

# Build an autonomous Wall-E Robot

by [djsures](#) on October 27, 2008

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## intro: Build an autonomous Wall-E Robot

Hi! After a kabillion requests, here you go!

First a little introduction: [Watch Video](#)

I started off with the toy titled "Interactive Wall-E". Available at [toys'r'us](#) current price \$34.99

I am a robot hobbist and have a lot of experiece with the programming and design to give robots expression and life. The first bit advice I can lend is to be confident. Second advice is to be creative. Together, you're mind will figure out the rest for you :)

There are plenty of peices available to you. [My workshop is nothing special](#). I keep a supply of parts that are low cost. I usually collect items from disassembling other toys :) . Sadly, servos are the most expensive parts of the bunch.

For fasteners I use Zip Ties and an arragement of small screws, bolts and nuts. All are available in cheap combo kits at your local hardware store.

To modify the casings, i use a speed adjustable [dremel](#) and sometimes my soldering iron to melt plastic. For dremeling, please keep a vacuum nearby. \*Warning: For melting, keep a window open with a fan!!

Also, if you choose to melt plastic peices, use a seperate bit on your soldering iron. The plastic will burn to the tip and make soldering a pain in the butt!

Now for the programming part... This is going to be the most challenging for many of you. And I know because even though some of us make it look easy, we all started with a struggle. Sometimes, a costly struggle!

I do my programming for these microcontrollers using CCS' PCW compiler. It's not a cheap purchase, but I also use it for business which justifies my cost. The language is C and it contains all the standard libraries you'd expect with a C Compiler. There are other languages, such as PicBasic and SourceBoost's C++. (I beleive sourceboost has a free trial download for their compiler)

The microcontrollers I prefer are the [Microchip PIC](#) . There are many other microcontrollers to choose and that's up to your discretion.

--- ADDITIONS ---

November 7 2008

After plenty of requests, I have decided to sell (for no profit) my board with a pre-programmed microcontroller. The software will be hard-written to the chip which means you won't be able to extract it, but you may use it :) ..

This will also require the need for previous soldering experience to assemble the parts of the board.



## step 1: Parts

Okay hopefully you've created a nice work area. Someplace with a table/bench that you don't mind getting dirty/burning/scratching/etc. (ie don't use your dining room table!)

Here is a list of the parts I used...

- Soldering iron

- 2 Parallax modified servos for the drivetrain

Available at: [http://www.hvwtech.com/products\\_view.asp?ProductID=114](http://www.hvwtech.com/products_view.asp?ProductID=114)

- 1 GWS Standard servo for the head (Left and Right motion)

Available at: [http://www.hvwtech.com/products\\_view.asp?ProductID=878](http://www.hvwtech.com/products_view.asp?ProductID=878)

- 2 GWS Pico servos for the arms (Up and Down motion)

Available at: [http://www.hvwtech.com/products\\_view.asp?ProductID=863](http://www.hvwtech.com/products_view.asp?ProductID=863)

- 1 GWS Micro servo for the head tilt

Available at: [http://www.hvwtech.com/products\\_view.asp?ProductID=862](http://www.hvwtech.com/products_view.asp?ProductID=862)

- 2 Sharp Analog Distance Sensors

[http://www.instructables.com/id/Build\\_an\\_autonomous\\_Wall\\_E\\_Robot/](http://www.instructables.com/id/Build_an_autonomous_Wall_E_Robot/)

Available at: [http://www.hvwtech.com/products\\_view.asp?ProductID=88](http://www.hvwtech.com/products_view.asp?ProductID=88)

- A collection of 3-Conductor Servo Cables

Available at: [http://www.hvwtech.com/products\\_view.asp?ProductID=690](http://www.hvwtech.com/products_view.asp?ProductID=690)

- 1 Box of assorted small screws/bolts/nuts  
Available at your local hardware store

- 1 Hobby Glue gun  
Available at Walmart or hobby store

- 1 bottle of crazy glue  
Or any type of good strong plastic glue

- 1 Soldering Iron  
I use an adjustable temp range soldering iron, which is costly but recommended. Sometimes you can come across these used in bargain classifieds or at electronic supply surplus shops.

- 1 Case of Jeweler Screw Drivers  
Available at walmart or any hardware shop

- (optional) 1 Freeduino SB PCB

Available: [http://www.hvwtech.com/products\\_view.asp?ProductID=682](http://www.hvwtech.com/products_view.asp?ProductID=682)

I had my own board designed that i use for my projects. So far, the most affordable opensource board i've seen is this Freeduino.





### step 2: Take the toy apart

Using your screw driver set, you'll want to disassemble the entire toy. Keep track of how it came apart, because the goal is to re-assemble :) ..

\*Note: It is not necessary to take apart the Eye Encloser. The wires from the Eye Encloser can be connected to your micro.



