Basics to Electronics - Overview 0

In this module you will dive into the inner workings of the machines in which you have been learning to operate. Basics of Electronics ties in how these machines operate from their core fundamentals to the individual components required to make machines work with precision. The goal of this module is to pull back the veil of CNC machining so that you may be able to use this knowledge when preparing files for your projects.

Final Deliverables

Read and Understand these terms for use later in this module.

A1- Intro to Circuits

With this assignment you will be introduced to terms and concepts that are used while Wiring. Understanding these terms will allow you to interface with Circuit Diagrams Arduinos, and Motors later in this module. Terms such as : Circuit, Ground, Positive, Negative, Voltage, and Amperage, are all commonly used while preparing a circuit. For this assignment please read and understand how each of these terms applies to circuits and electronics.

Circuit - This pertains to a complete circular path that electricity flows through. A simple circuit consists of a current, source, conductors, and a load. The term circuit can be used in a general sense to refer to any fixed path that electricity, data, or signal can travel through.

Ground- An electrical reference point that connects to the earth. Ground connects to neutral at a single neutral point on an electrical system measuring zero volts (0 volts).

Amperes- Electrical measurement of the quantity of the flow of electrons.

Current Flow Direction- It is not known for sure what direction currents flows. The conventional theory of current flow is from positive (+) to negative (-).

Voltage - The electrical force or potential difference measured in volts (V).

Ohms- Electrical measurement of the opposition of the flow of electrons in a conductor.

Basics to Electronics - Circuit Hardware 1

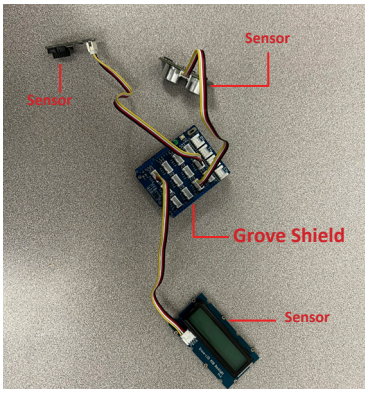
In this assignment, you will be introduced to the various hardware you will be using during this module. The hardware ranges from: Microcontrollers, Sensors, Shields, Motor Drivers, Stepper Motors, Servo Motors, and Power Supplies. All of these are commonly found within CNC machines at various scales of complexity. To complete this assignment you will need to associate the name of the hardware with the actual component. Shown below is the type of hardware associated with its name, all of this can be found in the Sensors Lab located in the Basement (AB006).

Final Deliverable

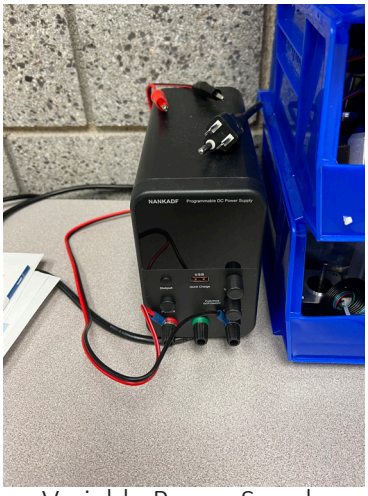
Look through and gain an understanding of what each component does and looks like.

A1- Circuit Hardware

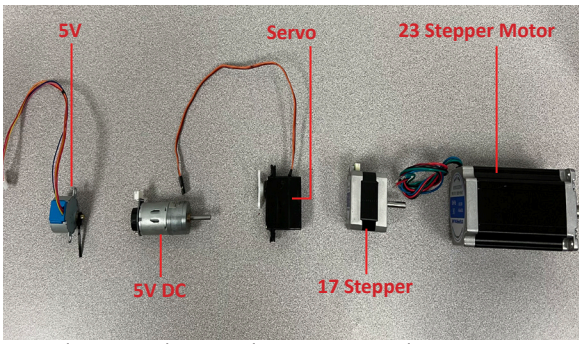
Here are examples of hardware available for use in the Sensors Lab. All of this equipment can be strung together to create moving and adaptable circuits and projects. As an example circuit, take an Arduino Microcontroller (Uno) and attach a Grove Shield + LCD Screen + Ultrasonic Ranger, this combination will allow you to make an electronic measuring tape. (Proceed to M5A2)



