Robotic Alien Tentacles by Monta – Build Sheet

by Monta Elkins (3/2016) for Let's Code Blacksburg

Audience: Those wanting to build robotic alien tentacles and learn more about Arduino programming and interfacing, using servo control to move real objects.

This isn't a "type this" "click here" you're done- type class. You will have to figure parts of it out. The provided reference materials should give you all the information you need. "Figuring it out" will lead to a greater understanding of the coursework and the process of building your own applications.

This course consists primarily of the "**Project Build Sheet**". Follow that outline to build your project. The Project Build Sheet contains several steps many of these steps are further explained by **Recipes in the Cookbook,** The Recipes are combined (with some additional information) to build this project.

If you understand the directions on the Project Build Sheet, you may skip the recipe pages in the Cookbook on how to do that section, though I'd recommend going through it to practice your "fail fast" technique.

I would not recommend skipping steps on the actual Project Build Sheet. Check off each as you go along. Even though some of the steps are rudimentary- they help lead you through a fail-fast process that will give you better results faster.

The collection of recipes can be used in a mix and match fashion in the future to build your own projects, similar to the way they are used to build this Robotic Alien Tentacle (RAT) project.

Experience: Participants are expected to have loaded and run simple Arduino code in the past. If you haven't done this, the Recipe pages should provide additional information. Experience with previous Arduino classes using potentiometers is helpful. If something is unclear, missing or misleading on any of the pages, please let me know.

Project Description: In this class we will build a two-degree-of-freedom, Robot Alien Tentacle that you can move using potentiomenters for control,

Parts:

- Arduino or clone and USB cable
- 2 servos and symmetrical servo horns
- 2 potentiometers
- Arduino Sensor Shield V4.0
- hot glue gun and glue sticks (can be shared)
- Razor knife (can be shared)
- 3D printed Robotic Alien Tentacle parts
- Foam core board for base (aprox. 4" x 10")
- 2 pieces of fishing line (4- 6 ft.)

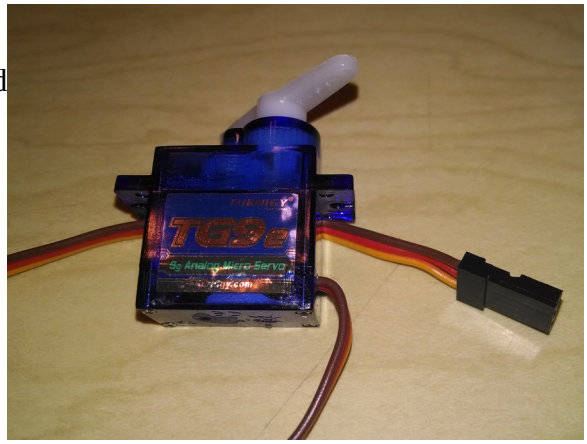
Overview
In this class, you'll use an Arduino, servos and 3D printed parts to construct a Robotic Alien Tentacle (RAT) controlled by two knobs..

This "tentacle" demonstrates the mechanism for many types of movie "practical props" like eye stalks, snakes, elephant trunks, animal tails, octopi (octopuses), or Cthulhu.

Also available for this class are the all the files needed to 3D print more tentacles, or modify them for larger or more complicated effects. Be sure to get the related files. The tentacles were designed using the opesource 3d design software FreeCAD which is available free for Linux and Windows.

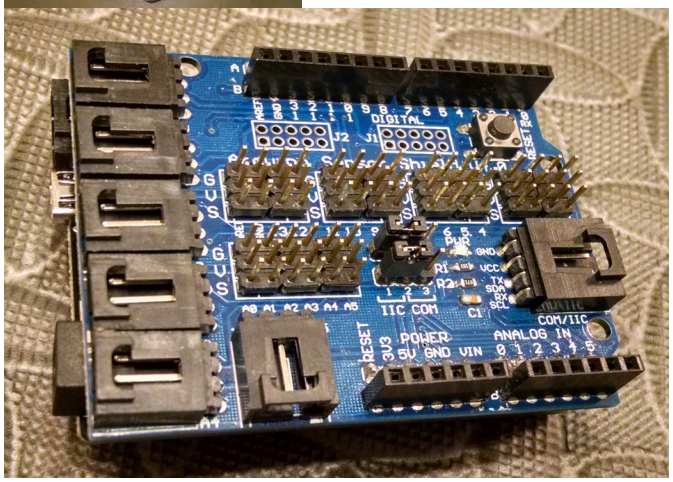
Vocabulary:

Servo – the servos we are using are small, electrical rotary devices, that can be commanded to rotate to a particular position. The servos we will be using are NOT capable of continuous rotation. (If you see the word “Continuous” on the servo you have the wrong one.) These servos originated in the remote control hobby market (think RC cars, airplanes etc.) They are typically rated on torque and speed and weight. The ones we are using a very inexpensive costing approximately $3.00 a piece in volume.