### step 3: Arms

You'll need to mount the servos onto the top part of the toy's case. This is going to be your first modification to the body. Hold the two mid sized servos to where the original arm mechanism was and notice how to fit them.

The photo on this step shows a mounted servo, and the original mechanism. You'll of course want to have both servos mounted, one for each arm.

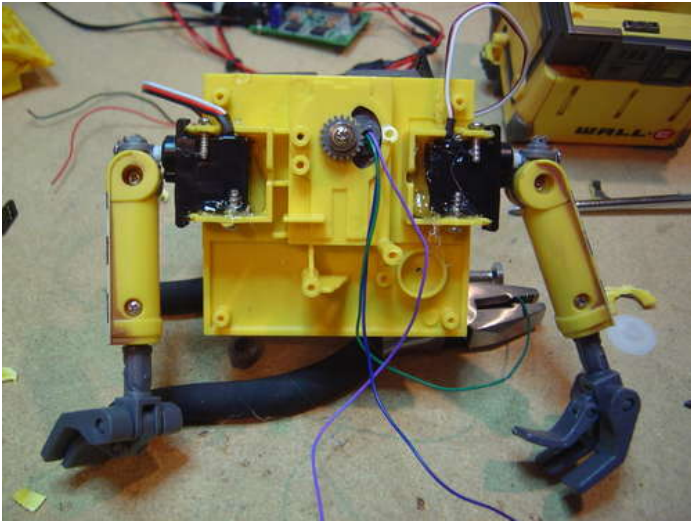
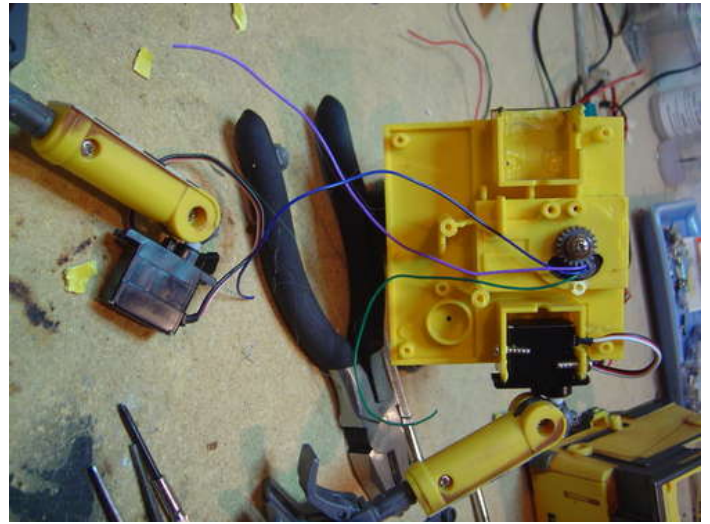
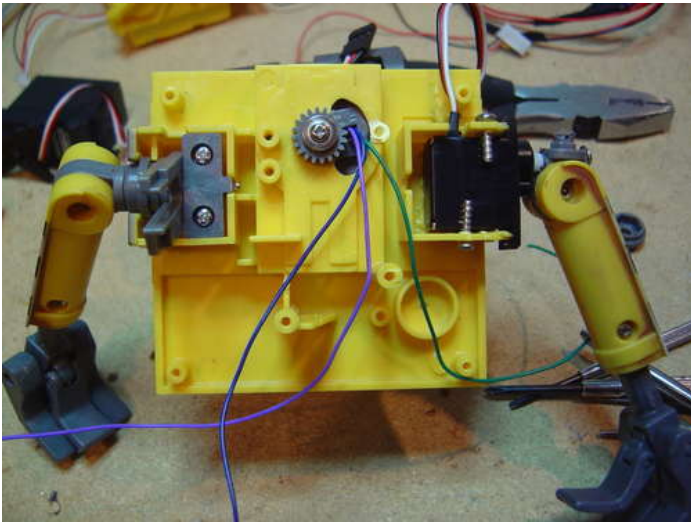
Use the dremel to cut away the plastic on the ends to fit the servos. Make sure you use a low speed on the dremel. Drill Style cutting bits work best.

- I used the glue gun to create a nice tight fit for the servos.

- I then melted two tiny holes in the plastic to fit small screws for additional support.

Mounting the arms to the servos is a little tricky. I don't have a clear photo of how i did it, but be creative. The servo packs come with a variety of bits and extensions. Be creative with those extensions. I took a 4 arm extension and trimmed it down to fit within the arm. No glue or screws were necessary.

Also, once you figured out how to mount the arm to the servo, make sure the servo and arm are both in the centered position. Becuase remember, the servo doesn't spin 360 degrees. It has a Start and Stop position! So for full movement, you're not going to want the arm mounted at bottom of the servo's positioning, or it will only be able to go up from that point :)



#### step 4: Mounting the head/neck

The neck will mount to the GWS Standard servo. This will allow it to move left and right.

