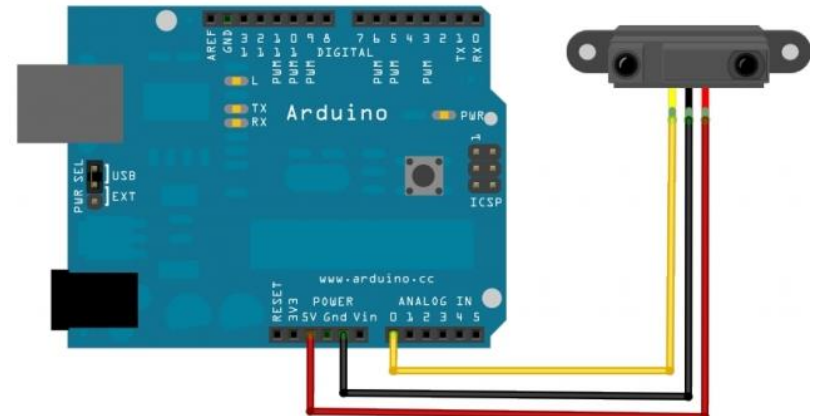
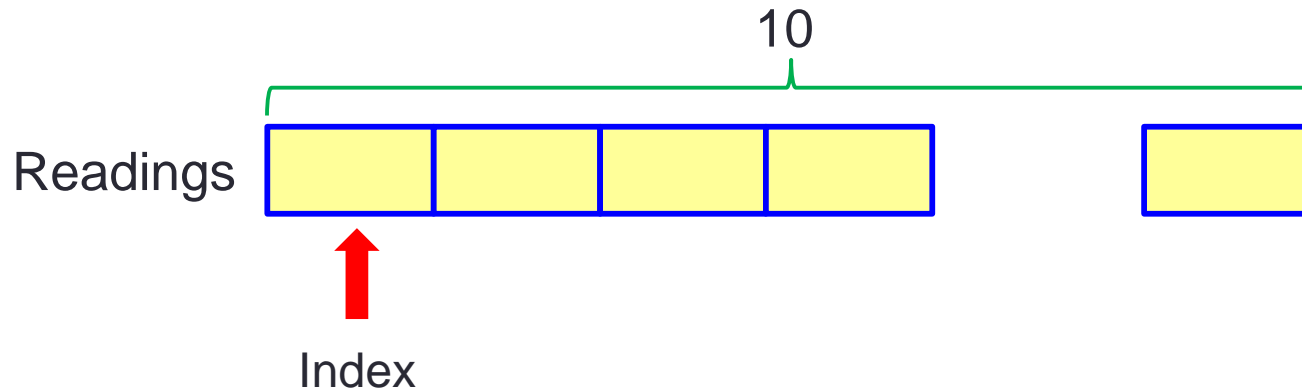
What is the minimum and maximum `analogRead` values?

# Practice – Fading LED according to Distance

- Fad an LED according to the distance from an proximity sensor
- Fad off the LED when the proximity sensor reading is small; fad on the LED when the reading is large

# Example – Smoothing

- Calculate a running average of an analog signal and print it on the computer screen



# Sketch Code – Smoothing

[Link](#)