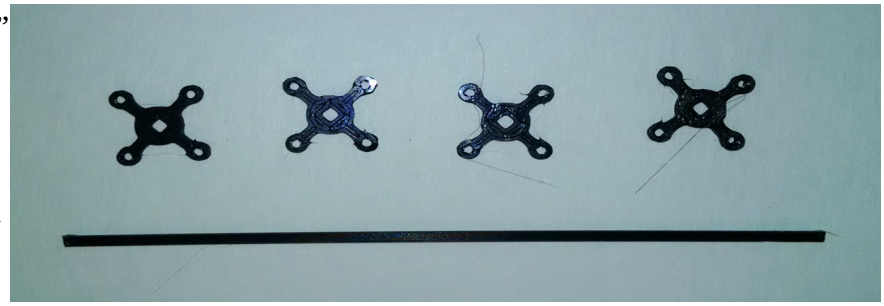
Servo Horn - The white plastic piece connected to the servo shaft. Servo horns come in various shapes, and multiple horns are shipped with the servos we are using. Some are somewhat 'pointy' (a 'horn' shape), while others are more symmetrical (a line) or have 4 points. Circular shapes are also common, but not included with all model servos. See some sample servo horns in the illustration.

Sensor Shield V4.0 – A sensor shield is used to make some of the connections easier. In particular the servo connections. **Take care when connecting it to the Arduino to check for proper pin alignment.** Use the pin labeled 0/RX on the sensor shield to line up the 0/RX pin on the Arduino board



1 DOF tentacle This is the 1 Degree of Freedom (1 DOF) tentacle. This tentacle does not require assembly (other than adding fishing line) and only requires one servo to operate. You can choose to make the 1 DOF Robotic Alien Tentacle or the 2 DOF Robitic Alien Tentacle in this class.

Stars and Spine (2 DOF tentacle) These are the "stars" and "spine" used to make the 2 Degree of Freedom (2DOF) Robotic Alien Tentacle. This tentacle requires assembly and uses two servos. You can choose to make the 1 DOF Robotic Alien Tentacle or the 2 DOF Robotic Alien Tentacle in this class.



Process:
This class is setup using a group of "recipes" that are combined. As you proceed through the different recipes, you generally do not have to "start over". The wiring connections do not have to be removed between sections but added together.

Combining the recipes *will require a little thought on your part*. When a single recipe is used twice (like the Servo Recipe we will use) a control wire will typically have to be connected to a different port and the software pin number adjusted appropriately. The Project Build Sheet will provide information on these changes.

These printed material, do not give you the answer as much as they teach you to find the answer so that you can design and build these projects and more on your own.

Robotic Alien Tentacle Project Build Sheet

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I'd recommend checking off each line on this page as the step is complete.
Additional information for some steps can be found in the Recipes referred to in brackets [ ] below.

1. Load blink onto your Arduino [Blink Recipe*]
    1. Change the delay value of the blink and reload the program to verify you can make changes

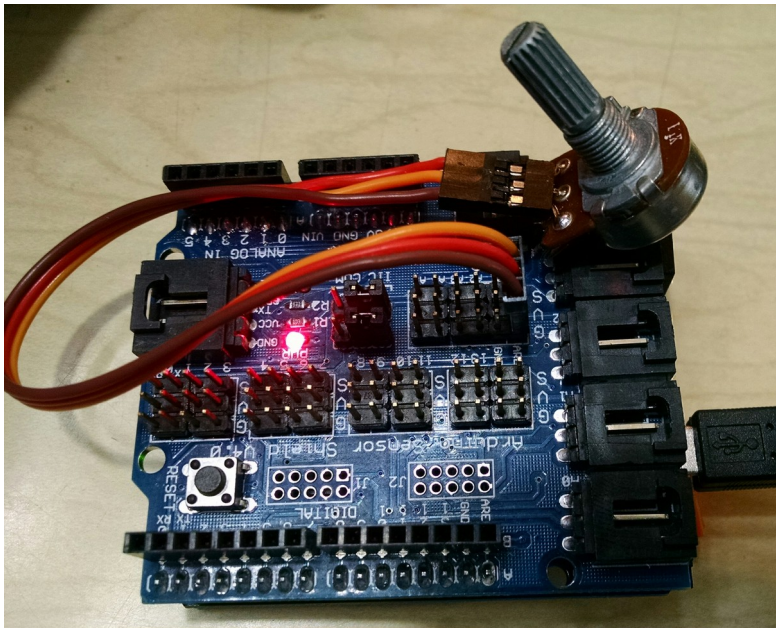
* Have a teaching assistant sign off on completion of this step here:_____

2. Print a line to the Serial port (and read it on the Serial Monitor). This will be used for monitoring later. [Serial Monitor page*]

3. Attach the Arduino Sensor Shield to the Arduino
    1. Disconnect the Arduino from power or USB and carefully align the sensor shield pins over the Arduino board and press into place.
        1. Be sure the boards line up. Use the pin labeled 0/RX on the sensor shield to line up the 0/RX pin on the Arduino board
        2. Reconnect the Arduino and verify that the Arduino board is still functional and that you can communicate with it. (I.e. blink still works)
        Note: that the sensor shield largely obscures the LED on the Arduino board used for the blink program tests.

