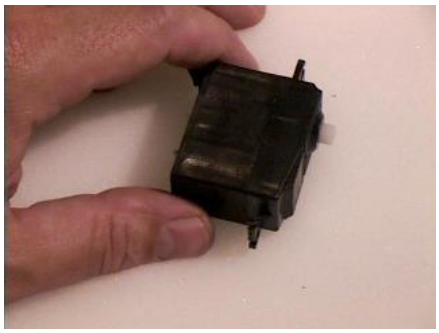
http://hauntspace.com/forum/posts/id_2939/title_animatronics-tutorial-part-1-servos/

Posted by: SoulEcho

Animatronics Tutorial

Part 1: The Servo



If you ever played with a radio/remote controlled car as a kid…you have used a SERVO before. They are often used in children's toys to control functions like steering. They are also used a lot by adults who enjoy building radio controlled cars, planes and helicopters.

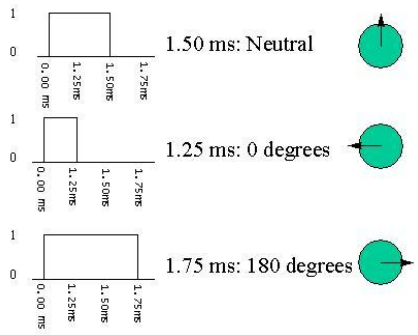
A SERVO is just a special kind of DC(direct current) motor. The difference between a SERVO and a standard motor is that a SERVO does not continually spin around freely. Instead, it uses a control signal to determine how far to spin. Another difference is that a SERVO cannot spin in a complete circle. Generally, a SERVO only has about 180-degrees on range.

Inside of a SERVO is a motor, gear set and shaft position sensoring and control circuit…all in a nice small little package. The gear set allows the SERVO to produce a large amount of torque compared to its size. Torque is the measurement of how much weight a machine can move. When purchasing SERVOs you will usually find a specification listed on it as "Stall Torque". This is the maximum amount of force the SERVO can apply before it stops.

Connecting the SERVO to a controller is fairly straight-forward. SERVOs have a 3-wire connector. One RED wire(for power), one BLACK wire(for ground) and a WHITE or YELLOW wire(for control). The first two wires are pretty self explanatory, but I feel it necessary to explain the control wire a little further.

SERVOs are controlled by Pulse Code Modulation(PCM). Okay, don't freak out…you don't REALLY need to memorize that. What PCM boils down to is a series of electrical pulses that are sent to the SERVO's motor. The longer the

pulse is sent, the further the SERVO will turn. Pretty simple huh? Well, yes and no. You could TECHNICALLY do this by hand…but the SERVO measures the pulse in milliseconds. I'm not sure you could press and release a button that fast. To put it into perspective…to make a SERVO turn a complete 180 degrees, you need to send a pulse for about 1.75 milliseconds or .00175 seconds. Good luck.



When all is said and done…the benefit to using a SERVO over some other form of motor is that you have greater control and a lot of power in a very small and light package.

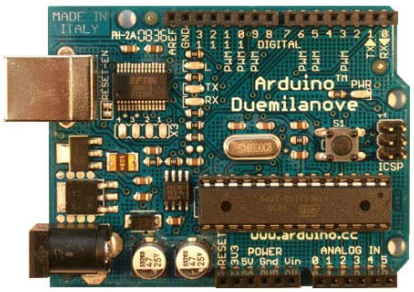
Part 2: The Arduino Board

I was actually planning on waiting a day or two before writing this one, but the weather is a little crappy outside and I am not a big fan of television...SO...I figured I would go ahead and right this now.

The Arduino Duemilanova is microcontroller board used primarily in robotics and small-scale animatronics. There are many different microcontroller boards on the market and they are all pretty good as far as I can tell. They are all just built for different purposes.

Okay...let me back up for a minute because I am sure there are a bunch of you screaming something at the monitor to the effect "WHAT IS A MICROCONTROLLER?!?!?!?!?!?!"

Well...a microcontroller is a circuit board that is capable of being programmed to perform specific tasks...in our case...controlling some servo motors and LEDs. It does this by using a small "computer chip" called a PIC (programmable interface controller). There are plans all over the internet on how to build one of these on your own. If you are the sort of person that likes to build everything from scratch and are good with a soldering iron...this may be something you would like to try. I, however, opted to just buy one. I had heard a lot of great things about this board (Arduino Duemilanove) and ordered one from www.robotshop.us for $30.



Let's look at what is on this board...

POWER

In the top left, that big square gold colored thing is actually the USB port. The USB is used to program the Arduino board and can also be used to power it.

Another option for power is the 2.1mm Center-Positive power jack on the bottom left (black rectangular piece). This is where you can plug a wallwart into the board for power. The Arduino board can use anywhere between 7 and 12 Volts. Going over or under these numbers can cause damage to the board.

The last option for supplying power to the board is through the power pins. In the picture above, there are two sets of pins along the bottom edge. The ones to the left are all for different power options. To SUPPLY power to the board, you could use a battery pack or a wallwart with the plug remove. The positive wire would get inserted into the Vin pin and the ground wire would plug into the GND pin right next to it.

To clarify...on a battery pack...the RED wire is positive and the BLACK wire is ground. On a wallwart...it is a little harder to tell. Normally the positive wire will have a stripe of some color running down it...but it may be necessary for you to take the wallwart apart to figure this out.

Also among these pins are two voltage output pins. One 3.3-volt(3V3) output and one 5-volt(5V) output. These two pins will be used to power the different components that you will attach to the board.

ANALOG INPUT PINS

There are 6 analog input pins on this Arduino board labeled 0-5. This is where you would connect any item that you plan on using to control you servos, motors or LEDs.

What could that be? You might ask. Well, one look at the SENSOR section on the robotshop site and your question will be answered...but that's not all of it. Yes, there are all sorts of sensors that you can use...from pressure sensors, heat sensors, range finders

and flex sensors...but you can also use ordinary buttons, switches and potentiometers. If you are wondering what a "potentiometer" is...just think DIMMER SWITCH. It changes how much power is passed through it.

Here is a video from The Makershed that shows you how to control a servo with a potentiometer...

Pretty simple huh? Okay...okay...All you "non-techie" people out there are going..."I HAVE TO WRITE A COMPUTER PROGRAM FOR THAT!?!?". Unfortunately...yes. Again, think of the Arduino as a REALLY small computer. It won't do anything until you tell it how to. But, have no fear...I will break that all down and give you the power to write a simple program before this is all over with. But that will be the last thing I cover...since it is the last thing you need to worry about. So just relax and keep reading.

Almost everything that you will use on this board will require 3 wires with the exception of LEDs or small DC motors. The three wires that will be used will be a power, ground and control wire. The control wire is just a way for things to communicate back and forth with the board.

DIGITAL OUTPUT PINS

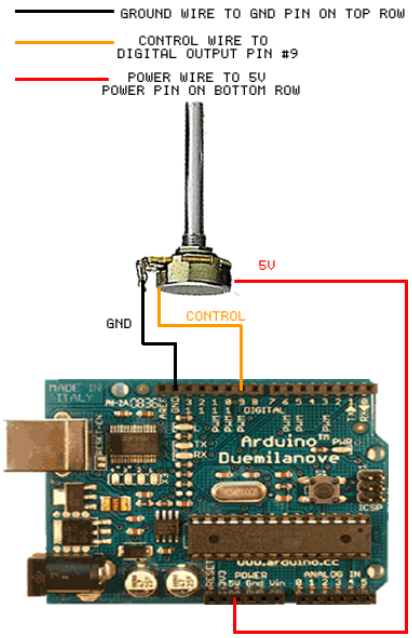
The entire top edge of the board is full of pins and fourteen of those are digital outputs pins(0-13). Some of these can also serve other purposes, but that is not necessary with what I will be making...so, I am not going to cover that here. If you are interested in learning more about this board, check out the Arduino website at:
http://arduino.cc/en/Main/ArduinoBoardDuemilanove

It will tell you about EVERYTHING on the board.

As I am sure you have guessed...the output pins are where you will connect the things that you want to control, whether that is LEDs, SERVOS, motors or anything else. The True and False of this statement is that "TRUE"...the control wire for such items will be connected to these pins, but the power and ground wires will be connected elsewhere on the board, such as the 5v pin or any of the three ground pins.

If you remember the video above...the potentiometer had three pins on it...one for power, one for ground, and one for control. The power pin on the potentiometer would be wired to the 5V pin on the bottom of the board, the ground pin would go to any of the three ground pins and the control pin could get wired to any of the digital output pins (0-13).

Let's see a picture of that...



See...it really isn't that difficult and any servo, motor or LED you buy will tell you what pins go to what. The picture above is wrong though...as I put a potentiometer into the digital output pins...just imagine it is a small motor or something...LOL. I think you get the idea though. If not, please feel free to ask as many questions as you want.

The only other things I will touch on with this board are the RESET button that is just above the big black rectangular thing on the right side and the big black rectangular thins itself. That is actually the brains of this entire thing...the programmable interface controller or PIC. That is the tiny little chip that will store your programs and take the input from whatever you use and turn it into a useable signal to control whatever you want it to.

I am sure this was all very confusing...but again...this isn't really anything you need to memorize. These Arduino boards are everywhere and are used quite frequently for different things...which means there is a wealth of resources on the internet to help you out.

Arduino also offers support and pre-made programs that you can use.
http://arduino.cc/en/Tutorial/HomePage

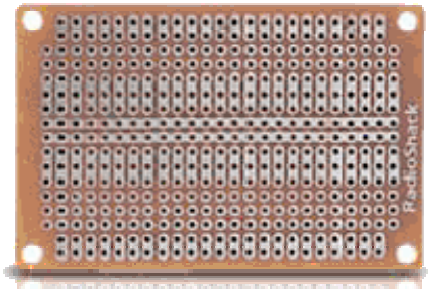
Another create place to check out is the MakerShed, brought to you by MAKE magazine.
http://www.makershed.com/

Part 3: The Interim Board

Animatronics Tutorial -

What I am referring to when I say "interim board"...is just the little bread board that I used to make it easier to wire everything to the Arduino board. This is MY method. I needed some soldering practice, so I opted for that method...but, they do make solderless breadboards if you prefer not to solder.

Here is what I used:



(1) Multipurpose PC board with 417 holes. Purchased from Radio Shack for $1.99 (276-150)

(1) package 75ft UL-Recognized Hookup Wire. Purchased from Radio Shack for $7.99. (278-1222)

This is used to make jumpers between the interim board and the Arduino board. They will also be used later to send power to the LEDs that will be in the heads.

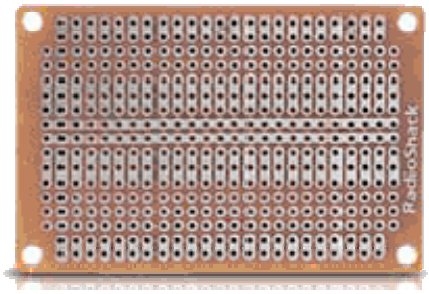
(1) package SFE Breakaway Headers. Purchased from RobotShop.com for $2.50.

These are used to connect the servo motors to the board.

Alright...well, the only thing left is a soldering iron and solder. I'll tell you right now...my soldering skills are less than stellar...and I was able to get this together.

First off...grab the SFE Headers and start breaking them off in sets of three. They break apart pretty easy, but is easier with a couple of pairs on pliers. Why sets of three? Well...if you remember...the SERVOS have three wires to make them run...BUT, the connector that comes on them makes it impossible to connect to the Arduino board without cutting off the connector.

THAT's where these headers come into play. We will put these on the interim board so that we can simply plug the servos into these.



Alright...so you have your headers broken off into groups of three. Let's take a look at that board again.

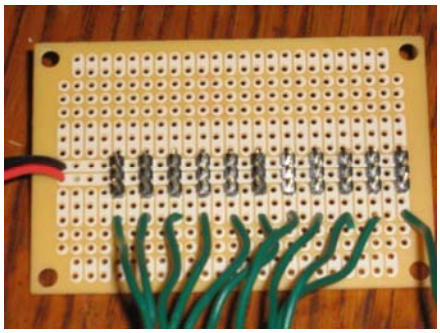
Right in the middle of this board, running horizontally, you will see two long stripes of conductive material (the silver stuff). This is what makes this particular board so nice for projects like this.

In its finished state, my prop will require (5) separate servos, that will each need to be connected to the same power supply and ground. These two strips make that incredibly easy.

This is a pic of the finished board...but, I will be able to walk you through the entire process from this picture.

Take you HEADERS and insert them into the board so that the first two pins are in holes in the two long strips that we discussed earlier. One of these strips will be used for the GROUND and the other will be used for POWER.

In the picture, you can see that I skipped a set of holes in between each HEADER. I did this to compensate for my poor soldering skills...LOL It doesn't really matter which way you set it up...as long as they are all in line and two of the HEADER'S pins are in the long horizontal strips.



If you take a good look at the board, you could divide it in half long ways and both halves would be identical.

Now...you really only need enough HEADERS to connect however many SERVOS you plan on using...but, I figured if I went ahead and put some extras on there...I could use this board for other projects in the future.

This is the point at which you need to start soldering these to the board. You can also adjust the pins prior to soldering so that you make sure you have enough on both sides of the board. I usually just have enough pin sticking out on the "solder side"...so that the solder will hold it in place.

Alright...time for the wires. The connectors on the servos are wired in this order: GROUND - POWER - CONTROL. Working off the picture above...the TOP pin will be our GROUND, the CENTER pin will be POWER and the BOTTOM pin will be our CONTROL.

TOP = GROUND
CENTER = POWER
BOTTOM = CONTROL

Time to crab your hookup wire and cut it this way:

BLACK - (1) piece, 6" long
RED - (1) piece, 6" long
GREEN - enough 6" long pieces so that you have one for each HEADER.

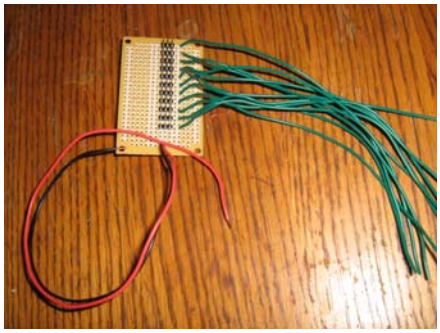
Remove (strip) about 1/4" of insulation off both ends of each wire.

Again, working from the picture above. Insert the BLACK wire through the last hole to the left in the TOP "long" strip. Solder in place.

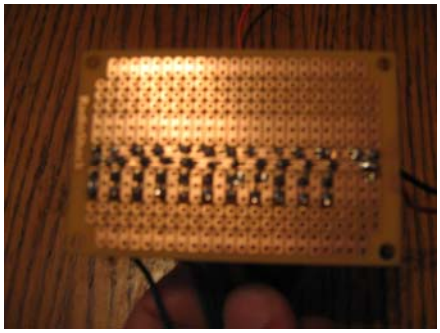
Insert the RED wire into the last hole to the left in the BOTTOM "long" strip. Solder in place.

The way in which we installed the HEADERS onto the board, places the bottom pin of each header into a hole that is connected to two more directly below it.

For each HEADER tha you used....insert one GREEN wire into the bottom hole in this group (See photo above) and solder into place.



When everything is done...you should have something that looks a little like this....



And...just to show you how bad my soldering skills really are...