Principles and Applications of Microcontrollers

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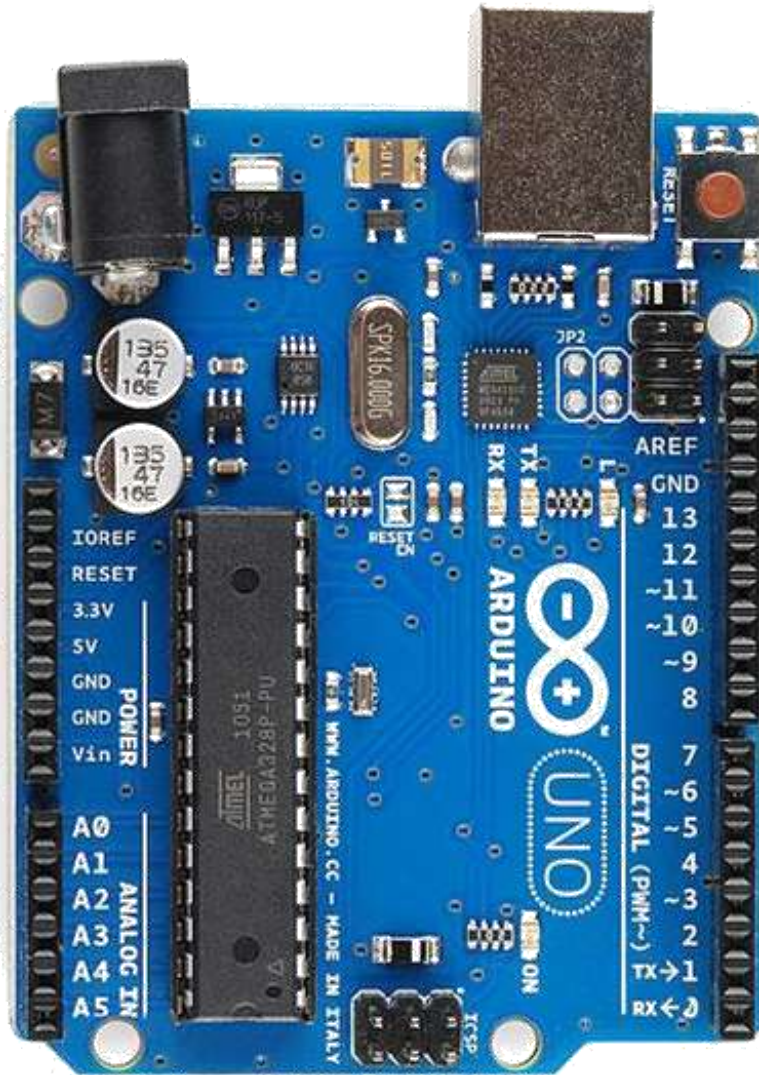
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Today:

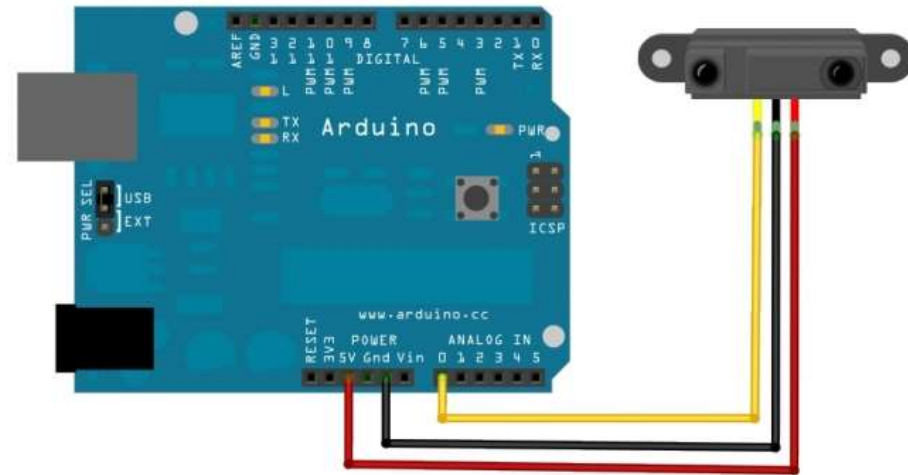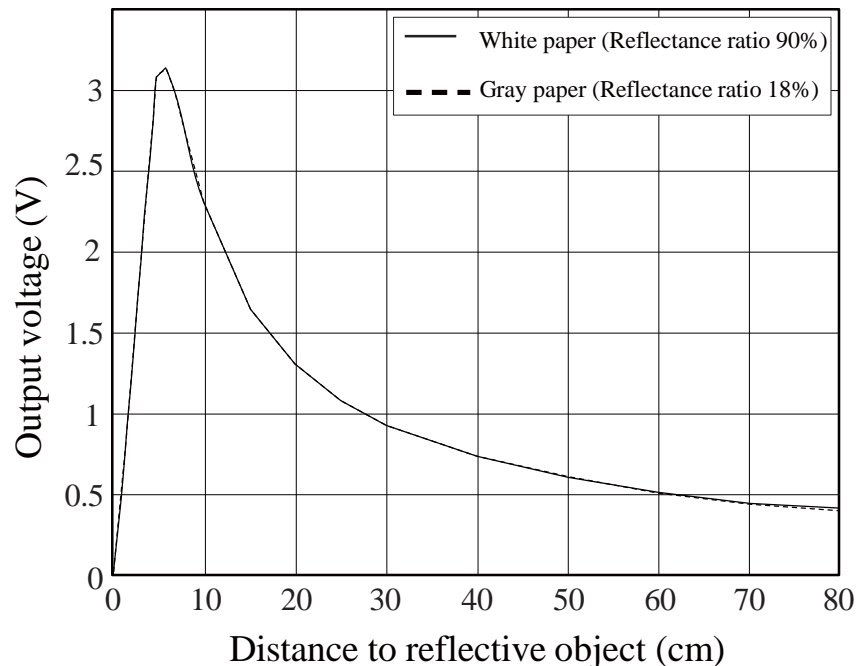- Arduino analog input
- Infrared sensor

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 <u>analog</u> 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?