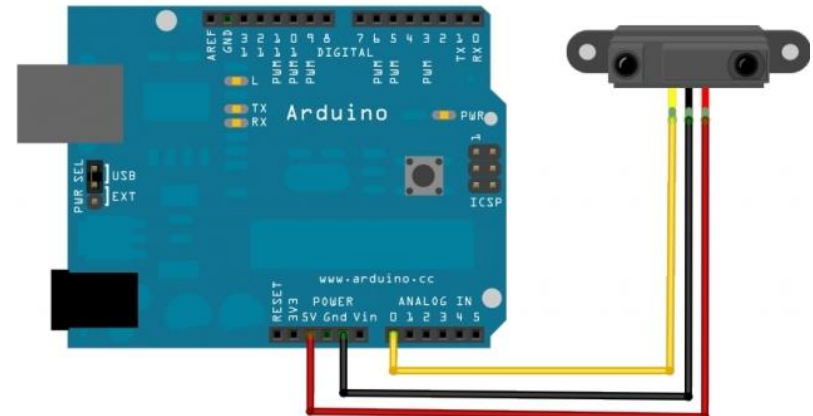
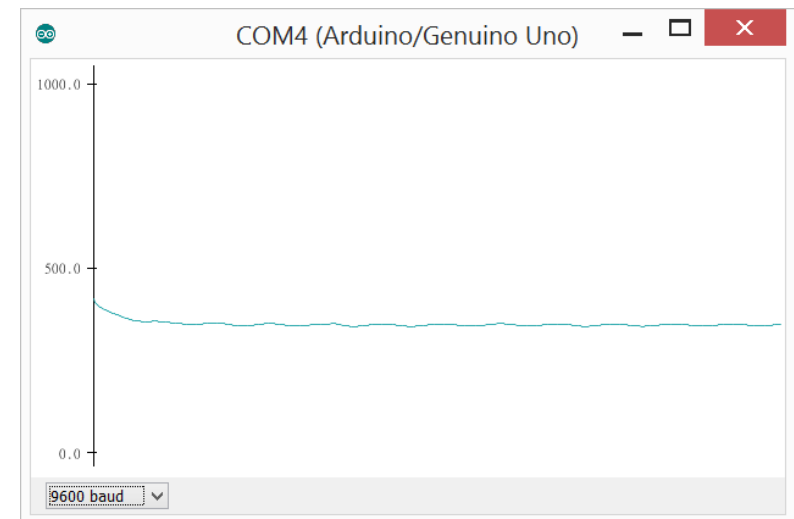
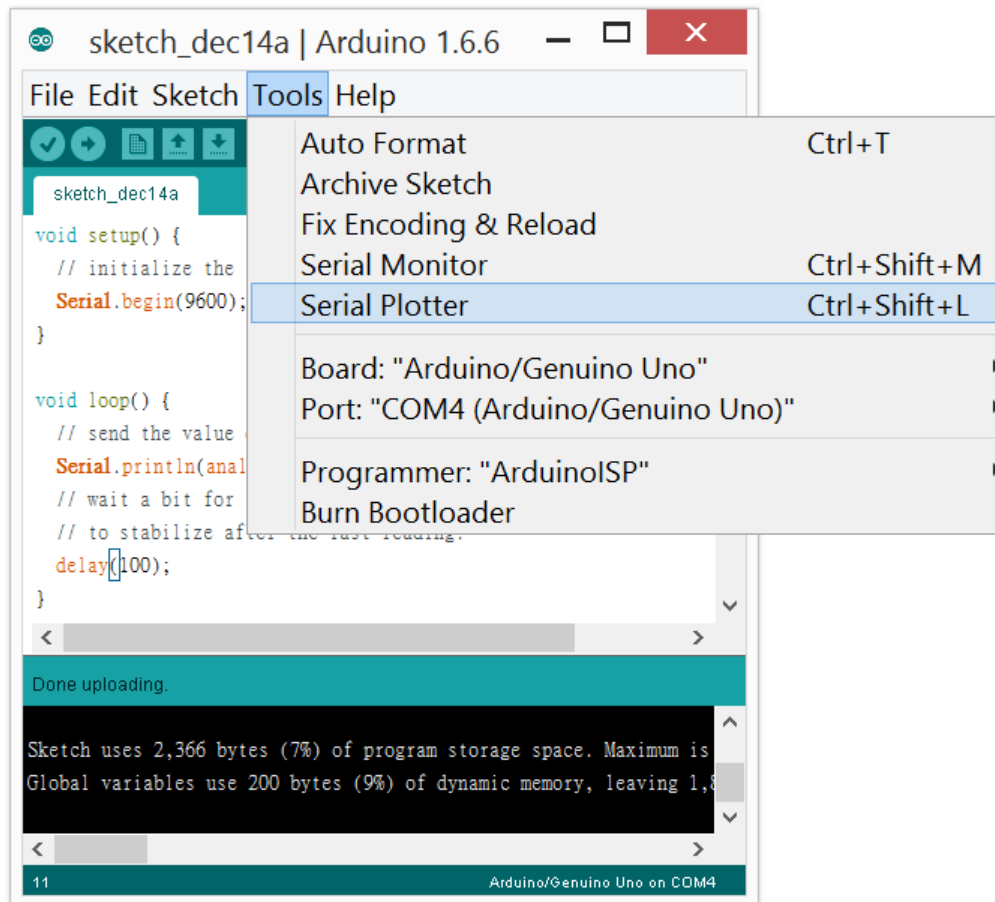
```
const int numReadings = 10;
int readings[numReadings];           // the readings from the analog input
int readIndex = 0;                   // the index of the current reading
int total = 0;                       // the running total
int average = 0;                     // the average
int inputPin = A0;

void setup() {
  Serial.begin(9600);
  for (int thisReading = 0; thisReading < numReadings; thisReading++) { // initialize
    readings[thisReading] = 0;
  }
}

void loop() {
  total = total - readings[readIndex]; // subtract the last reading
  readings[readIndex] = analogRead(inputPin); // read from the sensor
  total = total + readings[readIndex]; // add the reading to the total
  readIndex = readIndex + 1;           // advance to the next position in the array
  if (readIndex >= numReadings) {      // wrap around to the beginning if at the end
    readIndex = 0;
  }
  average = total / numReadings;       // calculate the average
  Serial.println(average);
  delay(10);
}
```