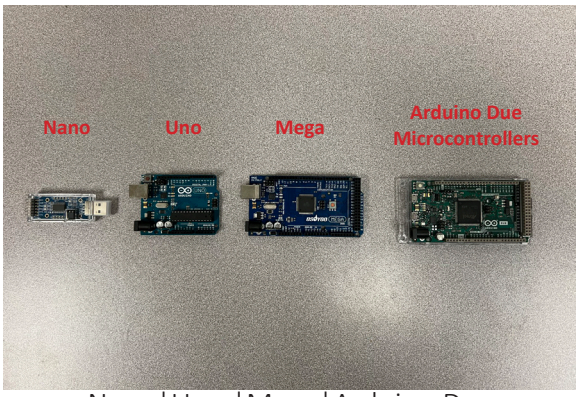
Grove Shield + Sensors



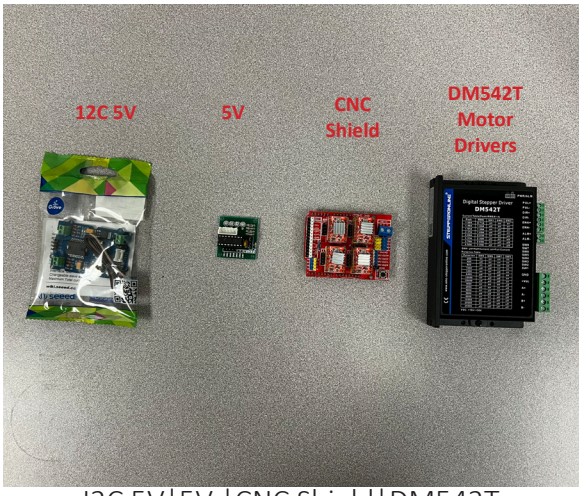
Variable Power Supply



5V|5V DC |Servo|17 Stepper|23 Stepper Motor



Nano|Uno |Mega|Arduino Due Microcontrollers



I2C 5V|5V |CNC Shield|DM542T Motor Drivers

Basics to Electronics - Circuit Prep 2

In this assignment, you will be assembling predefined circuits with varying levels of complexity. With options such as: (Flashlight, Measuring Tape, 5V Stepper Control, and 17 Stepper Control). The code required will be provided so all you will need to do is plug and screw all the components together.

Final Delieverables

Complete ONE Sensor Circuit & One Motor Cirucit

A2- Circuit Prep

What you'll need

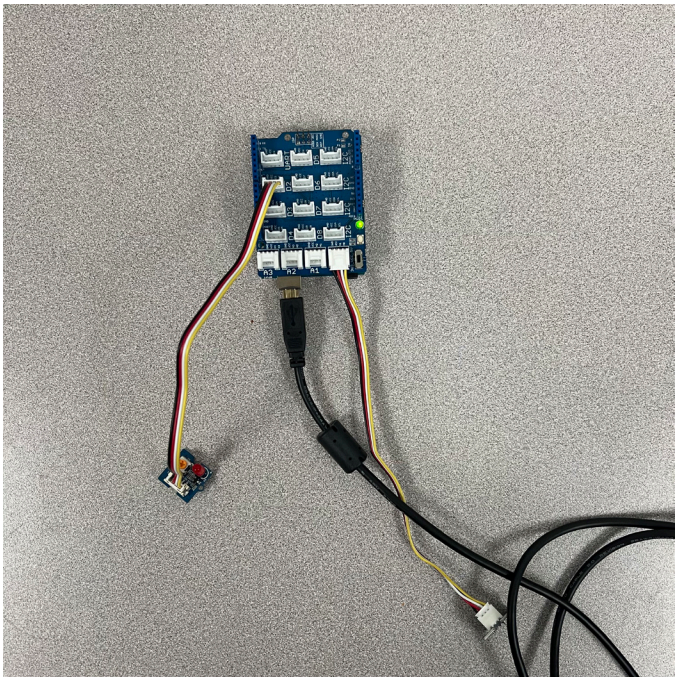
Arduino IDE
Https://www.arduino.cc/en/software

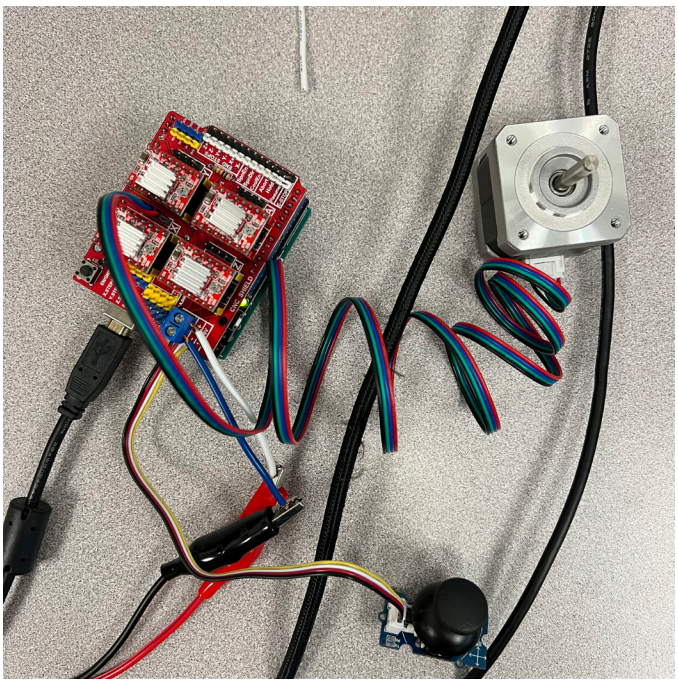
This is the software that allows you to edit and compile the code needed to run your circuit. Within this software are libraries that can be downloaded and imported to increase the capabilities of the software.