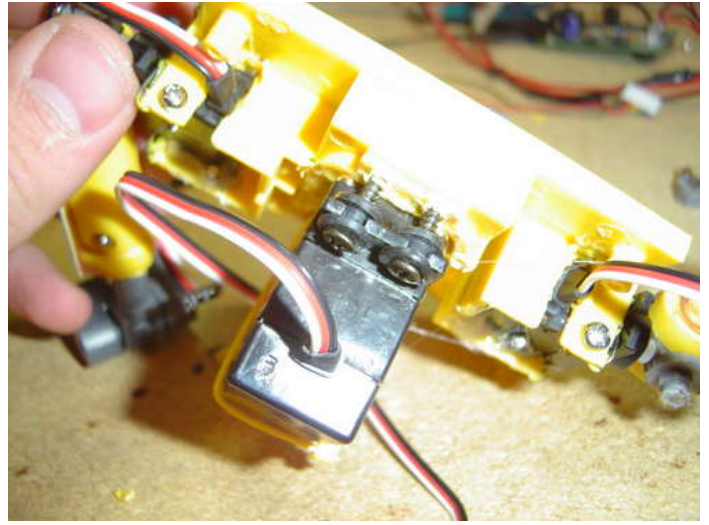
\*Note: Like the arms, the servo needs to be centered ;)

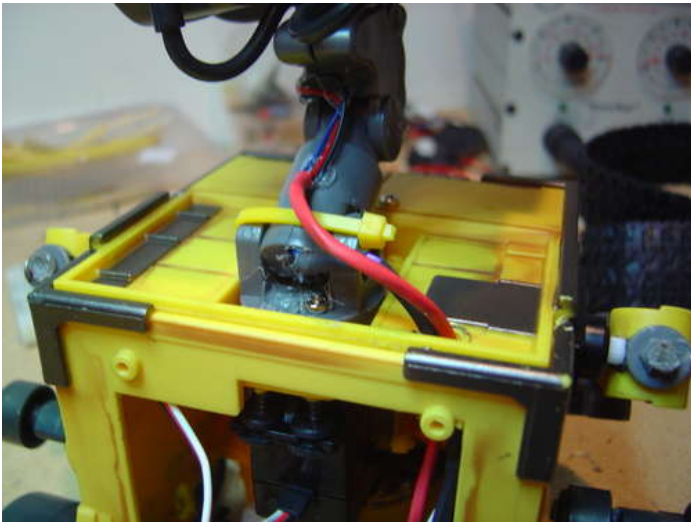
I used a combination of the dremel and soldering iron to flatten the neck adapter. I then melted 3 small holes to fit screws onto the circular servo accessory.

To fit the servo and mounted head bracket, you'll need to dremel the hole larger. Also remove and break off any plastic peices that prevent the servo from sitting flush against the plastic.

Recycling some of the wall-e screws and mounting locations, you'll be able to mount the servo.

When I mounted the head to the neck bracket, I used a zip tie temporarily. I later replaced it with a bolt and nut.





### step 5: Drivetrain - part 1

Now let's give wall-e some wheels!

So the toy doesn't have any motors or drivetrain. It's a push toy. So you'll need to be very confident and creative here.

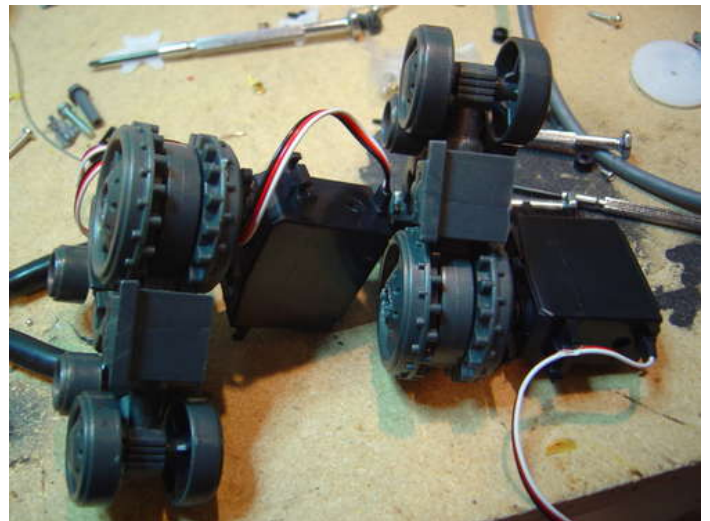
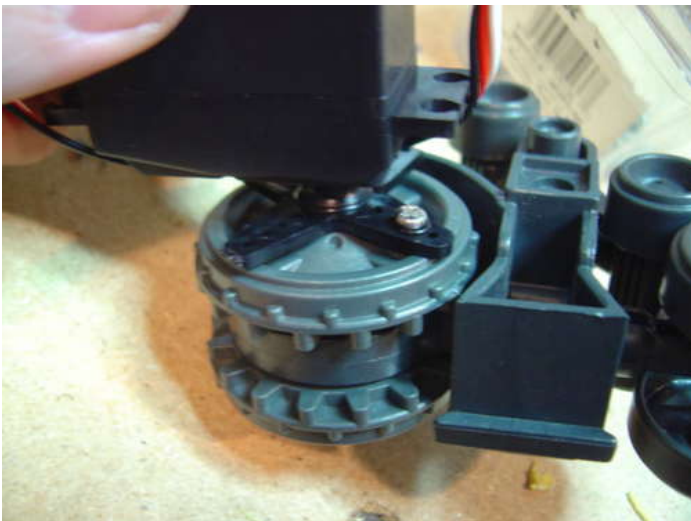
Twist and turn the wheels until the metal axel breaks loose. It's quite a struggle! I ended up using a dremel and cutting most of the pastic away that attached the axel to the wheels. You're going to want the inside of the wheels flat anyway, so don't worry :)