Example – Smoothing

• Calculate a running average of an analog signal and print it on the computer screen
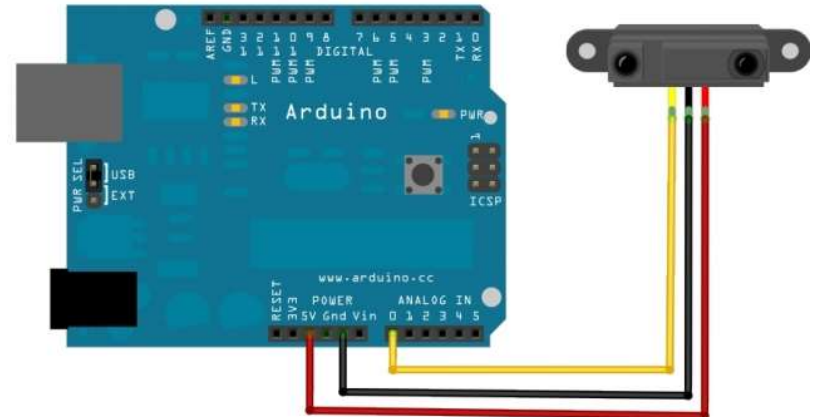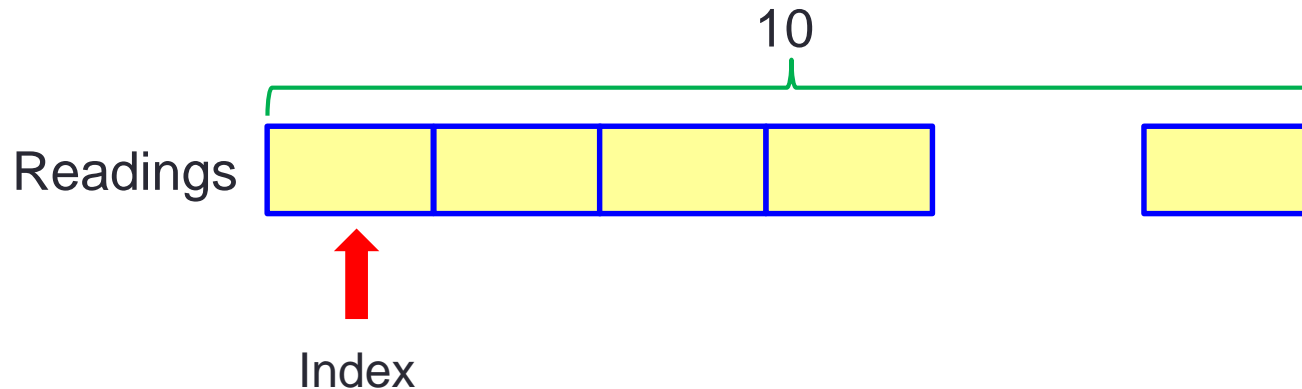
Sketch Code – Smoothing

