HARDWARE PROTOTYPING
WITH ARDUINO

...with an introduction to Raspberry Pi and ESP8266
WHAT’S ARDUINO?

• Rapid prototyping tool
• Based on a micro controller board and development environment
• The micro controller uses inputs, performs calculations, and gives an output
• The development environment enables the user to tell the micro controller what to do with the input using software
• USB programmable
• Multi-platform - Windows, Mac OSX, Linux
• Inexpensive - ~$35 (much less for generic)
WHAT CAN I DO WITH AN ARDUINO BOARD?

• Depends....

• What components do you have?

• What do you want to do?

• https://www.youtube.com/watch?v=nz_tgDD8FNw
STARTER KIT COMPONENTS

• The Arduino Development Board
• Breadboard
• Capacitors
• DC motor & Servo
• Diode
• LEDs
• LCD
• Piezo
• Light dependent resistor
• Push buttons
• Resistors
• Temperature sensor
THE ARDUINO BOARD

1. USB (type B)
2. Barrel Jack
3. Ground
4. 5V supply
5. 3.3V supply
6. Analog input (E.g. temp sensor)
7. Digital input/output
8. Pulse Width Modulation
9. Analog Reference
10. Reset Button
11. Power LED
12. TX/RX LED
13. ATmega microcontroller
14. Voltage Regulator
15. Pin 13 LED

HTTPS://LEARN.SPARKFUN.COM/TUTORIALS/WHAT-IS-AN-ARDUINO
WHAT ELSE CAN I CONNECT?

Arduino can interface easily with a huge variety of external modules/devices:

- Thermometers
- Accelerometers
- GPS receivers
- Bluetooth transceivers
- Touch screens
- Cellular/GSM modules
- Other wireless modules (Xbee, Zwave, etc.)
- SD Card storage
- Relays
WHAT CAN ARDUINO NOT DO?

• Arduino has no (built-in) real-time clock
• Arduino only has no TCP/IP, ethernet, WiFi…
• Arduino has limited RAM and flash memory
LETS GET STARTED!

• Connect your Arduino to the computer with the USB cable

• Make sure you see the green “ON” LED

• Open the Arduino IDE application

• Select **Tools>Board:>Arduino Uno**

• Select **Tools>Port>/dev/tty.usbmodemfd1311**
  (this may change depending on device/brand/revision)

• Open **File>Examples>01.Basics>Blink**
1 /*
2  Blink
3  Turns on an LED on for one second, then off for one second, repeatedly.
4
5  Most Arduinos have an on-board LED you can control. On the Uno and
6  Leonardo, it is attached to digital pin 13. If you’re unsure what
7  pin the on-board LED is connected to on your Arduino model, check
8  the documentation at http://www.arduino.cc
9
10  This example code is in the public domain.
11
12  modified 8 May 2014
13  by Scott Fitzgerald
14 */

17 // the setup function runs once when you press reset or power the board
18 void setup() {
19     // initialize digital pin 13 as an output.
20     pinMode(13, OUTPUT);
21 }
22
23 // the loop function runs over and over again forever
24 void loop() {
25     digitalWrite(13, HIGH); // turn the LED on (HIGH is the voltage level)
26     delay(1000); // wait for a second
27     digitalWrite(13, LOW); // turn the LED off by making the voltage LOW
28     delay(1000); // wait for a second
29 }
EXAMPLE 2: LED FADE IN/OUT

- Open File>Examples>01.Basics>Fade
- Notice that pin number is now represented by a variable
- Change the digital pin connection to 9
- Click to compile and verify your code
- Click to upload to the board and run
/*
Fade

This example shows how to fade an LED on pin 9 using the analogWrite() function.

This example code is in the public domain.
*/

int led = 9;       // the pin that the LED is attached to
int brightness = 0; // how bright the LED is
int fadeAmount = 5; // how many points to fade the LED by

// the setup routine runs once when you press reset:
void setup() {
  // declare pin 9 to be an output:
  pinMode(led, OUTPUT);
}

// the loop routine runs over and over again forever:
void loop() {
  // set the brightness of pin 9:
  analogWrite(led, brightness);

  // change the brightness for next time through the loop:
  brightness = brightness + fadeAmount;

  // reverse the direction of the fading at the ends of the fade:
  if (brightness == 0 || brightness == 255) {
    fadeAmount = -fadeAmount ;
  }

  // wait for 30 milliseconds to see the dimming effect
  delay(30);
}
HOW DOES THIS WORK?

• Not a true analog output!

• LEDs don’t tolerate a wide range of voltage input

• PWM = Pulse Width Modulation

• LED cycles on/off 490 or 980 times per second, faster than the eye can perceive

• Duty cycle is varied, essentially changing the average analog voltage
GENERAL CAVEATS FOR ELECTRONICS

• All electronics contain magic white smoke that makes things work. Don’t let the smoke out.

• Static electricity is fun, but it can let the smoke out

• Disconnect power when making wiring changes

• Be careful when interfacing devices that operate at different voltages!
WHAT'S RASPBERRY PI?

• More robust rapid prototyping tool
• A credit card sized computer
• Runs low-memory *nix OS, like Raspbian
• Can connect directly with keyboard, mouse, ethernet, and monitor
• Inexpensive - $35-$45
• Also available as part of a kit, similar to Arduino Starter Kits
WHAT CAN I DO WITH A RASPBERRY PI?

• Depends....

• What components do you have?

• What do you want to do?

• https://vimeo.com/90103691
CANA KIT COMPONENTS

- 1 x Raspberry Pi2 Model B 1GB
- 1 x 8 GB MicroSD Card - Raspberry Pi Recommended MicroSD Card with the new NOOBS
- 1 x Raspberry Pi 2 Case
- 1 x CanaKit 2.5A MicroUSB Power Supply specially designed for the Raspberry Pi 2 (5-foot cable)
- 1 x Premium Quality HDMI Cable (6-foot)
- 1 x WiFi Adapter/Dongle (Ralink RT5370 chipset)
- 1 x Set of Heat Sinks
- 1 x Breadboard
- 1 x 40-pin GPIO Ribbon Cable
- 1 x 40-pin T-Shaped GPIO to Breadboard Interface Board
- 2 x Push Button Switches
- 1 x RGB LED
- 2 x Red LEDs
- 2 x Green LEDs
- 2 x Yellow LEDs
- 2 x Blue LEDs
- 10 x 180 Ohm Resistors
- 5 x 10K Ohm Resistors
- 1 x CanaKit General Guide for Beginners to Electronic Components

New Pi 2
WHAT CAN RASP PI NOT DO?

• Does not support analog components, requires external ADC
• Has no integrated wifi, can use USB for wifi adapter
• No on-board pins, requires bread board for GPIO
• Not simply plug-and-play, no RaspPi app, like Arduino
MORE INFO

About it

Getting started

Project ideas
https://hackaday.io/projects/tag/raspberry%20pi

Check out a kit from RNOC (App Lab)
rmoc-lab-staff@lists.gatech.edu