Now we're going to simply pry out the center cap on the wheels. This will expose a philips head screw. Remove that screw and the wheels will come apart.

Using the 4 arm accessory of the Parallax Modified servos, melt corresponding holes into the inside of the wheels. Use small screws and attach the 4 arm accessory to wheel.

Trim off any part of the servo accessory that sticks out using the dremel.

Do both sides the same.. Look at the pics :)



### step 6: Drivetrain - Part 2

Okay now we're going to mount the drivetrain to the case. This is exciting because it's a lot of dremeling!

Take a good look at the pictures and see how much to cut away.

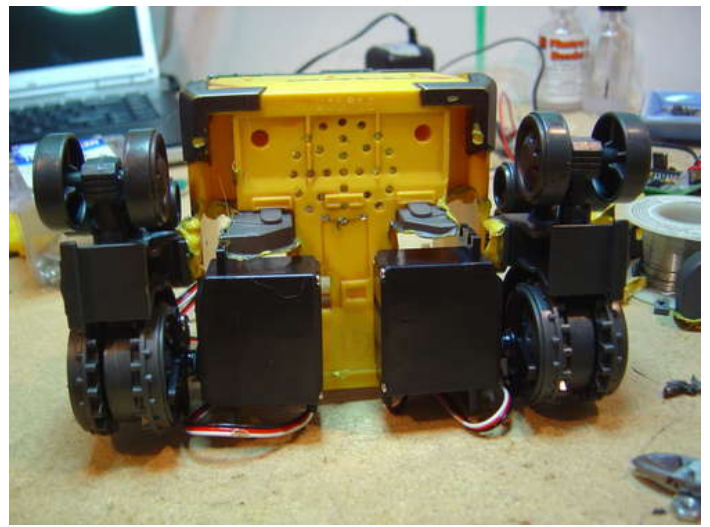
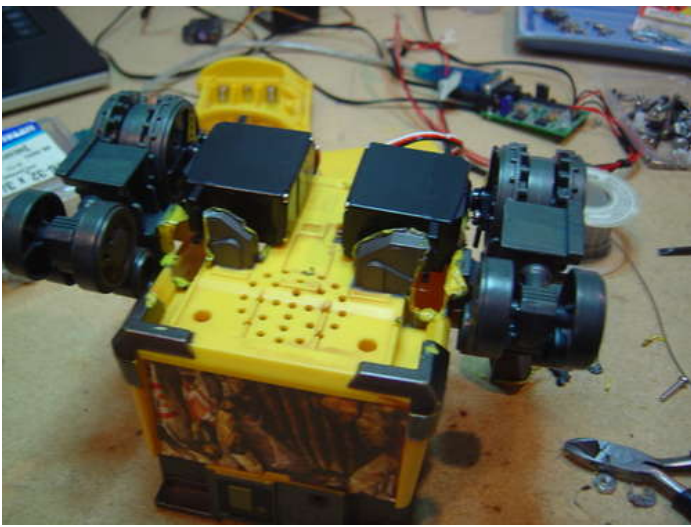
It's best to take this part slow. I use a marker to outline where to cut. ... I cut a little, then measure, cut a little, then measure. Etc...

Once the servos fit flush and the mounting bracket fits to the case, then you must be close! Sweet!

To mount the servos, i first used a bead of hot glue gun to hold the servo in place. Glue guns are great because they'll provide a temporary mount, but not permanent by any means!

To securely mount the servos, i used zip ties! I used the nice fat zip tie, and a pair of plyers to tighten it up solid.

Yay next step!