Examples of libraries are Grove Sensors. On their website (https://wiki.seeedstudio.com/Grove_System/) they have an example code available to test all of the sensors we have in the lab. Typically they will also provide a downloadable .zip file that can be imported into the IDE to open examples rather than copying them.

Lastly when using the Variable Power supply be very careful not to touch the bare metal clips as these will be outputting the voltage set by you. Please ensure that the rubber sleeves are on the clips before powering on the supply. When you have the voltage set and are ready to power your circuit, simply hit the Output button to start your circuit.

(Proceed to M5A2 a or b)





Basics to Electronics - Circuit Prep 2a

In this assignment, you will be assembling a predefined circuit, the Flashlight. It uses only a few components and cables to show the capabilities of sensor feedback.

Final Deliverables

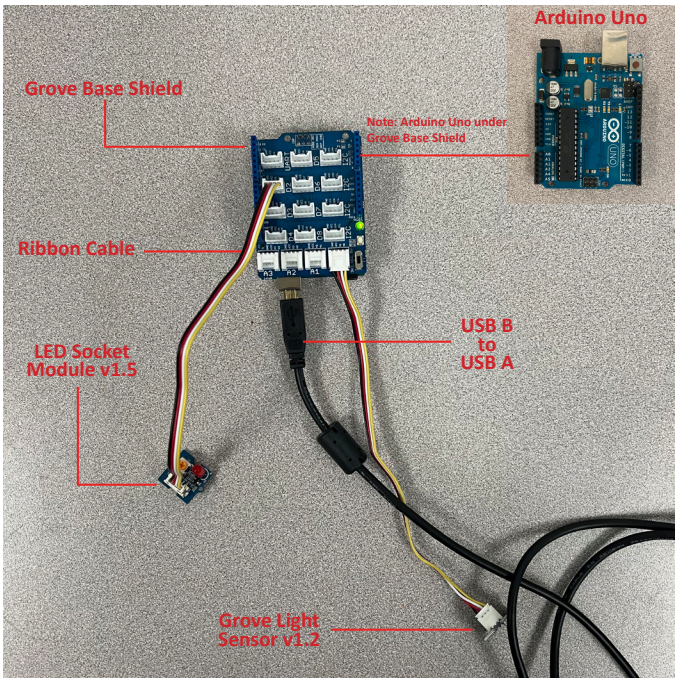
One Functioning Circuit

2a- Flashlight(Sensor)

What you'll need

The Flashlight Sketch(Code)-

Follow the Instructions and Parts list found at the top of the code provided. It will walk you through connections, switches, compiling, and uploading your code. Then once finished test out your circuit by placing your hand over the light sensor and watching the LED glow.



(Code Download Link)

Components Required
Arduino Uno- Arduinos
Grove Base Shield- Arduinos
USB B to USB A Cable- Misc Cables
LED Socket Module v1.5- Dials/Switches/LEDS
Grove Light Sensor v1.2- Sensors
If sensors need cables grab any ribbon cable from the clear bin

Instructions
- Attach Grove Shield to the Arduino Uno by lining up the pins on the side and the 6 pins with the blue block on the underside of the grove shield
- Ensure LED Socket Module is plugged into D2
- Ensure Light Sensor is plugged into A0
In Arduino IDE go to Tools<Board<Arduino Uno
In Arduino IDE go to Tools<Port<Look for the COM port that says (Arduino Uno) next to it.
If no COM port shows with (Arduino Uno) next to it, go to the windows button<search device manager<Ports (COM & LPT)< Look for COM port labeled Arduino Uno
Ensure Arduino Switch is set to 5V it is located on the grove shield next to the green LED
Finally, click the right-facing arrow at the top left of the Arduino IDE to flash the code onto the Arduino
(Proceed to M5A2 c or d)

Basics to Electronics - Circuit Prep 2b

In this assignment, you will be assembling a predefined circuit, the Measuring Tape. It uses only a few components and cables to show the capabilities of sensor feedback.