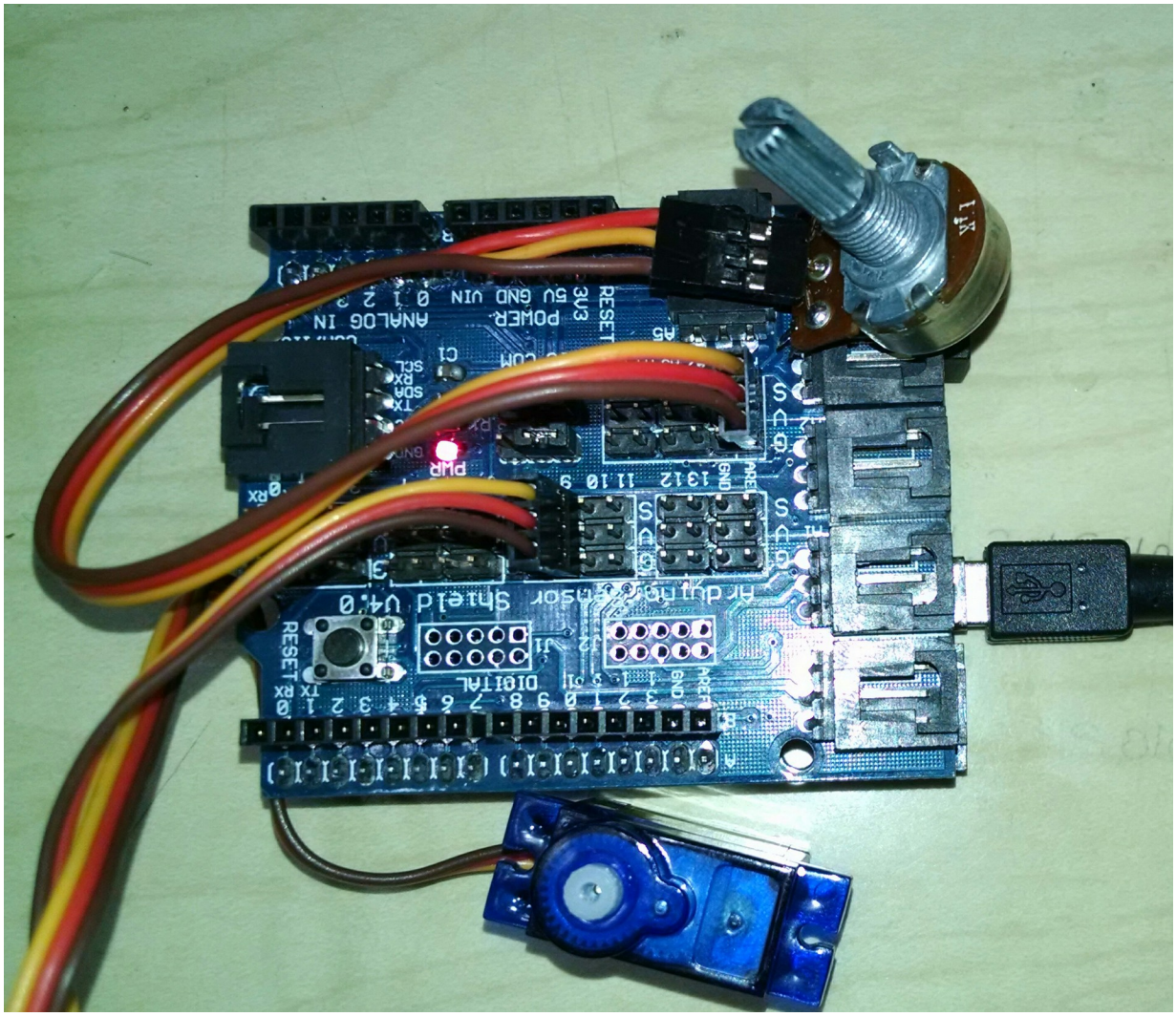
4. Wire a potentiometer (either one) [Potentiometer Recipe* use it for the code reference, it does not show using the sensor shield]
    1. Plug potentiometer lead into the sensor shield at position **A0**
    2. Make sure the connector is turned so that the brown wire is connected to **G** (ground) and the orange wire is connected to **S** (signal)
    3. Print the output of the pot to the laptop using the serial connection (view with Tools -Serial Monitor)