### step 7: Distance Sensor & Assembly

I supposed you'll want your wall-e to see. So did I!

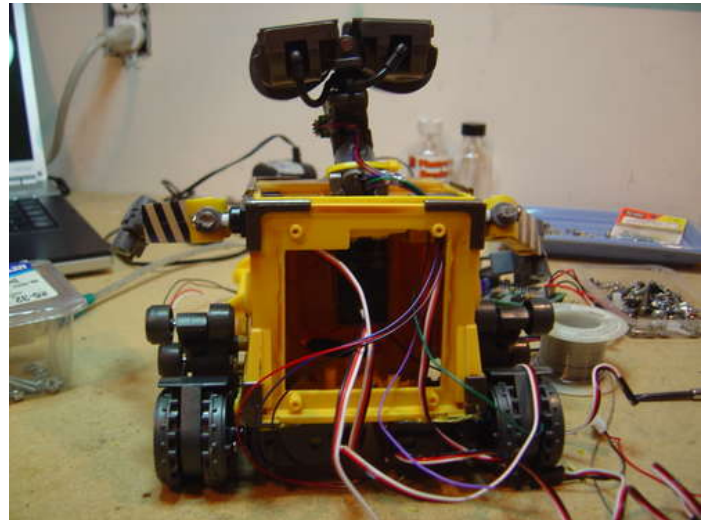
So I used one of the sharp distance sensors mounted on his neck. I had to dremel a bit of the sensor housing to make it fit flush.

Maybe melt/drill a little hole through the top plastic of the box to push the wires through.

The wires that come with the sharp sensor are very small and easily break from fatigue. I replaced the wires with the Servo wire/plug combo that is listed in the parts.

I use those servo wire/plug combos for everything.. LCD's, Speakers, LED's, etc...

Tuck all the wires through their holes when you assemble the unit.



### step 8: Head Tilt

Nothing makes Wall-e come more alive than his eye tilting. It adds a lot of character to his personality.

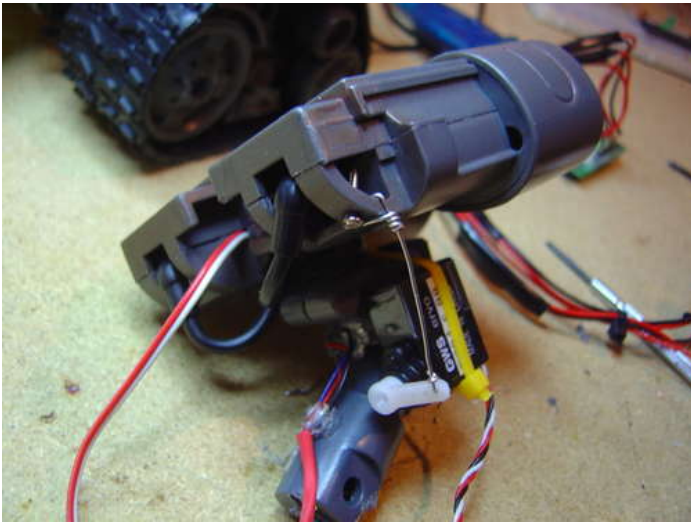
The eyes of the toy is tiltable by hand, but not automated. I put a drop of Crazy Glue to hold both parts of the eyes together. That way, the servo moves both eyes. You may want to not Crazy Glue the eyes together for an even funnier expression.

I mounted the smallest servo of the parts list to the neck. Of course I used a yellow zip tie and some hot glue gun ;)

Then use a peice of hard wire from the servo arm to the head.

Also, the electrical wires from the servo are very short. I used the servo wire/plug combo to extend the wires. And covered up the solder joints with shrink wrap.

\*NOTE: Do not attempt to move this tiny servo arm by hand! You will break the plastic gears inside. Trust me, I broke one by trying. If the peice isn't lined up, simply remove the arm and attach it in line. DO NOT TRY TO MOVE IT.



## step 9: Circuit and Programming

Alright, i'm really struggling on how to include an easy how-to on this instructable for this step.

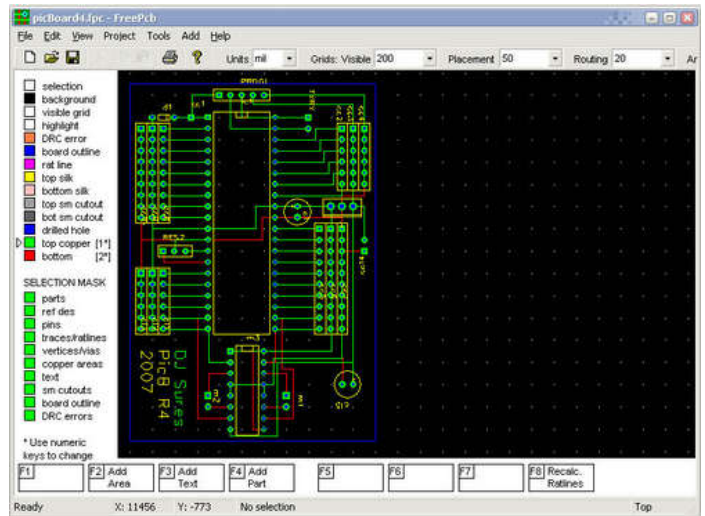
It's best to have some understanding of a few items before attempting this part.