Final Deliverables

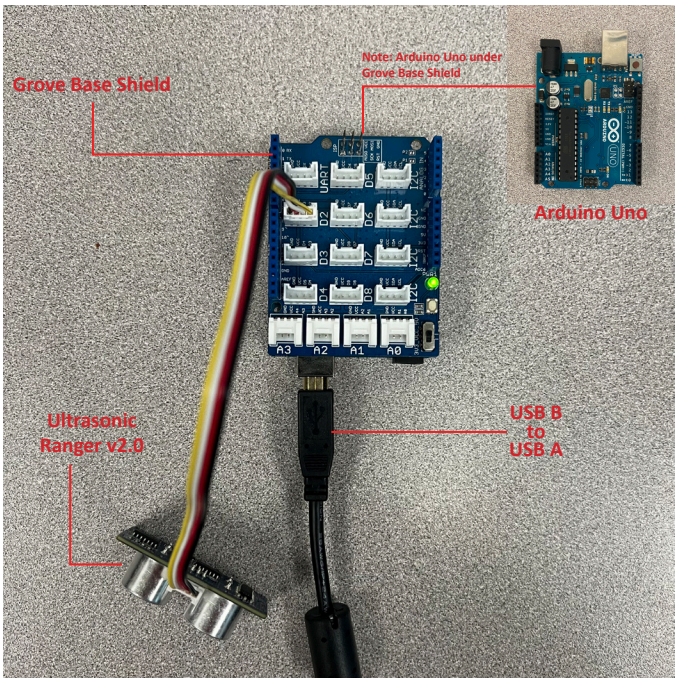
One Functioning Circuit

2b- Measuring Tape(Sensor)

What you'll need

The Measuring Tape Sketch(Code)-

Follow the Instructions and Parts list found at the top of the code provided. It will walk you through connections, switches, compiling, and uploading your code. Then once finished test out your circuit by placing your hand over the Ultrasonic sensor and watching the Serial Monitor change.



Components Required
Arduino Uno- Arduinos
Grove Base Shield- Arduinos
USB B to USB A Cable- Misc Cables
Ultrasonic Ranger v2.0
If sensors need cables grab any ribbon cable from the clear bin

(Code Download Link)

Instructions
- Attach Grove Shield to the Arduino Uno by lining up the pins on the side and the 6 pins with the blue block on the underside of the grove shield
- Ensure the Ultrasonic Ranger Module is plugged into D2
In Arduino IDE go to Tools<Board<Arduino Uno
In Arduino IDE go to Tools<Port<Look for the COM port that says (Arduino Uno) next to it.
If no COM port shows with (Arduino Uno) next to it, go to the windows button<search device manager<Ports (COM & LPT)< Look for COM port labeled Arduino Uno
Download the Ultrasonic Ranger Library from (https://github.com/Seeed-Studio/Seeed_Arduino_UltrasonicRanger/archive/master.zip)
To install this library go to Sketch<Include Library<Add .Zip Library<Downloads select the folder and open it
Now you have the necessary library required to run this code
Ensure Arduino Switch is set to 5V it is located on the grove shield next to the green LED
// Finally click the right-facing arrow at the top left of the Arduino IDE to flash the code onto the Arduino
(Proceed to M5A2 c or d)

Basics to Electronics - Circuit Prep 2c

In this assignment, you will be assembling a predefined circuit, 5V Stepper Control. It uses only a few components and cables to show the capabilities of electronic motors.

Final Deliverables

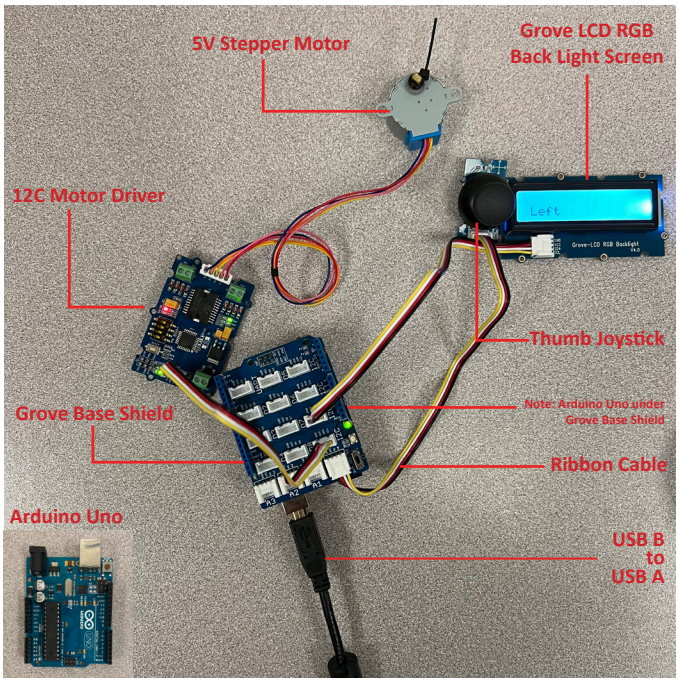
One Functioning Circuit

2c- 5V Stepper Control(Motor)

What you'll need

5V Stepper Control Sketch(Code)-

Follow the Instructions and Parts list found at the top of the code provided. It will walk you through connections, switches, compiling, and uploading your code. Then once finished test out your circuit by moving the joystick and watching the motor spin.