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);
}
```
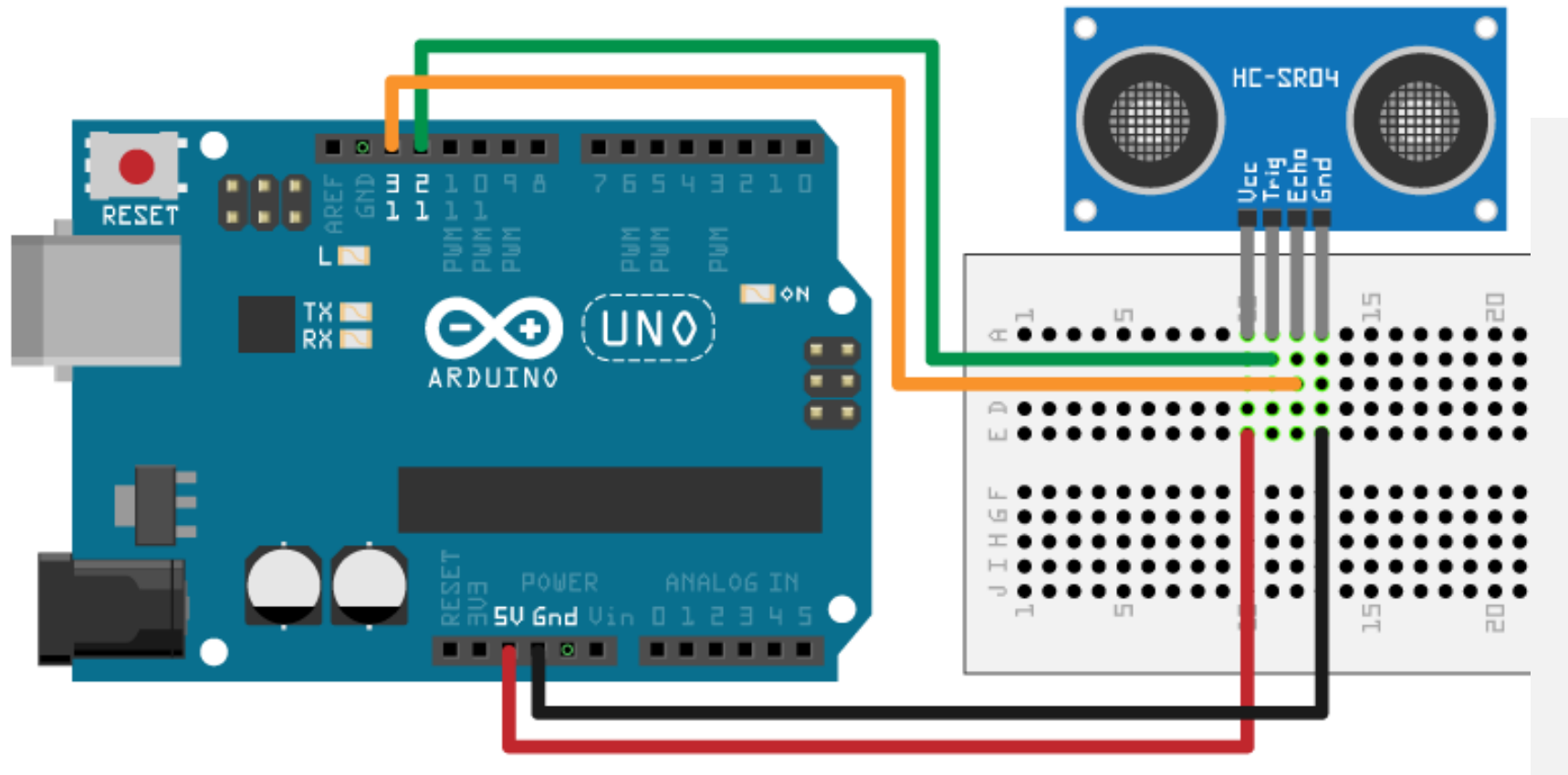
Example – Serial Plotter

- Plot the analog signals