- How a servo works  
<http://en.wikipedia.org/wiki/Servomechanism>
- What is a microcontroller  
<http://en.wikipedia.org/wiki/Microcontroller>
- Circuit design  
[http://en.wikipedia.org/wiki/Circuit\\_design](http://en.wikipedia.org/wiki/Circuit_design)

```

1 #include "nako.h"
2 #include "util.c"
3 #include "djtone.c"
4 #include "audioControl.c"
5 #include "sounds.c"
6 #include "adc.c"
7 #include "actions.c"
8 #include "ROVSERVOS.c"
9 #include "djeservo.c"
10 #include "scans.c"
11 #include "movements.c"
12 #include "STALIB.H"
13 #include "nodes.c"
14
15 void main() {
16
17     unsigned int randomStuff;
18     unsigned int lastEyeADC;
19
20     setup_adc_ports(AND_TO_ANI);
21     setup_adc(ADC_CLOCK_INTERNAL);
22     setup_ssp(SSP_DISABLED);
23     setup_ssp(FALSE);
24     setup_timer_0(RTCC_INTERNAL_RTCC_DIV_1);
25     setup_timer_1(T1_DISABLED);
26     setup_timer_2(T2_DISABLED_0);
27     setup_comparator(OC_NC_NC_NC);
28     setup_vref(FALSE);
29
30     initActions();
31     initMoveServos();
32     startUpSound();
33
34     playSample();
35
36     delay_ms(150);
37
38     flashEye();
39
40     scand(ADC_PORT_EYE, true);
41

```



## step 10: Circuit Design

I created my own circuit using a program called FreePCB

I designed the circuit to host a 40 pin Microchip PIC microcontroller. The chip i prefer is the 18F4685. The 40 pin Microchip PICs all have the same pinouts, so they are replaceable. Of course, what ever circuit you design will need to be specific to the pins of the microcontroller you choose.

The most common of the 40 pin Microchip PIC's is the 16F877a.

To have the circuit printed onto PCB, i used Alberta Printed Circuits. The cost was around \$200 for 20 circuit boards. I use these boards for all my projects.

Many people defend their choice of microcontroller. I respect that and am not pushing the PIC, I simply use it.

HVWTech has a great selection of microcontrollers to choose from...

Link: <http://www.hvwtech.com/products.asp?CatID=90&SubCatID=0&SubSubCatID=0>

On my board, i put a 3 pin connector to each I/O of the micro. The pins supply GND, +5, Signal. This lets me easily plug in servos and my own wired devices (LCD's, LED's, Sensors, Speakers, etc)

[http://www.instructables.com/id/Build\\_an\\_autonomous\\_Wall\\_E\\_Robot/](http://www.instructables.com/id/Build_an_autonomous_Wall_E_Robot/)

The board also contains:

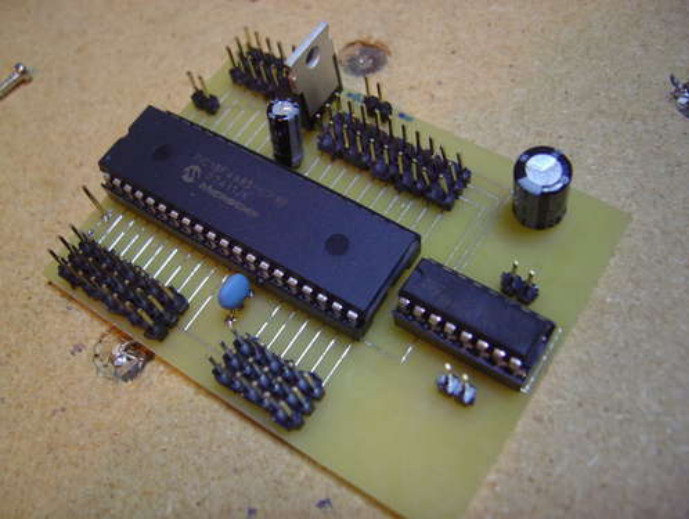
- capacitor to filter noise and regulate the current.
- +5 voltage regulator.
- 20 MHz Resonator.
- 1 Motor controller (which i seldomly use, i prefer servos)
- Programming pins
- HVP Diode (high voltage programming)

--- ADDITION ---

November 7 2008

After plenty of requests, I have decided to sell my board with a pre-programmed microcontroller. The software will be hard-written to the chip which means you won't be able to extract it, but you may use it :) ..