* Have a teaching assistant sign off on completion of this step here:_____



5. Connect a Servo to the Sensor Shield [Servo Recipe*] note: recipe doesn't show the use of the sensor shield
   On the sensor shield the pins are labeled G,V,S
   G is ground (negative)
   V is Voltage (+5v)
   S is "Sense" or a connection the the same numbered pin on the Arduino (ex. pins 0-13)
   1. Plug the Servo directly into the sensor shield in the pin 9 position
      1. Make sure the brown (or black) wire aligns with the “G” on the shield (see picture below)
      2. Look for the servo shaft to make a slight movement (“bump”) when power is applied
   2. Test control of the servo using a program

* Have a teaching assistant sign off on completion of this step here:_____



6. Use the Pot to control the servo positions by:[Potentiometer Control of a Servo's Position Recipe*]

1. Map the pot input from 0 to 1023 to the servo **outputs 30 to 150** using the map command

* Have a teaching assistant sign off on completion of this step here:_____

Decision Point

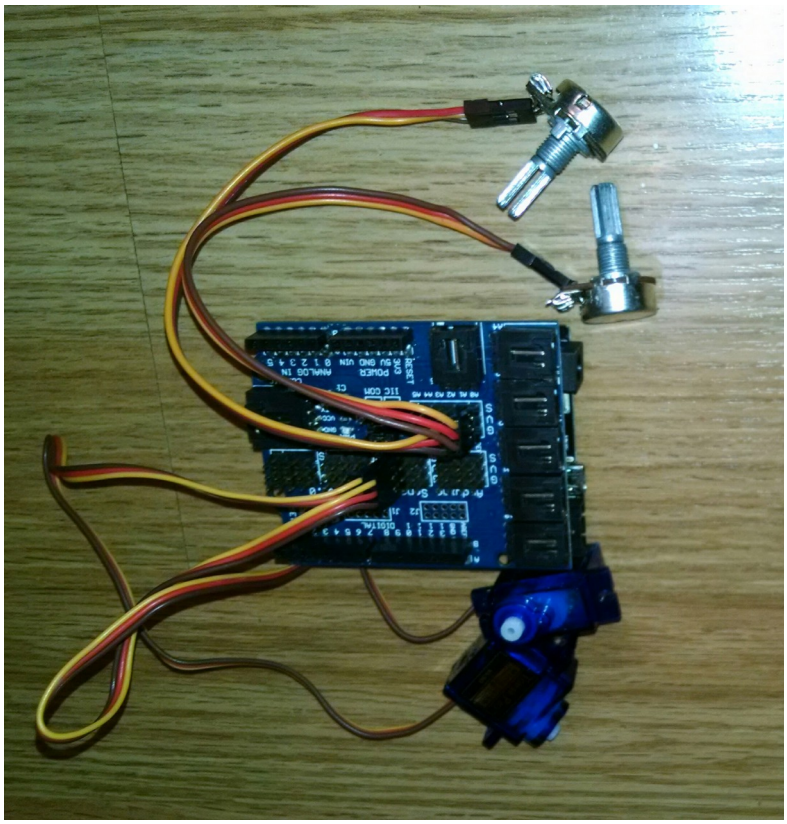
If at this point you feel like you are ahead of the game and would like to do the full 2 DOF Degree of Freedom Robotic Alien Tentacle, continue with the connection and setup of the second potentiometer and servo below.

If you would like to complete the 1 DOF Robotic Alien Tentacle instead (which is a shorter project), **stop here** and ask for instructions from a Teaching Assistant. The !DOF tentacle only requires 1 pot, 1 servo and a single thread. There are pictures for its construction at the end of this document. After completing its construction skip the steps related to the additions of a second servo and pot, and continue with Building the Foamcore Base operation.

7. Wire a second potentiometer [Potentiometer Recipe*]
    1. Connect the power and ground to the second pot.
    2. Connect the output of the pot (center pin) to the analog input **pin A1** on the Arduino
    3. You will need to define a second variable for it.
        int sensorValue1;
    4. Duplicate the analog read statement with the correct value for the second input
        1. sensorValue1 = analogRead(A1); // Read Pot value
    5. Verify that you can read the Pot setting by adding additional print statements (you may need to add a small delay to read the output)
        1. Serial.print ("Pot 1 value=");
        2. Serial.println(sensorValue1); // Print the Pot value to the serial port
    6. You may want to re-position the pots on your protoboard if necessary for ease of access to both.
    7. **Optional step**:print the outputs only if the change from pot input is > 2 /*/

* Have a teaching assistant sign off on completion of this step here:_____

8. Wire a second servo [Servo Recipe*]
    1. Look for a “bump” when the power is connected
    2. Connect the servo input wire (in our case the “orange wire”) to the Sensor Shield **pin 8**
        1. Make sure the brown (or black) wire aligns with the “G” on the shield
        2. Look for the servo shaft to make a slight movement (“bump”) when power is applied
    3. Test control of the servo using a program
        1. Create another servo object
            Servo servo1;
        2. Attach the new object to **pin 8**
            servo1.attach(8);