(Code Download Link)

Components Required
Arduino Uno- Arduinos
Grove Base Shield- Arduinos
USB B to USB A Cable- Misc Cables
I2C Motor Driver- Motor Drivers
5v Stepper Motor- Motors
Thumb Joystick- Dials/Switches/LEDS
Grove LCD RGB Back light Screen v4.0- Dials/Switches/LEDS

Instructions

All instructions on assembly and programming are within the Sketch/Code.

(Proceed to M5A3)

Basics to Electronics - Circuit Prep 2d

In this assignment, you will be assembling a predefined circuit, Nema 17 Stepper Control . It uses only a few components and cables to show the capabilities of electronic motors.

Final Deliverables

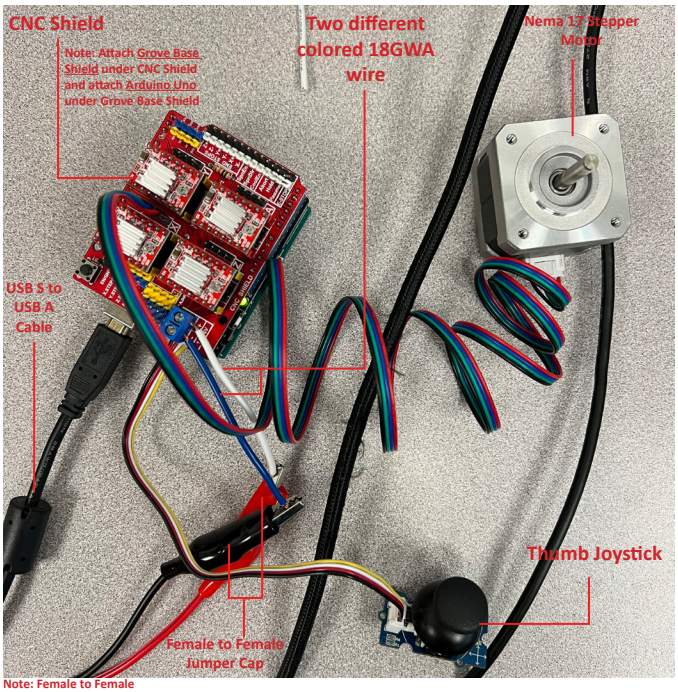
One Functioning Circuit

2d- Nema 17 Stepper Control(Motor)

What you'll need

CNC Nema 17 Control Sketch(Code)-

Follow the Instructions and Parts list found at the top of the code provided. It will walk you through connections, switches, compiling, and uploading your code. Then once finished test out your circuit by moving the joystick and watching the motor spin.



(Code Download Link)

Components Required

Arduino Uno- Arduinos
Grove Base Shield- Arduinos
CNC Shield V3- Stepper Drivers
USB B to USB A Cable- Misc Cables
Nema 17 Stepper Motor
Thumb Joystick- Dials/Switches/LEDS
Variable Power Supply - 24v 1.5A
Phillips Head Screw Driver
Two different colored 18GWA wire
Wire Strippers
Female to Female Jumper Cap

Instructions

All instructions on assembly and programming are within the Sketch/Code.

(Proceed to M5A3)

Basics to Electronics - Complex Circuit 3

In this assignment, you will be assembling a predefined circuit, Nema 23 Stepper Control. This circuit will test all the assembly knowledge you've learned within this module thus far as it combines sensors and motors to create a cohesive circuit.