This will also require the need for previous soldering experience to assemble the parts of the board.



## step 11: Software

Once you choose your microcontroller and built/print your PCB... The next step is programming.

I always suggest learning C. Simply because I find the Basic implementation for microcontrollers far more confusing!

The programming i've done for my Wall-e is quite extensive and is a result of years of evolution. I have been evolving my robot software platform over the years.

In autonomous mode, my Wall-e creates a 2 dimensional map of objects around him. This prevents him from getting stuck or backing into objects. The theory and logic behind this technique is difficult and the implementation can be very challenging.

In addition to his enviromental awareness, his personality is also complex. His actions, movements and modes are not entirely random. He collects points and begins to favour successful actions. Much like you would expect a pet.

It's taken years of observing, programming and pulling my own hair to figure a lot of this out. Start slow, and be creative. Figure out ways to add personality quirks to your robots that bring them to life!

For more information regarding his programming, visit: <http://atomic.speculation.org/index.html?page=52>





### step 12: Battery.. POWER!

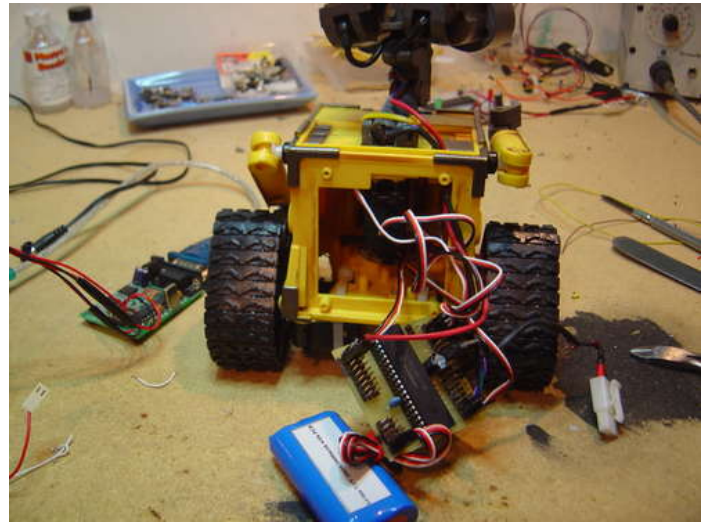
Because my wall-e does have 6 servos and a microcontroller, his power consumption is high.

Due to size constraints, i was limited to a small battery.

My choise was a 2000mha LION 7.4v cell. LION batteries don't like to be drained, so be prepared for a low life expentency.

The 2000mhz battery gives my wall-e about 30 minutes of life between charges.

You can purchase your battery at any Battery Depot or similar outlet.



### step 13: Enjoy!

I hope you enjoy your new robot. For more information about my projects and robots, please feel free to visit my website at <http://atomic.speculation.org>

Bye bye!

DJ

## Related Instructables



**My Autonomous HomeMade Wall-E Robot** (slideshow) by djsures



**My Autonomous Cookie Monster Robot** (slideshow) by djsures



**K-9 The Autonomous Robot Pet** (slideshow) by djsures



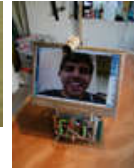
**Autonomous, Self-Assembling Robots** by dan



**SemiAutonomous Submersible robot for underwater research** by leevonk



**Robots (guide)** by randofo



**Sparky - DIY Web-Based Telepresence Robot** by sparkyrust



**The SOMA Project** by thesomaproject



## Comments

[36 comments](#) [Add Comment](#)



**J-Five** says:

I seen it at Wal-Mart for like \$24.00.

Nov 9, 2008. 7:51 AM [REPLY](#)



**Kiteman** says:

You know those 1000+ lines of code?

Oct 28, 2008. 7:01 AM [REPLY](#)

I realise they're probably very precious to you, being a long personal project, but, are you going to reveal them, or does anybody following this ible have to spend the same sort of time creating their own code?

Note of honesty - I doubt I'll be making one of these.

Question from #2 son - "Ask him, how much?" (I think he means "How much would you sell another one of these for?")



**djsures** says:

i won't be releasing the code. you won't need to spend 1,000+ lines of code either . but throughout time, i imagine your code will evolve also :)

Oct 28, 2008. 10:47 AM [REPLY](#)

in fact, on the pic in C using CCS PCW .. you will be able to create a very simple robot with few lines of code . one that can avoid obstacles by merely scanning the IR Sharp Distance Sensor .

Lots of forums out there for microcontroller programming ..

Well #2 son, i know i won't be making another wall-e . but it can be your goal to make one :)



**diskinclud** says:

You're sure we can't convince you somehow?