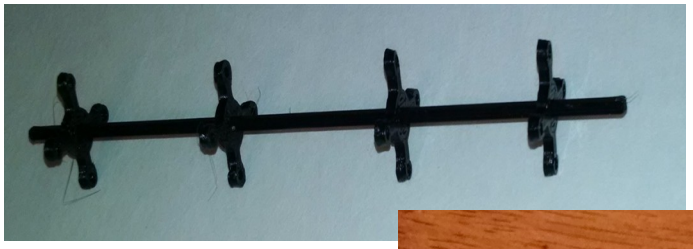
9. Program second servo with scaled pot input
    1. Create a variable to store the second servo's position
        1. *int servo1Setting=90;*
    2. Map the second input pot reading to a position for the second servo
    3. *servo1Setting=map(sensorValue1,0,1023,30,150);*
    4. print the value for testing (you may need to insert a delay)
        Serial.print ("Servo 1 setting");
        Serial.println (servo1Setting);
    5. Then set the position of the second servo
        servo1.write(servo1Setting);
10. Test that the pot movements move the servos

* Have a teaching assistant sign off on completion of this step here:_____

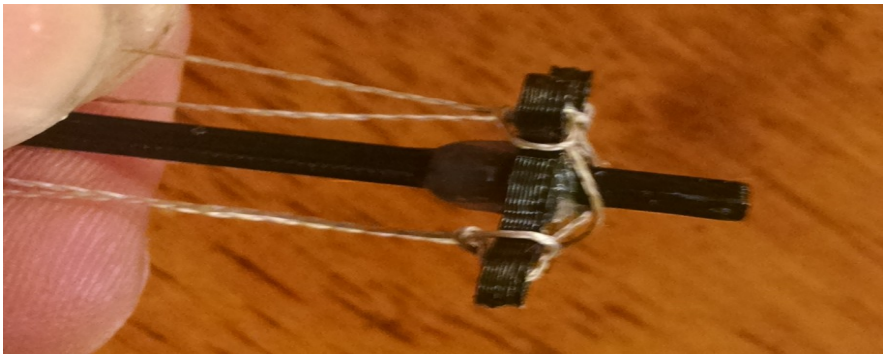
Fail

If the servo can rotate more than 360 degrees (a full circle), you have chose the wrong servo (a “continuous rotation” servo.) Choose a different servo
Try adding an external battery pack
May need a potentiometer 'deadband' (advanced topic)
Check off every step in the list before here :)

11. Build Tentacle
    1. placing “stars” on spine
        1. place 4 stars on the spine
        2. leave about a centimeter on either end.
        3. evenly space middle two
        4. hot glue on both sides

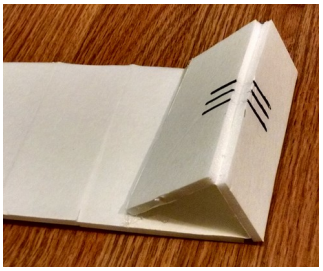


    2. Threading Stars
    Use single male pin header to clean out small holes in stars if necessary to allow the thread to pass through
        1. Place a single thread across the top down opposite sides
        2. Place thread through the holes
        3. even out thread lengths on both sides
        4. loop thread at top over both spikes of the star to prevent slipping (glue not necessary)



5. place a second thread across the top and down the opposite sides
6. even out thread lengths
7. loop thread at top over both spikes of the star to prevent slipping(glue not necessary)
8. note: string is supposed to slide through the holes in the remaining stars. Do **NOT** glue the string on the other stars.

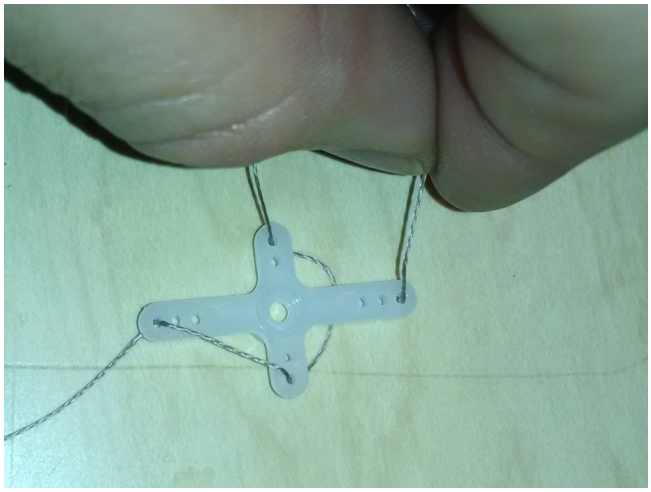
3. Build Foamcore Base



   1. score foam core at 2 inches and 3.5 inches from one end to allow bending. (Do not cut all the way through the foam board) [Check foam core board first before cutting; it may already have score marks]
   2. This will allow folding into a triangle shape where the first section of the triangle is 2 inches long and the second section 1.5 inches long. See illustration.
   3. Fold into a triangle shape and hot glue along the bottom making **front face tilt back slightly** to give your Robotic Alien Tentacle room to move downward.
   4. Use use tentacle as a guide for location to mark and cut 3 slots in foam core approximately 1 inch long. Only three slots are needed because the Robotic Alien Tentacle will be rotated such that two strings use the center slot.