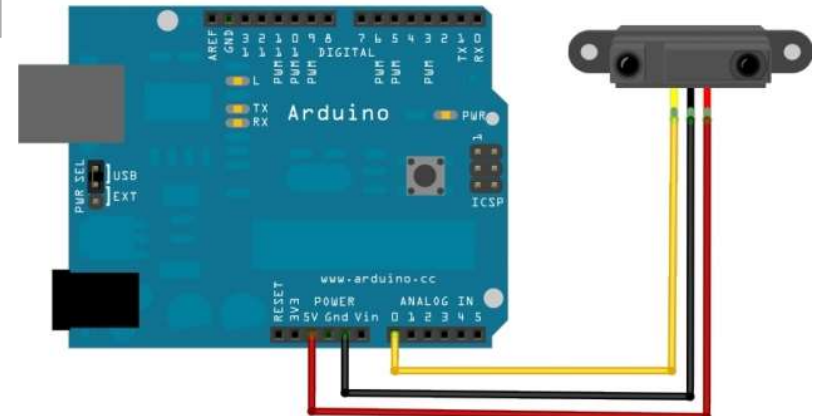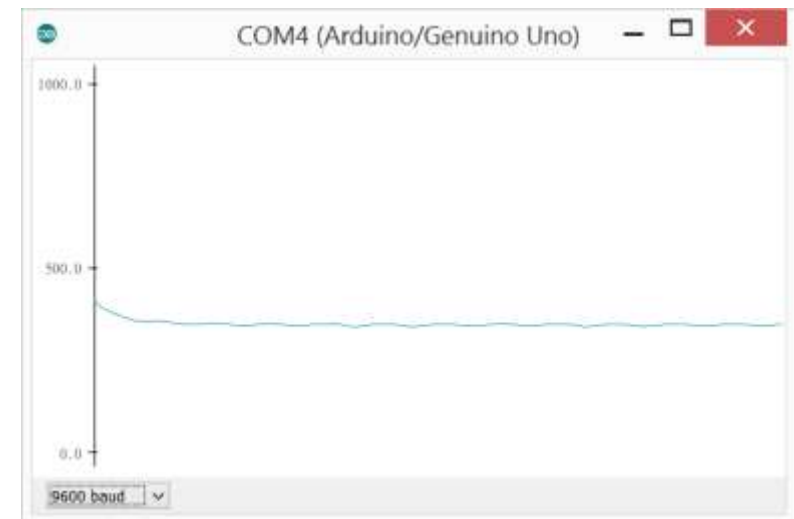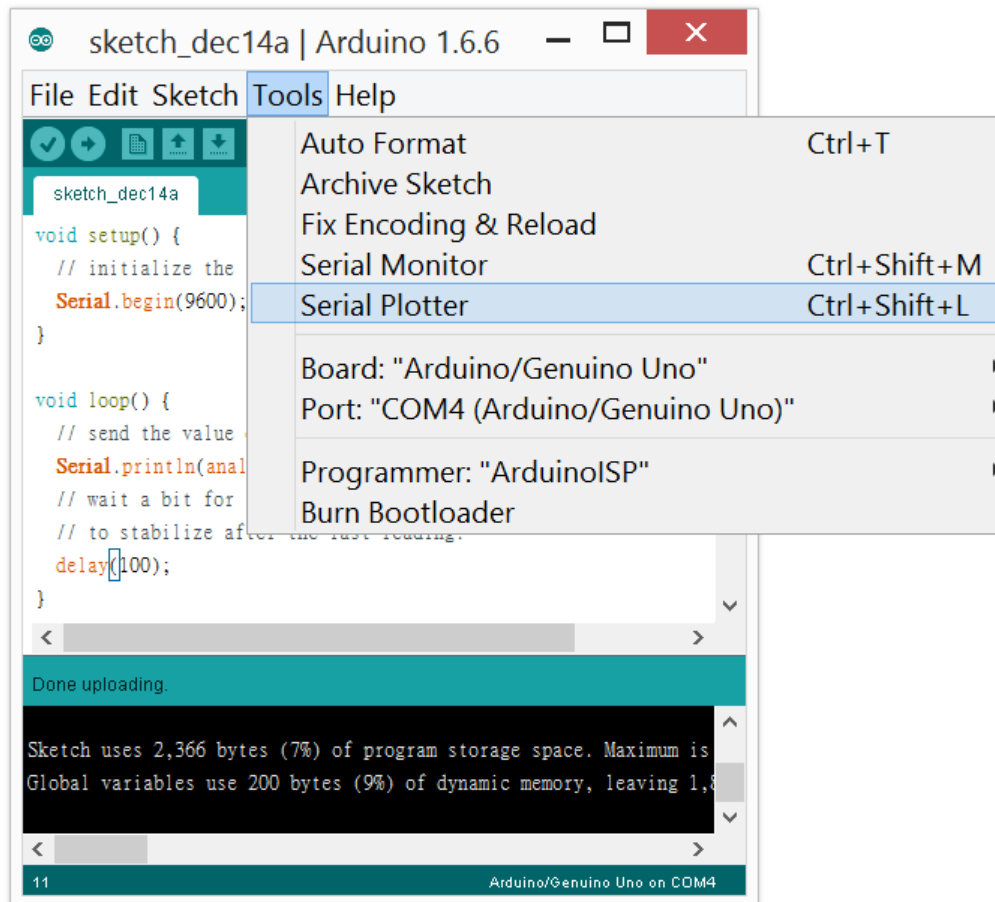
Example – Ultrasonic Sensor

- A digital device

Sketch Code – Ultrasonic Sensor