Final Deliverables

One Functioning Circuit

A3- Nema 23 Stepper Control

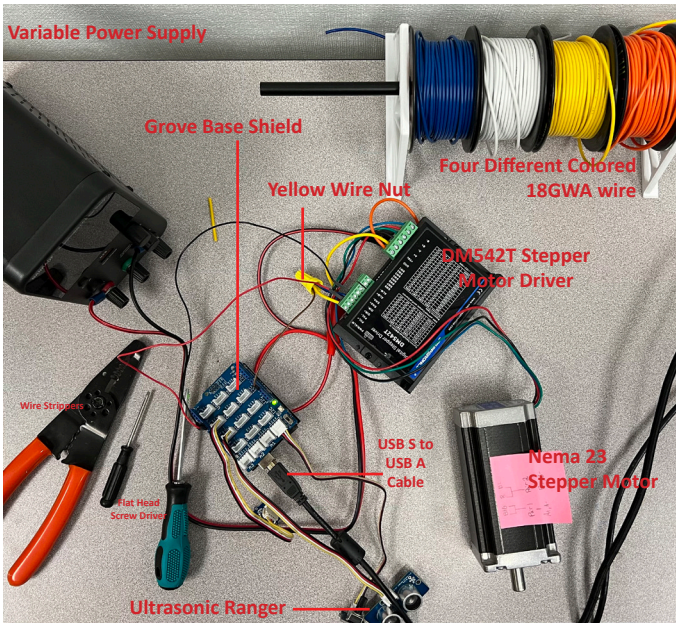
What you'll need

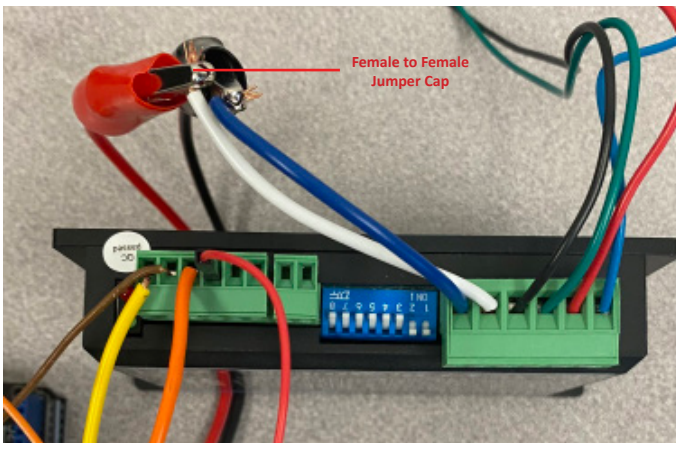
CNC Nema 23 Control Sketch(Code)-

Follow the Instructions and Parts list found at the top of the code provided. It will walk you through connections, switches, compiling, and uploading your code. Then once finished test out your circuit by moving your hand in front of the sensor and watching the motor spin. Adjust the Potentiometer to control speed and press the button to reverse the direction

Components Required

Arduino Uno- Arduinos
Grove Base Shield- Arduinos
DM542T Stepper Motor Driver
USB B to USB A Cable- Misc Cables
Nema 23 Stepper Motor
Button- Dials/Switches/LEDS
Potentiometer- Dials/Switches/LEDS
Ultrasonic Ranger- Sensors
Variable Power Supply - 24v 2.5A
Flat Head Screw Driver
Four different colored 18GWA wire
Wire Strippers
Male to Male Bread Board Jumpers
Multimeter
Yellow Wire Nut





(Code Download Link)

Instructions

All instructions on assembly and programming are within the Sketch/Code.

Basics to Electronics - Arduino IDE 4

In this Assignment, you will continue on from M4A3. Taking your Complex Machine and automating its mechanical system through electronic motors. By completing this assignment you should begin to understand how machines begin to work. This will also stress test your Complex Machine by allowing you to move your system at greater speeds possible than cranking by hand. Look for lockups, loose connections, or bent components during your stress test to improve your design.

Final Deliverables
One Motorized Complex Machine

---

1. Define your Input Shaft(Hand Crank Shaft). This will be different for all projects.

2. Define which motor you plan on using.
   - -Nema 17
   - -Nema 23
   - -5v Stepper

3. Find an adapter to connect your input shaft to the rotational shaft of the motor. You may have to laser cut or 3D Print an adapter plate depending on the size and shape of your input shaft.

4. Assemble your circuit. Depending on which motor you decide to use, you will have to assemble a functioning motor circuit to test your machine.

5. Flash your code. Once again depending on your chosen circuit you will have a slightly different code. To help we have some basic format code to get you started but you may have to edit inputs or names dependent on how you have configured your assembly. Use prior assignments to reference your code if needed.

Nema 17 Continuous Spin:
Nema 23 Continuous Spin:
5v Continuous Spin:

Proceed to M5A6

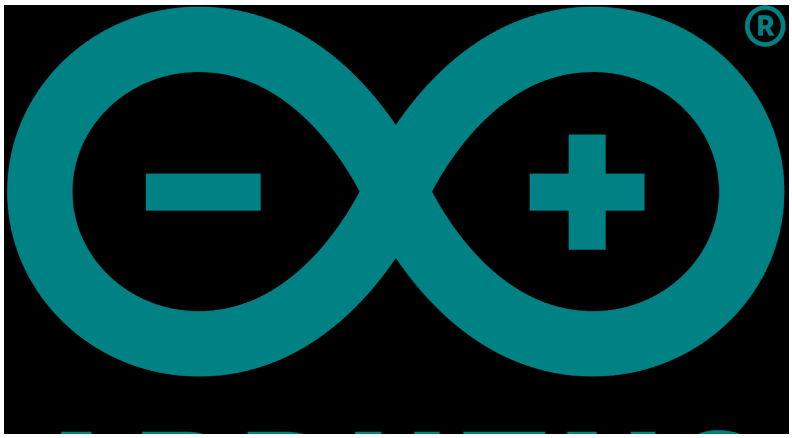
Basics to Electronics - Arduino IDE 4

In this Assignment, you will be introduced to the other half of electronics, the code, while initially intimidating with a little bit of curiosity and reading it really is just an instruction guide to making electronics move and function. There are two different ways to produce working code, one is through a text editor or IDE. (Integrated Development Environment) This is most likely what you think of when you picture coding, however, there is another type that is just as powerful. Visual Coding, using blocks or "nodes" to control your electronics, both do the same thing so it is up to you to decide which you're more comfortable with.

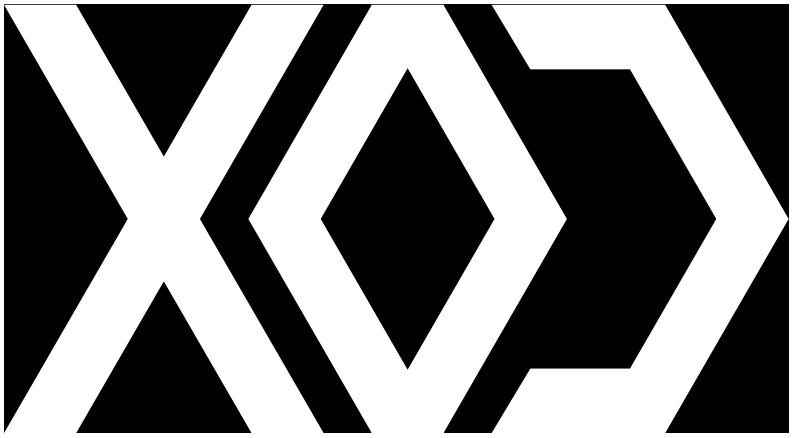
Within this assignment, we will introduce you to both Arduino IDE and XOD. If you have made it this far in the module then you have at least opened Arduino IDE and read through some instructions. Arduino IDE is the backbone of what makes Arduino an open-platform microcontroller. It allows ultimate flexibility in how your Arduino acts. While initially intimidating understanding what code makes what happen is the easy part. There are plenty of experts out there to help and plenty of forums that have more than likely already answered the question you are asking.

XOD on the other hand is more accustomed to those of us who are new to coding and may have used other visual coding platforms before such as Grasshopper, Blocky Code, Scratch Code, etc. These allow us to better understand just how code is linked together to perform functions.XOD is no different than Arduino IDE its only difference is its appearance, in XOD you place a node or block down onto the canvas and it will show you its required inputs and outputs. This makes it much easier to string together a series of nodes to move a motor.

To start here are some links on the "Basics" of Arduino Coding. Read up on how the IDE functions initially to better understand the concepts of working with Arduino then make your decision on whether to work with the IDE or XOD. Lastly, as a warning, XOD is relatively new in the Arduino Coding Community, therefore many of the GROVE Sensors found in the Lab are not useable within XOD. You're more than welcome to search for them but understand that you may have to revert back to the IDE for specific functions.



https://www.arduino.cc/en/software



https://xod.io/downloads/?skip=1

Basics to Electronics - Arduino IDE 4a

In this assignment, we will be using the Arduino IDE to create a sketch(code) that allows us to interface with electronics. Code is the instruction set that tells electronic components what and how to do what we expect. In Arduino IDE we will be using a text interface to generate an instruction set that will alter a numerical value using a potentiometer. To start we will need to understand some of the basic rules that come with C++ coding.

https://www.javatpoint.com/arduino-coding-basics

A4a- Altering Data

Links Needed

Grove Sensors Wiki Page
https://wiki.seeedstudio.com/Grove_System/

To complete this assignment you will need to select a few sensors to work with. Grab a Visible Light Sensor and an Ultrasonic Ranger and one potentiometer (either sliding or rotational). The goal of this circuit is to have the Arduino record all of the sensor's values and then alter their strength by the value of the potentiometer.