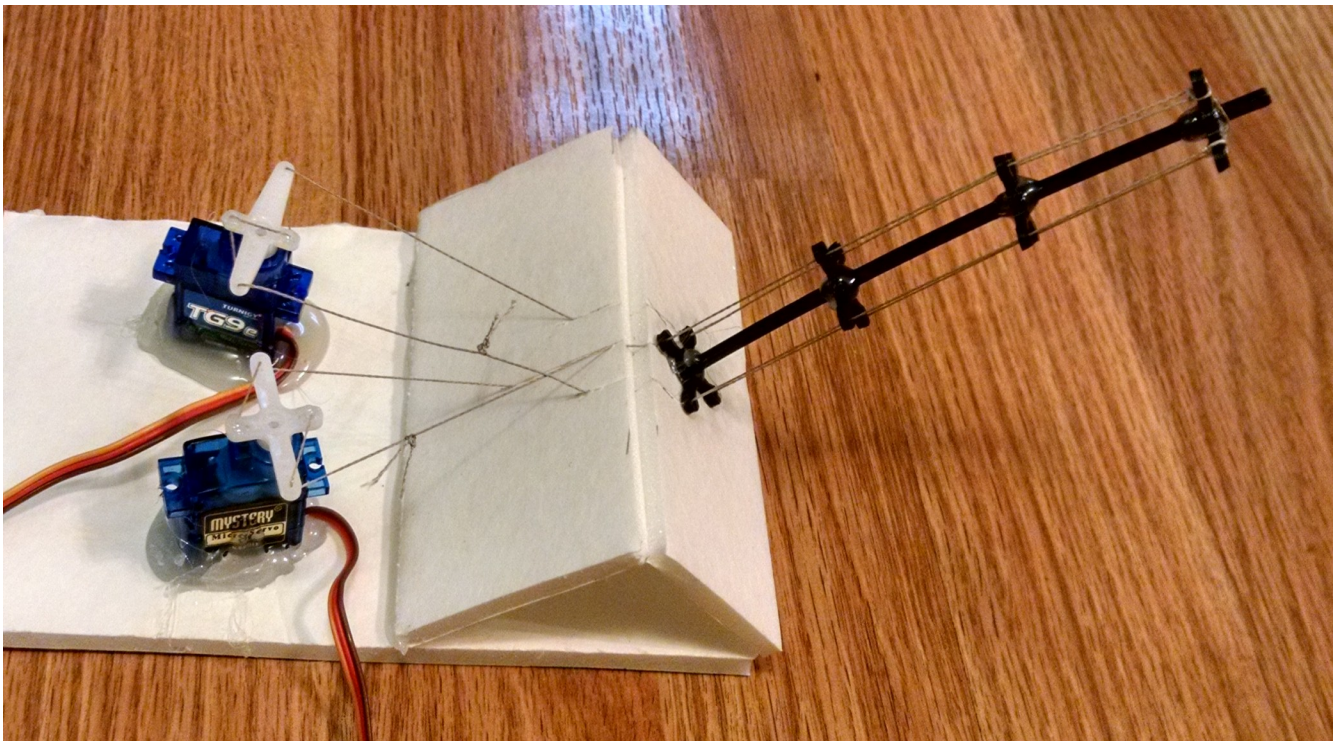
4. Install the Completed Tentacle
   1. slide 3 lower strings into slots cut in foam core
   2. test - pull individual strings gently and look for movement in the tentacle.
   3. place a **small** amount of hot glue at the base,
   4. push the tentacle in place being careful **not** to get glue on the strings
   5. place 4th string in place

5. Servos



   1. Center Servos with pots before beginning
   2. thread an opposite pair of strings onto servo horn using 4 holes as shown in picture so that it is adjustable. (Beginning with the hole furtherst from the center) Tie ends together multiple times so the knot doesn't slip, keeping the servo horn close to the tentacle mount.
   3. Adjust so that thread lengths are even on both sides.

4. put small hot glue dots on servo horn strings (on short sides)
5. glue down servo with extra hot glue up the back side, **while pulling strings taught**.
6. hold servo in place while glue cools. (*this takes longer than expected*).
7. Use smallest screw to hold servo horns in place on servo.