# Example – Serial Plotter

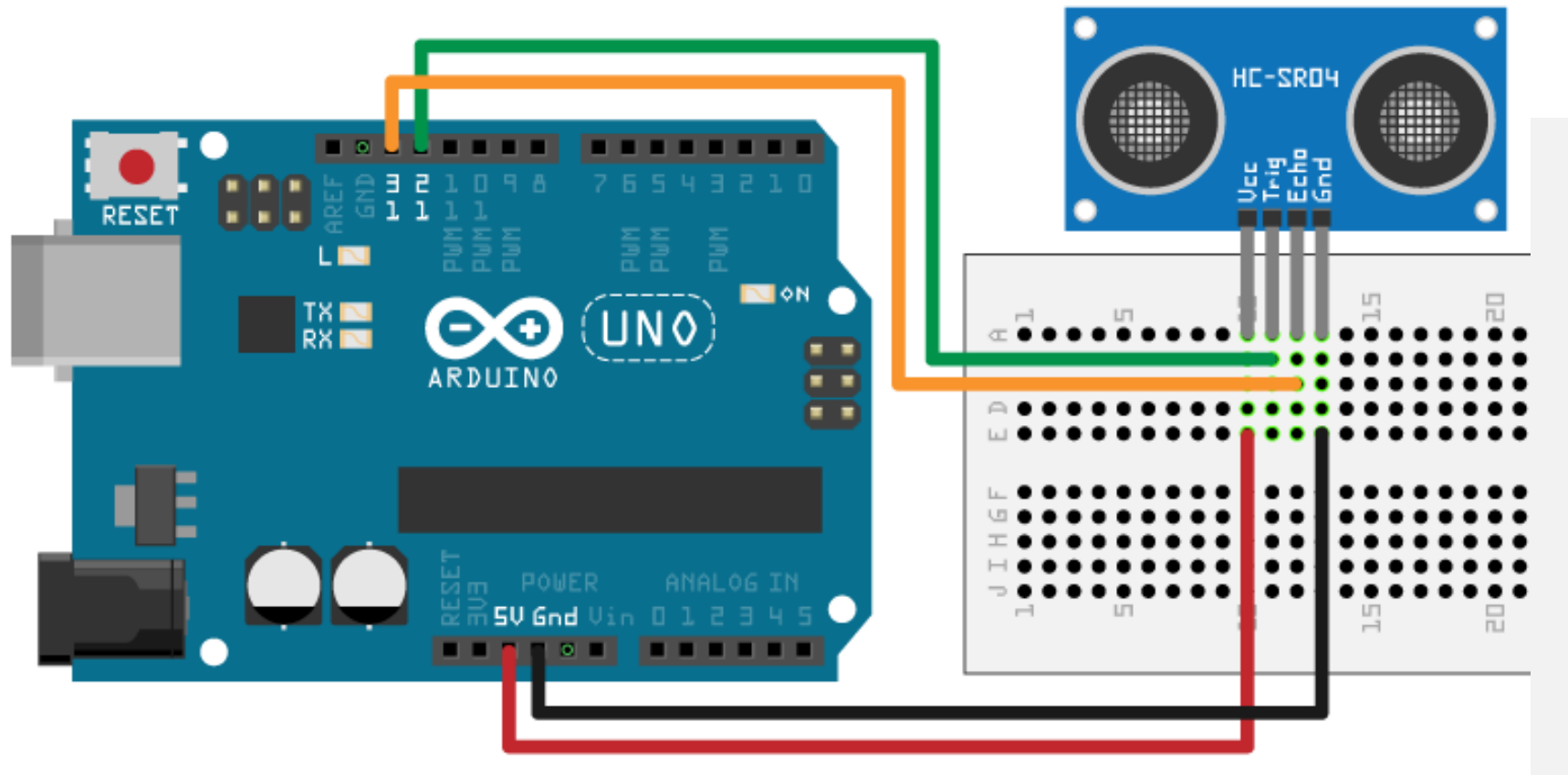
- Plot the analog signals





# Example – Ultrasonic Sensor

- A digital device



# Sketch Code – Ultrasonic Sensor

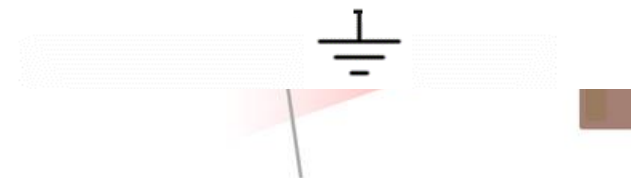
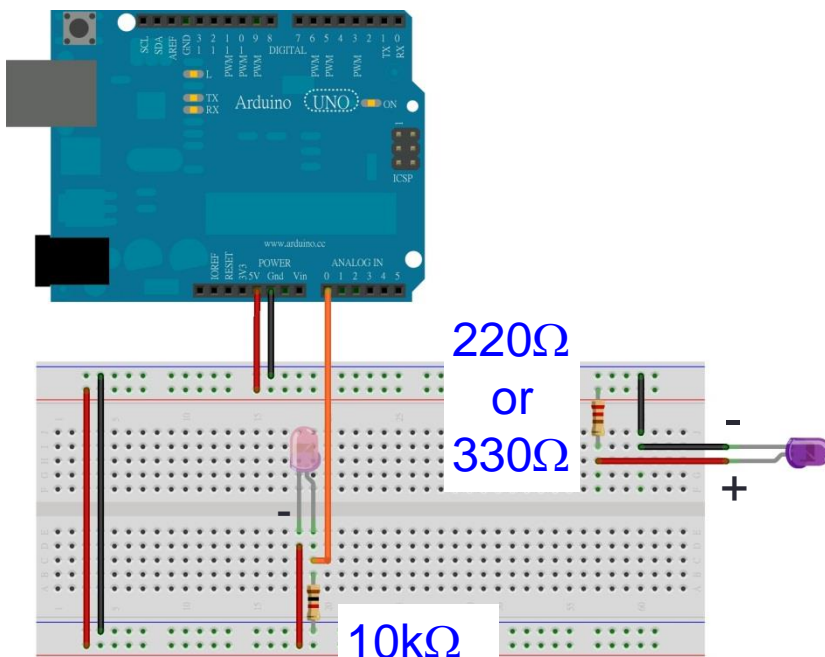
```
int TRIGPIN = 12; // Pin to send trigger pulse
int ECHOPIN = 13; // Pin to receive echo pulse
void setup() {
  Serial.begin(9600);
  pinMode(ECHOPIN, INPUT);
  pinMode(TRIGPIN, OUTPUT);
}

void loop() {
  digitalWrite(TRIGPIN, LOW);           // Set the trigger pin to low for 2us
  delayMicroseconds(2);
  digitalWrite(TRIGPIN, HIGH);          // Send a 10uS high to trigger ranging
  delayMicroseconds(10);
  digitalWrite(TRIGPIN, LOW);           // Send pin low again
  int distance = pulseIn(ECHOPIN, HIGH); // Read in times pulse
  distance = distance/58;                // Calculate distance (in cm) from time of pulse
  Serial.println(distance);
  delay(50);
}
```

# Example – IR Sensor

- An infrared (IR) sensor is an electronic device that emits and detects infrared radiation to sense surroundings
- It is an analog device