```c
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 <u>analog</u> device

+5 V

220Ω
or
330Ω

-
+

10kΩ
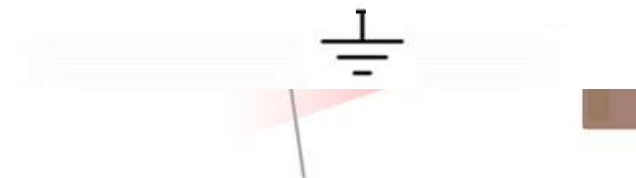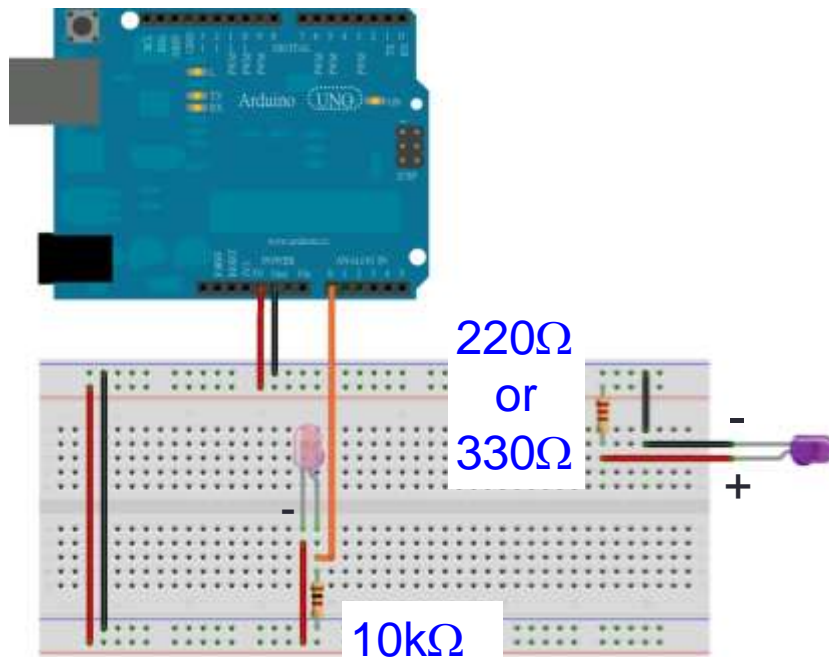
Object present - reflected IR light detected by sensor

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:

Black Track Line
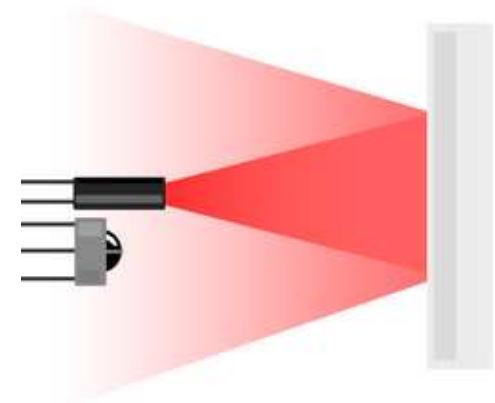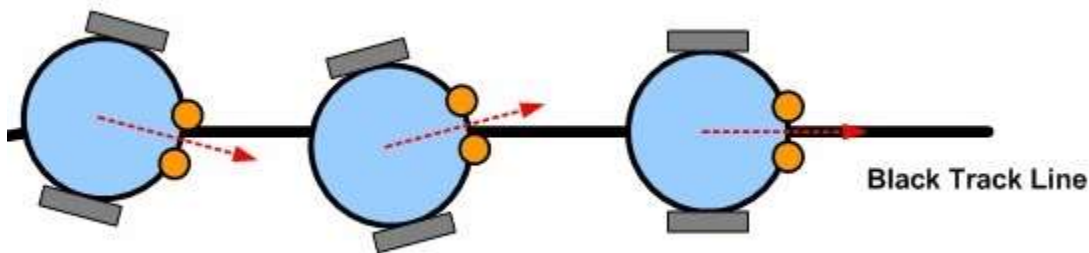
Lightly colored objects reflect more IR light
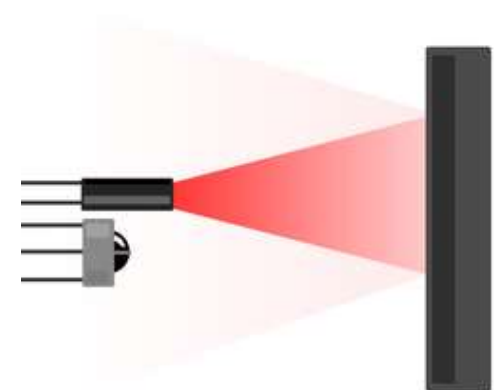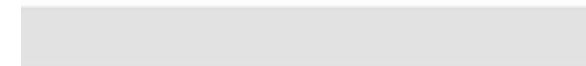
Darker colored object reflect less IR light

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

Getting Started

Reference

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

$V_R = 5V$
$V_A = 0V$

$V_R = 0V$
$V_A = 5V$

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V_A