Fail
Be sure to use "regular" servos, not the "continuous rotation" ones.
Make sure the shield pins are aligned correctly and inserted into the Arduino
If you are having trouble threading the holes, try cleaning them with a pin on a jumper wire and cut a few centimeters off the end of the thread to remove any unraveled sections.
If strings remain too loose it may be possible to tighten them using a toothpick, ask how.
Connect external battery pack (add capacitors)

At this point the class is complete:

Hope you enjoyed this class. Please tell your friends about Let's Code Blacksburg. Also if you have comments or class suggestions or future class topics or if you would like to teach a class- contact Let's Code Blacksburg, we'd love to hear from you!

If you think of any addition items for improvement to the class materials for this class after you leave please send them along to Monta.LCB@geekslunch.com , I depend on your comments to make these classes better. “Success lies on the FAR side of failure”.

Advanced Topics

If you finish early and would like to explore further consider the following (on your own):

1. Programming the Arduino to move tentacle without user input
2. Programming the Arduino to move the tentacle based on commands typed into the serial terminal

Let me know the if you complete an advanced project.

Thanks!

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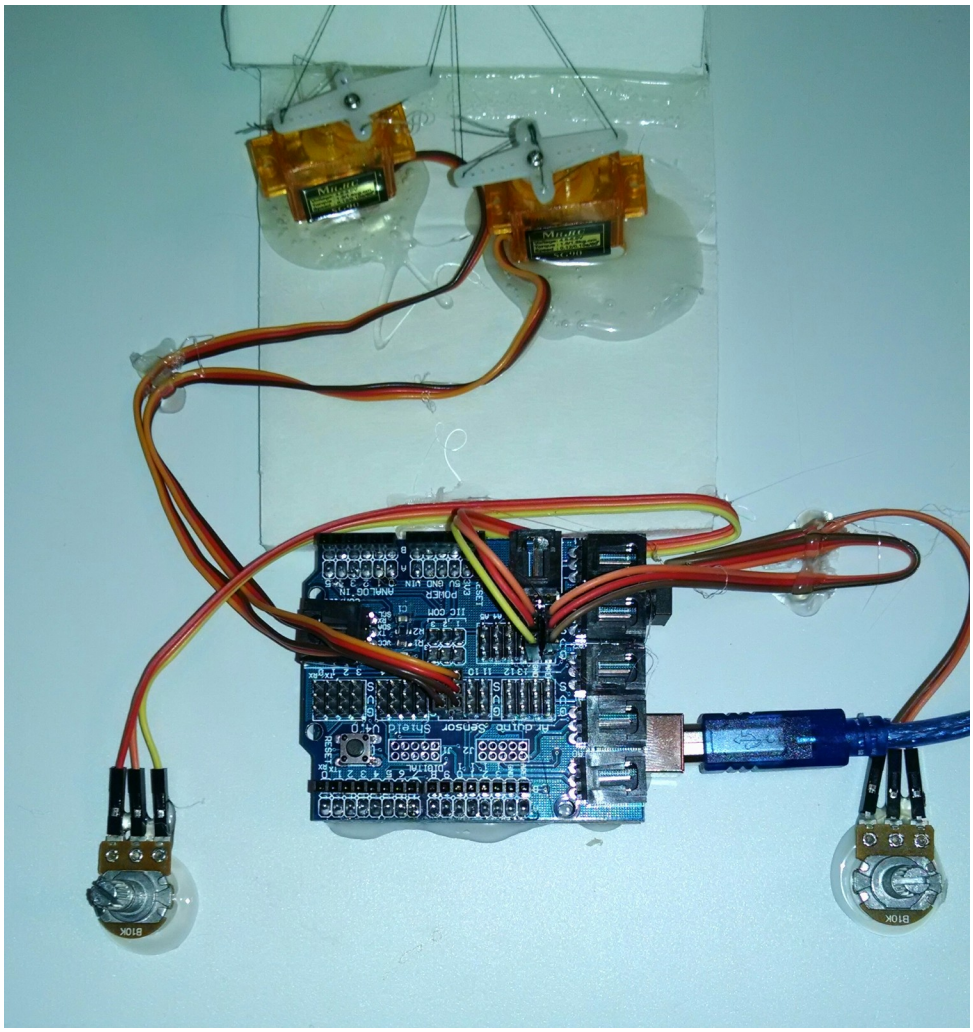
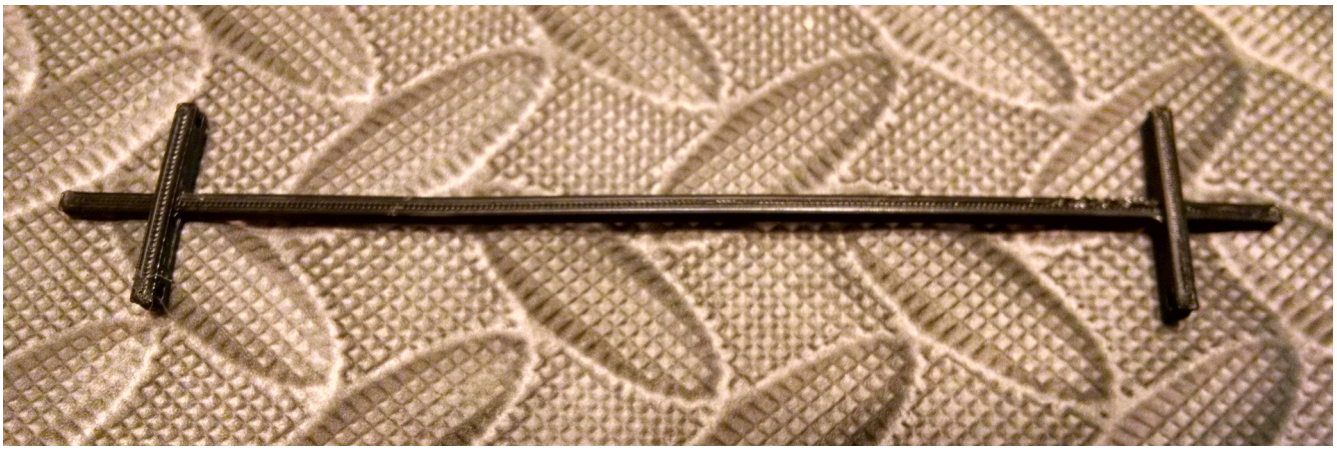
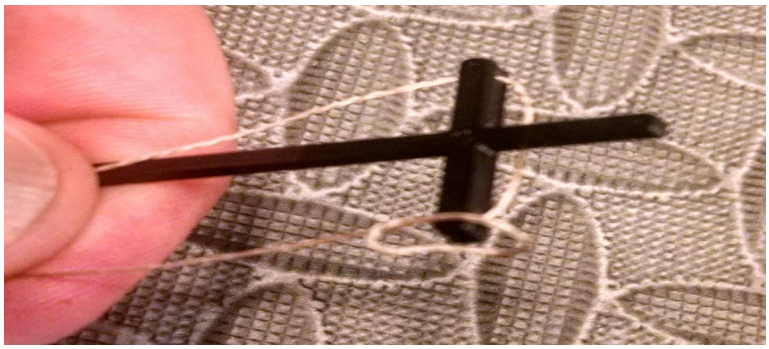


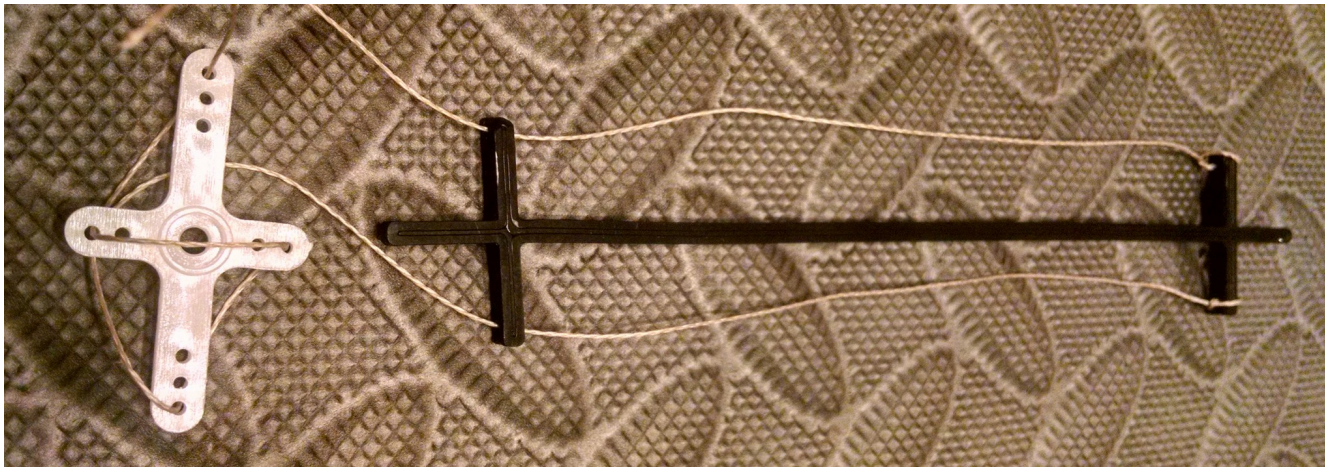
1 DOF (Degree of Freedom) Robotic Alien Tentacle

The 1 DOF version only requires one working pot and servo.
Follow the recipe to get 1 working pot and servo as above; then thread the 1 DOF tentacle as below.





The 1DOF tentacle only requires a singe thread.



After completing the 1DOF tentacle, return to the instructions for building the foamcore base.