Sensor Links
https://wiki.seeedstudio.com/Grove-Light_Sensor/

https://wiki.seeedstudio.com/Grove-Ultrasonic_Ranger/

https://wiki.seeedstudio.com/Grove-Rotary_Angle_Sensor/

https://wiki.seeedstudio.com/Grove-Slide_Potentiometer/

(Proceed to M5A5)

(Code Download Link)

M5A3 §

```
1  ////////////////////////////////////////////////////////////////////////
2  #include "Ultrasonic.h"
3  Ultrasonic ultrasonic(3);
4  #define ROTARY_ANGLE_SENSOR A1
5  #define ADC_REF 5
6  #define GROVE_VCC 5
7  #define FULL_ANGLE 300
8  int light_sensor = A0;
9  ////////////////////////////////////////////////////////////////////////
10
11 void setup()
12 {
13 Serial.begin (9600);
14                    Set PinMode of Potentiometer to Input
15 }
16
17 ////////////////////////////////////////////////////////////////////////
18
19 void loop()
20 {
21
22
23
24                    Read from Ultrasonic Ranger
25                    Read from Light Sensor
26                    Create Variables
27
28
29
30
31 float Light = raw_light/degrees;
32 float Measure = RangeInInches/degrees;
33
34  Serial.println(Light);
35  delay(250);
36  Serial.println(Measure);
37  delay(250);
38 }
39
```

Instructions:
Go to each of those links and look for the example code section. Look under the Void Setup and Void Loop functions. Read to understand how it is drawing in the information from the sensors. Figure out what code you will need from each function to make the sensor work. After the code has been copied over to your IDE alter your variables to match that which is shown below.

value = raw_light

Basics to Electronics - Arduino IDE 4b

In this assignment, we will be using the XOD IDE to create a sketch(code) that allows us to interface with electronics. Code is the instruction set that tells electronic components what and how to do what we expect. In XOD IDE we will be using a node interface to generate an instruction set that will alter a numerical value using a potentiometer. To start we will need to understand some of the basic rules that come with C++ coding.

First, Complete the Tutorial within XOD IDE then begin coding your Altering Data assignment.

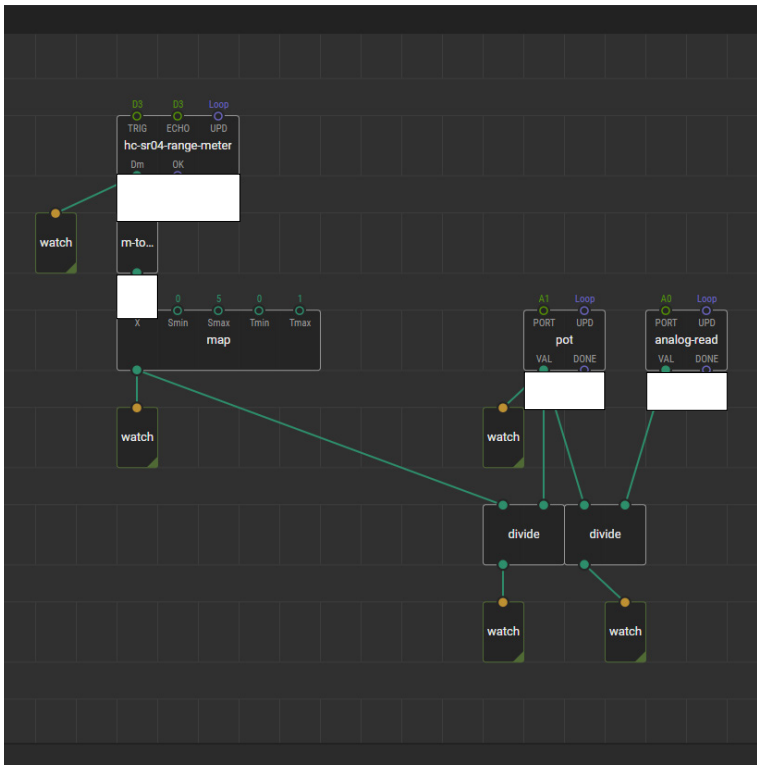
A4b- Altering Data

(Code Download Link)

To complete this assignment you will need to select a few sensors to work with. Grab a Visible Light Sensor and an Ultrasonic Ranger and one potentiometer (either sliding or rotational). The goal of this circuit is to have the Arduino record all of the sensor's values and then alter their strength by the value of the potentiometer.

(If you receive an error about cloud usage capacity, create an account using the orange person icon in the top right, then sign in to resolve this error)

(Proceed to M5A5)



Instructions:

First, complete the tutorial prompted when you open XOD IDE. This will show you how to navigate and use simple nodes. Then fill in the blanks on the code above using the hardware names below. As you fill it out use the HELP menu to understand what the node is doing. Be sure to mirror where you plugged in your hardware to the ports mentioned in the inputs!

Node Bank
Potentiometer
Analog Read
hc-sr04-range-meter
mtoin