\_\_\_\_\_●+5 V



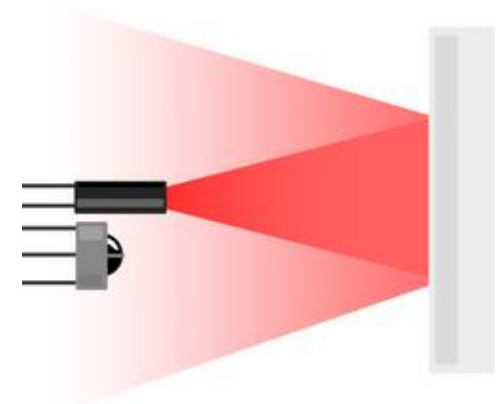
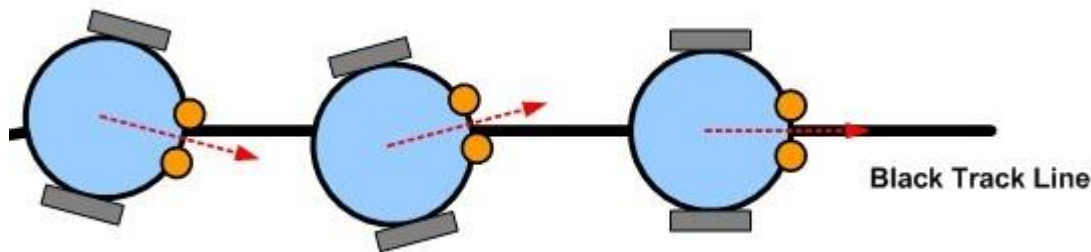
Object present - reflected IR light detected by sensor

# Sketch Code – IR Sensor

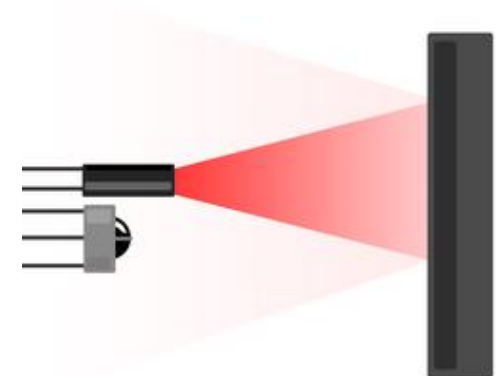
```
void setup() {  
  Serial.begin(9600); // initialize serial communication at 9600 bits per second  
}  
  
void loop() {  
  int sensorValue = analogRead(A0); // read the input on analog pin 0  
  Serial.println(sensorValue);      // print out the value you read  
  delay(1000);                     // wait for 1000 milliseconds  
}
```

# IR Sensor to Detect Brightness

- IR sensors can be used to detect brightness of objects
- An approach to detect black line using two IR sensors:



Lightly colored objects reflect more IR light



Darker colored object reflect less IR light

# What Have We Learned So Far?

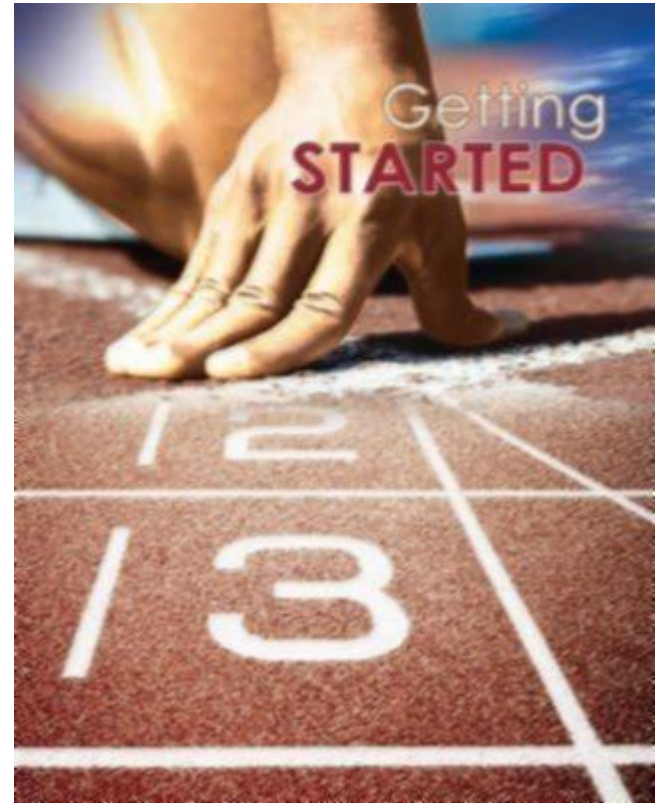
- There is a component in the microcontroller that can read analog input – analog to digital converter (ADC)
- IR sensors can be used for object detection or black line tracking

# Reminder

- Download and install Atmel Studio to your laptop  
(<https://www.space.ntu.edu.tw/navigate/s/75A6ED71D81449949E2587E865B819E2QQY>)



# Getting Started





# Reference

- <http://www.arduino.cc/>
- ATmega328P data sheet
- IR receiver working principle:

