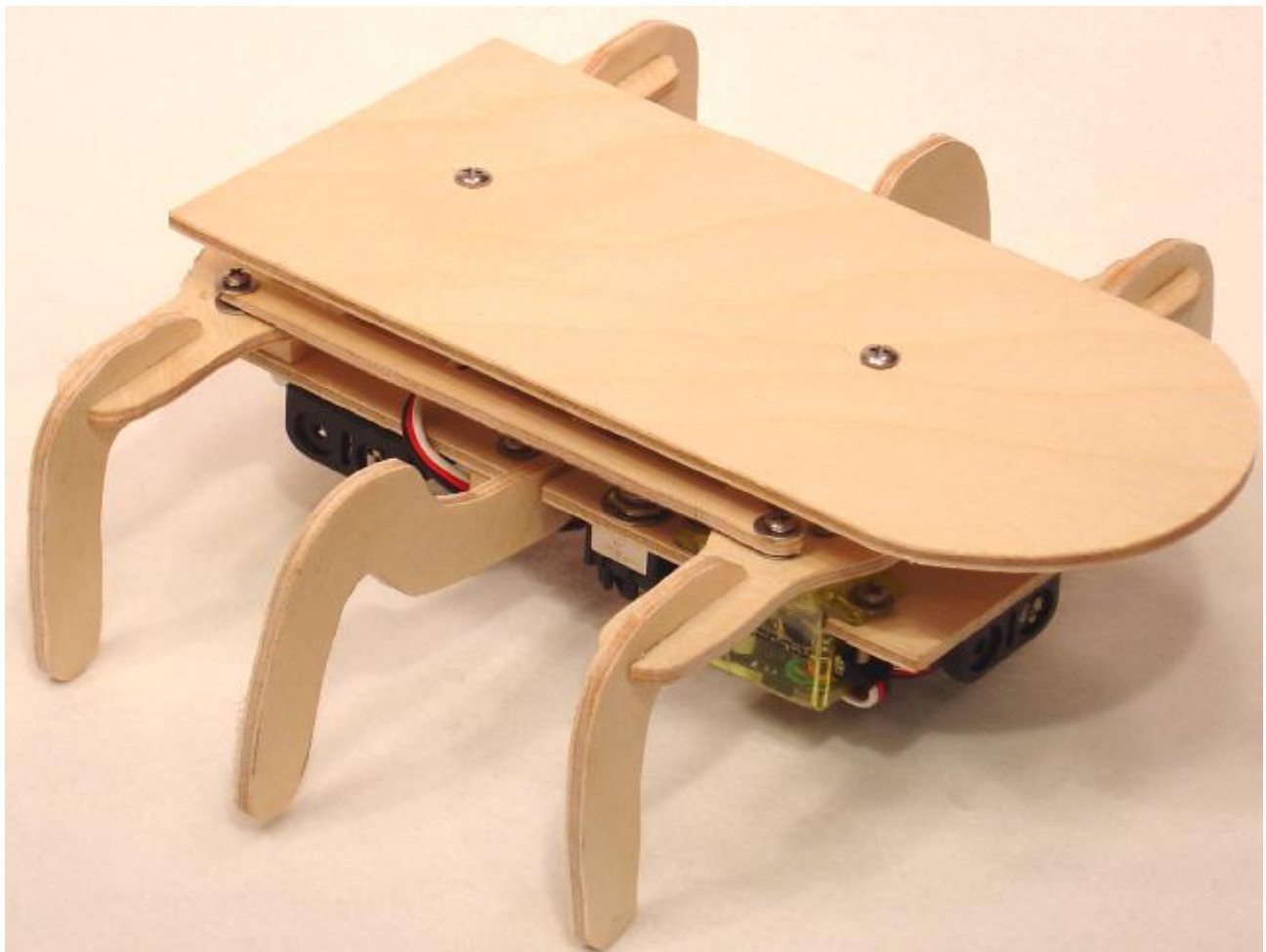


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Build a Mini Servo Walker  
as seen in  
March 2005 of SERVO Magazine

Pick up an issue at  
<http://www.servomagazine.com>



Have you ever wanted to build a hex walker robot? In this project I will show you step by step how to build a six-legged crawler using only 3 servos. With six legs and 3 servos we can experiment with different gates and full directional control over the robot.

This project will be presented in three parts:

Part 1: Walker Mechanical Construction

Part 2: Walker Electrical Construction

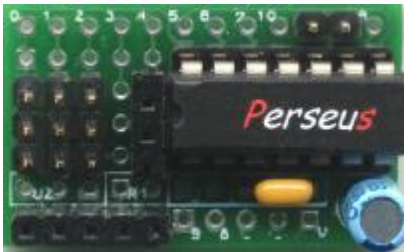
Part 3: Calibration, Programming and Control

## The Components

Let's take a look at some of the components needed to build this small walker.



The heart of the crawler is the super small 9 gram dragonfly servo. The small size of the servo lets us build an extremely small and lightweight robot. These small servos are very reasonably priced at less than \$9 each.



To control the small servos we will use the even smaller Perseus microcontroller. I chose this microcontroller because it has a very small 1.25" x .75" carrier board that can sport up to 5 servo connectors. Its through-hole design makes it very well suited to the beginner. The Perseus chip, carrier and RS232 Driver board can all be purchased for less than most other microcontrollers alone.

The Perseus microcontroller is one of several Athena-class microcontrollers that were designed to make the jump into microcontrollers as easy and inexpensive as possible. The compiler software for these microcontrollers is free and can be downloaded from the Kronos Robotics web site at [www.kronosrobotics.com](http://www.kronosrobotics.com). The software has a difficulty setting that can be set from beginner to expert and has a simulator so you can run through the included tutorial without purchasing a single item.



We will build the base and legs for the crawler out of 1/8" Baltic Birch plywood. You can pick up a 12" x 24" piece at your local craft store for less than \$5. That will be enough for four or five robots this size. You will also need some 3/8" x 3/8" pine stock as well. You can pick this up at your local craft store for less than \$2.



Probably the most difficult parts to get will be the hardware. Most of these will be #2 machine screws and various washers and nuts. Kronos Robotics is offering a package that contains all the hardware.

## The Tools

For the mechanical construction you will need something to cut out all the wooden parts. I recommend a scroll saw. I did a complete write up on the scroll saw in the February 2005 issue of Servo Magazine. The cuts are not critical so there are only a couple places where real accuracy is needed when cutting out the parts. A hand coping or fret saw and knife could also be used but will take you much longer to complete the project. You can also use a fret saw and a small jig saw may work as well. A bandsaw will work for all but the inside servo mounts.

You will need a drill with 1/16", 3/32", 1/8" and 5/16" bits. I used a drill press but a hand drill should work just as well.

A soldering iron (and solder) will also be needed to connect the 2 battery holders and to build the Perseus carrier board in Part 2. I also recommend a bit of heat shrink as well.

You will need a couple of hand tools such as a small Philips screw driver and a pair of needle nose pliers. These will be used to tighten the small lock nuts as they can't be done by hand.

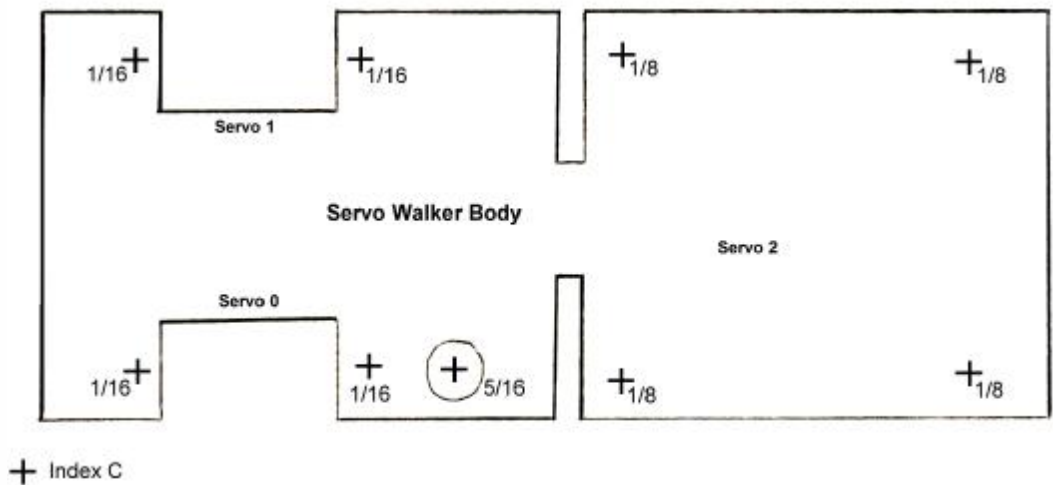
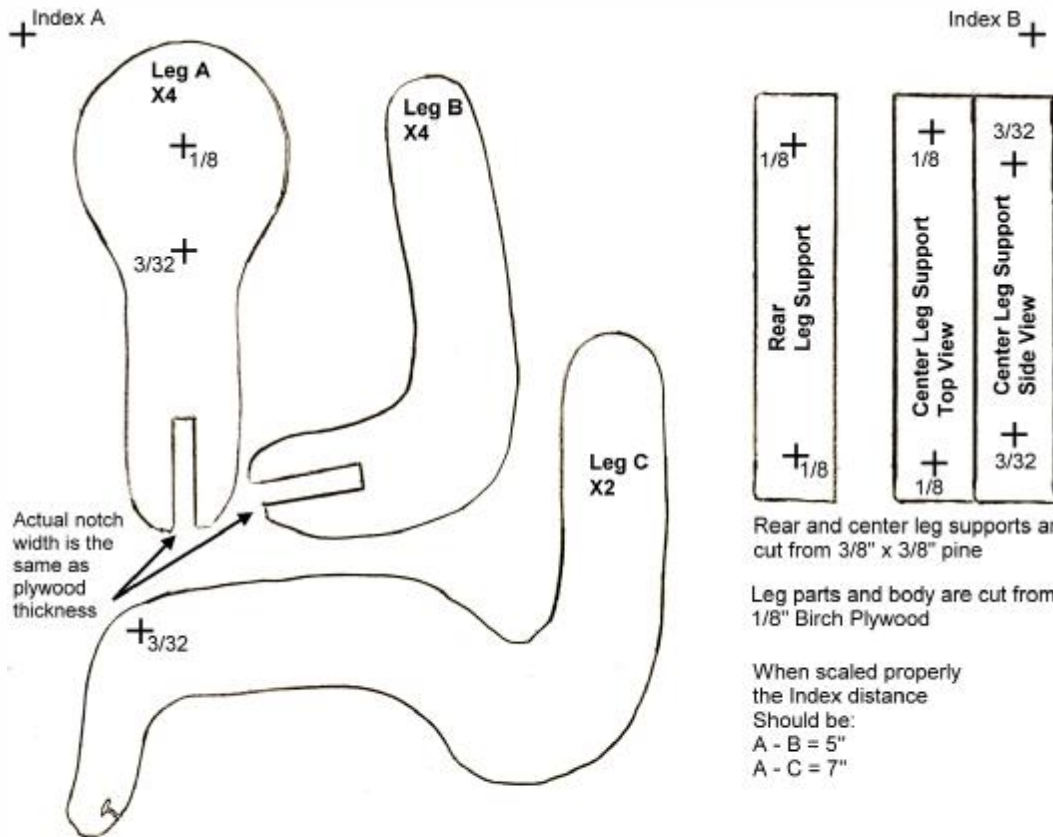
In Part 3 we will start the programming of the walker. For this you will need an EZ232 driver from Kronos Robotics (Less than \$10) and a copy of the compiler software (free from the Kronos robotics web site) A PC running Windows and 9-pin serial cable will also be needed.

## The Plans

I have included a full size set of plans for all the cutout parts. There are index marks on the plans so as long as your reproduction is set to the proper size you will be ok.

When enlarged or reduced the distance between Index A and Index B should be 5". The distance between Index A and Index C should be 7"

The Kronos Robotics hardware kit will also include a printed sheet (at the correct size) of the plans.



Plans

## Mechanical Construction

Now the fun part. Let's start building the walker. Before we start let me say a few things about this design. I designed this crawler with two things in mind:

### Repeatability:

I wanted a walker that could be built consistently; that could be built by 20 different people but still behave the same.

### Construction Forgiveness:

I wanted a walker that could still function even if errors in construction were made.

### Cost:

I wanted a walker that could be built completely for under \$70. Even less if you have some of the parts in your junk box.

The mini servo walker design is very forgiving, as most of the cuts are not critical. In fact, variations in the pieces will give your walker a bit of character. For instance rounding the corners on the walker base will make the walker a bit more bug like.

Hole placement should be as close as possible but as long as you are within 1/32 you should be fine.

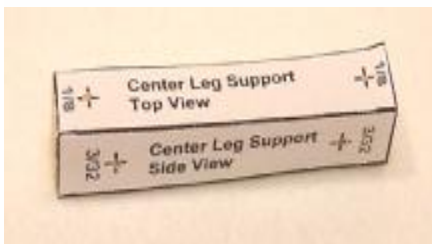
Ok let's start



### Step 1

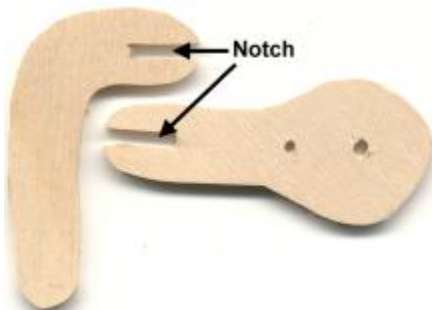
Cut out all the parts in the plan. Note that some parts require more than 1 cutout. For example you will need 4 Leg A parts and 4 Leg B parts. You will need 2 Leg C parts.

The Rear and Center Leg Supports are both a 3/8" x 3/8" x 2" piece of stock. They can be cut from pine, basswood or maple, all of which were available at your local craft store.



Place the template for the Rear Leg Support on the stock and mark the 2 holes.

For the Center Leg Support, bend the template in half where the top view and bottom view come together and place on the stock as shown.



The most critical cut of all the parts is the thickness of the notch shown. The actual thickness of the notch should match the thickness of the plywood stock you are using. It can be a bit smaller but not larger, so I recommend you cut it a bit small, you can increase the width as needed.



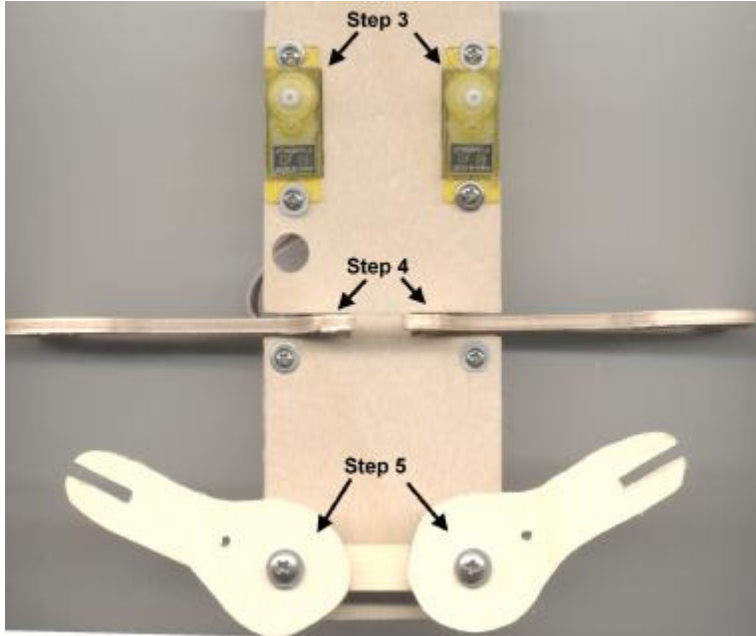
Make sure you place a small notch in the center legs as shown. This notch will be used later to hold the end of a small rubber band.



Step 2

Attach the 2 center legs to the Center Leg Support as shown in Figure 8, use two  $\frac{3}{4}$ " #2 machine screws. Install in the following order: #2 machine screw, #2 washer, Leg C, #2 washer, Center Leg Support, #2 washer, #2 lock nut. Make sure you install into the two  $\frac{3}{32}$  holes.

Tighten so that the legs are seated firm against the support but still move freely.



Step 3

Install the two servos into the servo slots shown.. The  $\frac{1}{16}$ " holes in the base will act as our nuts and hold the machine screws nicely. Use  $\frac{3}{8}$ " #2 machine screws and #2 washer on each hole. You will have to push the screw firmly to get it started. Don't over tighten or you will strip the wood. You can also attach a #2 hex nut as well.

Step 4

Take the Center Leg assembly and attach it to the base as shown..

You will use 2,  $\frac{3}{4}$ " #2 machine screws. Attach in the following order. #2 machine screw, #2 washer, base, #2 washer, #2 hex nut.

The  $\frac{1}{8}$ " holes are over sized so that you can position the support as needed. Make sure the legs move freely and don't rub against the base. Tighten the nuts.

Step 5

Install the Rear Leg Support and Legs as shown.. Use 2, 1" #4 machine screws in the following order. #4 machine screw, #4 washer, Leg Part A, #4 washer, Rear



Leg Support, base, #4 washer, #4 lock nut.

Tighten so that the legs are firm but rotate freely.



### Step 6

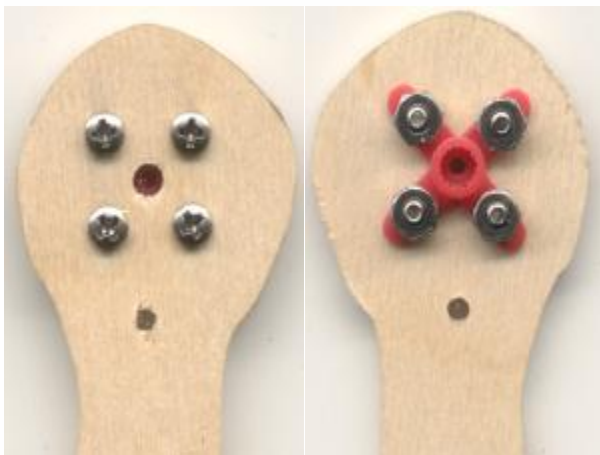
Take 2 of the 4-sided servo arms and drill 1/16" holes as shown. The 1/16" hole is just a bit small for the #2 machine screws to allow the plastic to act as a lock washer for us once the arm is attached to the leg.



### Step 7

Take the servo arm and center it on the 1/8 hole and mark the 4 holes you drilled in step 6. If you insert the small screw used to attach the servo arm to the servo it will help you center the arm. Please note that if the arm is not 100% centered it won't affect operation at all.

You will need to do this with the two remaining Legs.



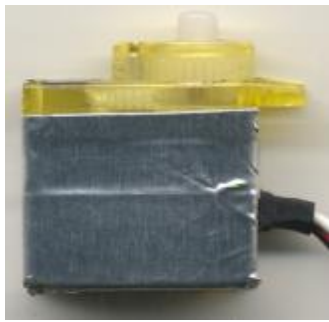
### Step 8

Drill 4, 3/32" holes into each leg. I insert 4 1/4" #2 machine screws and attach the servo arm to the leg as shown. Use a #2 hex nut to help hold the screw in place.



### Step 9

Take one of the two sided dragonfly servo arms and snip off one side as shown. Make two snips at a slight angle so you don't put too much stress on the arm when you cut it.



### Step 10

When using micro servos we sometimes must make special provisions for mounting due to size or construction. The Dragonfly servo is held together with a small plastic band and a small label. This prevents us from mounting the servo reliably using mounting foam tape. To correct this we simply remove the clear plastic label (tape) and the plastic band. We then take a piece of metal air-conditioning tape and wrap the servo as shown..

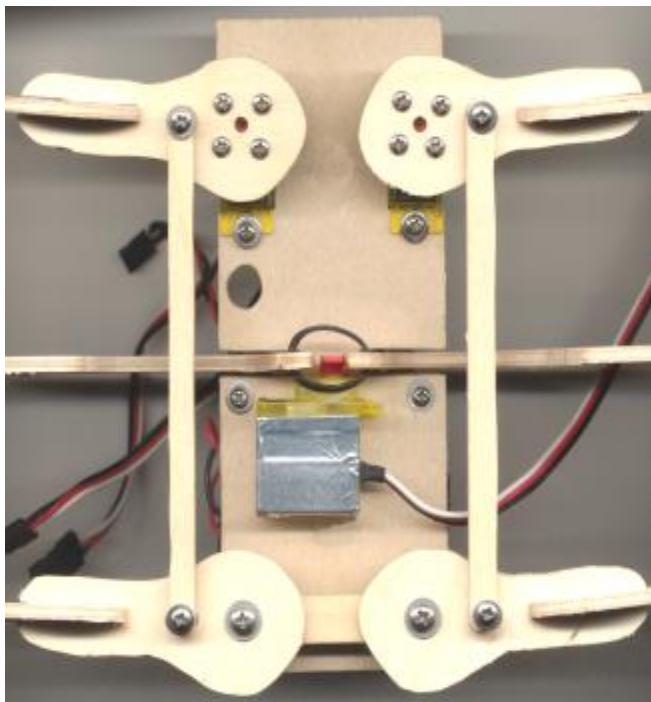
We must also remove the left mounting flange from the servo as it comes in contact with the Center Leg Support mounting screw.



Place the arm on the servo so that it points straight up in the orientation shown. Don't worry about the current servo position as we will calibrate later.

Next, position the servo as shown so that the arm is dead center of the two center legs. Do a dry fit, then add a piece of mounting foam tape and position in place. You can pick up some double stick foam strips at any department or home store. Don't use the removable type. I recommend a name brand as it's much firmer and holds the servo better.

Place a small rubber band across the top of the two center legs as shown. The rubber band will cause the leg not being pushed down to lift up. The best place to pick-up the rubber bands is in the hair care section of the department store. These small rubber bands are used to make small pony tails.



### Step 11

Attach the front legs you completed in Step 8. At this point you may also attach the lower legs to all of the upper legs by inserting the notches into each other.

### Step 12

Now attach the Rear Leg Drive as shown. The leg drive is used to move the rear leg when the front leg moves. Use a 1/2" #2 machine screw in each leg in the following order. #2 machine screw, #2 washer, leg drive, #2 washer, leg, #2 washer, #2 lock nut.

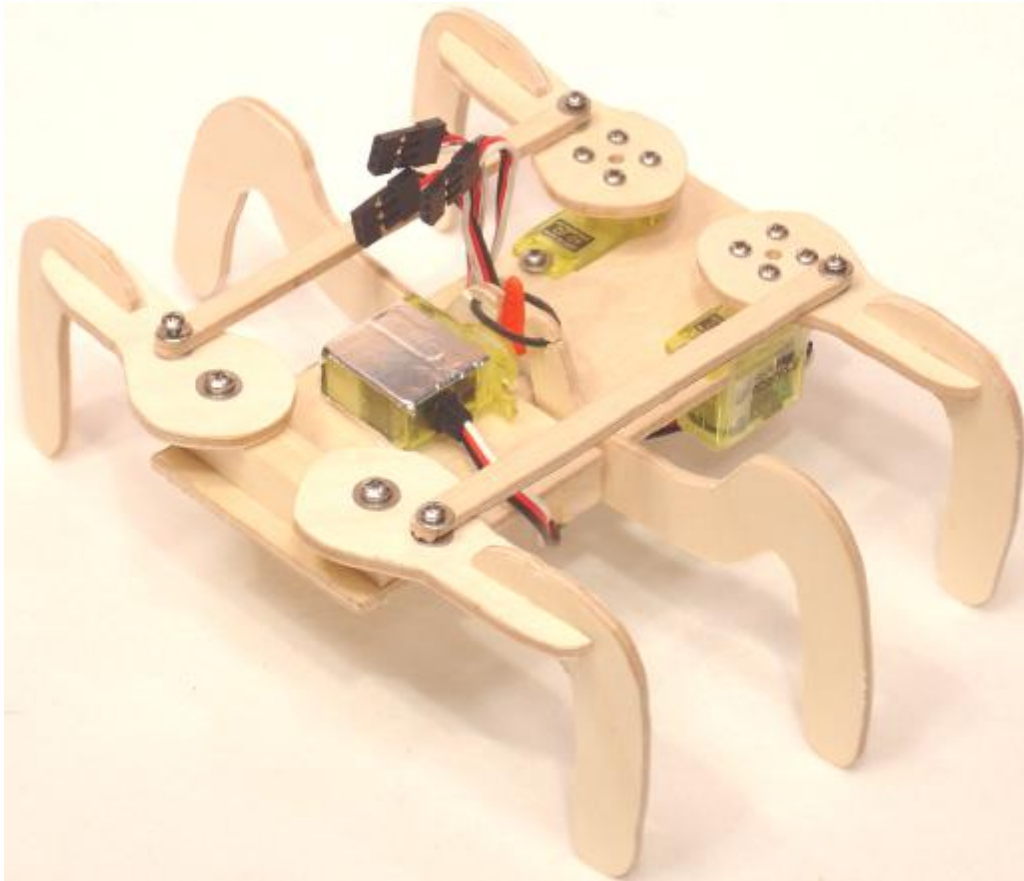
Tighten enough to remove the wiggle.

Now attach the lower legs if you have not already done so in Step 11. The leg parts A and B are held together by friction. If you have cut the slots too wide they may not hold together, and you may need to apply a drop or two of hot glue to strengthen the joint.

This concludes the mechanical construction phase. Go ahead and insert the small screws that came with your Dragonfly servo into the servo arms and tighten them. This will hold the legs in place until we are ready to calibrate.

You can also run the two front servo connectors up through the 5/16" hole. Take the center servo connector and run it around the side then back up through the 5/16" hole from the bottom.





At this point you have a complete walker eagerly waiting for its power source and brain. In Part 2 I will show you how to install all these.

Some things to check before you proceed to part 2.

- Make sure all joints with locknuts are not too tight. The piece should move freely but not wiggle.
- The upper and lower leg joint should be firm and should not wiggle.
- The center servo should be securely attached to the base and should not move in any direction. If it does the foam tape you are using is too thick.

#### Parts List

12 x 24 or 12 x 12 Sheet of 1/8" Baltic Birch

Can be purchased at most craft or hobby stores. It can also be purchased from <http://www.woodcraft.com>

Servos

3, Dragonfly servos. Get them at <http://stores.channeladvisor.com/rc-toys-hobbies/Items/400010?>

Hardware Package

Kronos Robotics at <http://www.kronosrobotics.com/xcart/customer/product.php?productid=16434>

Hardware package contains the following if you wish to source them separately:

- 1, 2/8" x 3/8" x 2" pine rear mount support
- 1, Piece of Metal Tape
- 1, Piece of 1/6" heat Shrink
- 2, Small Rubber Bands
- 1, Piece of double sided mounting foam tape

- 4, #2 3/4" Machine Screws
- 4, #2 1/2" Machine Screws
- 4, #2 3/8" Machine Screws
- 8, #2 1/4" Machine Screws
- 10, #2 Hex Nuts
- 6, #2 Lock Nuts
- 2, #4 3/8" Machine Screws
- 2, #4 1" Machine Screws
- 6, #4 Washers
- 2, #4 Hex Nuts
- 2, #4 Lock Washers

1 sheet containing prescaled drawing plans

## Related Products

- Perseus .....<http://kronosrobotics.com/xcart/customer/product.php?productid=16382>
- EZRS232 Driver .....<http://kronosrobotics.com/xcart/customer/product.php?productid=16167>
- Perseus Carrier 1 .....<http://kronosrobotics.com/xcart/customer/product.php?productid=16390>
- Perseus Carrier 1 Option Pack <http://kronosrobotics.com/xcart/customer/product.php?productid=16391>
- 1K Trimmer .....<http://kronosrobotics.com/xcart/customer/product.php?productid=16378>
  
- 7.5v Switching AC Adapter ...<http://kronosrobotics.com/xcart/customer/product.php?productid=16305>
- 9 Pin Cable .....<http://kronosrobotics.com/xcart/customer/product.php?productid=16259>
- Breadboard & Wire Kit .....<http://kronosrobotics.com/xcart/customer/product.php?productid=16303>