Oct 30, 2008. 5:41 PM [REPLY](#)



**djsures** says:

I added an addition to the intro. For no profit, i will sell the board unassembled with my Wall-e Code on it. It'll require soldering experience, but that's fun :)

Nov 7, 2008. 7:39 AM [REPLY](#)



**diskincluded** says:  
Rock on!

Nov 7, 2008. 4:21 PM [REPLY](#)



**crafty\_crayons** says:  
lol

Nov 2, 2008. 12:50 PM [REPLY](#)



**Kiteman** says:  
OK, thanks.

Oct 28, 2008. 10:51 AM [REPLY](#)



**djsures** says:  
I've decided (for no profit) to sell my Wall-e's circuit board with a pre-programmed microcontroller. If you're interested, contact me. I've received a lot of requests, so it's the least i can do to support this instructable :)

Nov 7, 2008. 7:40 AM [REPLY](#)



**lance\_r** says:  
would it be overkill to use an arduino on this or even possible im a little newbish at robot programing and building

Nov 5, 2008. 11:03 PM [REPLY](#)



**djsures** says:  
not at all .. the board and chip i used is a lot more powerful then the arduino, it's just that i made it myself. :)  
btw, i'm building a new one using the larger remote control wall-e (49.95 at toys-r-us)

Nov 5, 2008. 11:47 PM [REPLY](#)



**KevinM** says:  
This is a GREAT hack and robot, but will he take out the garbage? :)

Nov 1, 2008. 5:48 PM [REPLY](#)



**crafty\_crayons** says:  
lol

Nov 2, 2008. 12:49 PM [REPLY](#)



**Spe1715** says:  
In parts list you have two IR distance detectors.  
You used one for the neck, where's the other one?

Oct 31, 2008. 4:02 AM [REPLY](#)



**djsures** says:  
i put one at the bottom looking down . i added that sensor at the end . i must have forgotten to instructable it .  
thanx for noticing :)

Oct 31, 2008. 11:15 AM [REPLY](#)



**rickfmdj** says:  
Just too cool and lots of time.

Oct 30, 2008. 6:34 PM [REPLY](#)



**hobbesyeo** says:  
This is really cool. I wish I had the time to do this.

Oct 30, 2008. 5:37 PM [REPLY](#)



**Ankush** says:  
Could I use an ATMEL-AVR microcontroller to build the same?.

Oct 27, 2008. 11:34 PM [REPLY](#)



**askjerry** says:  
Atmel processors are not expensive and you can program them in C, Assembly, or as I prefer... with Bascom BASIC. The BASIC can be downloaded FREE and will program up to 4K of code... if you need to register to get the full version it's only \$80 which is really cheap considering all it does. The programmer can be as simple as 4 resistors and a parallel connector. (Look in the help area of the software for a schematic.)

Oct 30, 2008. 12:43 PM [REPLY](#)

The Mega-8 has plenty of space, the Mega-168 has even more... 8 A/D 8 or more digital, and 2 timers. If you really want more... look at the Mega-32 which is a 40 pin monster.

Bascom is available here:

[http://www.mcselec.com/index.php?option=com\\_docman&task=cat\\_view&gid=73&Itemid=54](http://www.mcselec.com/index.php?option=com_docman&task=cat_view&gid=73&Itemid=54)

You can also visit our robotics web page at <http://robomo.com> as we do quite a bit with the AVR chips.



**djsures** says:  
thanx for ur feedback jerry! super helpful  
your robomo.com website looks great . u guys have a great thing going on there .  
keep up the good work,  
DJ

Oct 30, 2008. 1:20 PM [REPLY](#)



**djsures** says:  
of course . i don't know the amtel-avr line, but this is what you'll need...  
- 1 ADC Input for Neck IR Sharp Sensor  
- optional 1 ADC Input for Edge Detection IR Sharp Sensor  
- 6 digital outputs for servos  
- 1 digital output for eyes (or 2 if you want eyes to be seperate)  
- 1 internal timer for drivetrain servos

Oct 28, 2008. 1:35 AM [REPLY](#)



**Ankush** says:  
Thanx for the info, will keep u posted on my developments.. thanks again.

Oct 29, 2008. 10:41 PM [REPLY](#)



**fwjs28** says:  
step 2...u kiled wall-e!?!?!  
\*sniffle\*

Oct 29, 2008. 12:28 PM [REPLY](#)



**Plasmana** says:  
...To make him better.

Oct 29, 2008. 1:18 PM [REPLY](#)



**fwjs28** says:  
i guess.....was he hurted??  
\*sniff\*

Oct 29, 2008. 4:21 PM [REPLY](#)



**Trebawa** says:  
All you need now is to install solar panels to supplement the battery power!

Oct 27, 2008. 7:43 PM [REPLY](#)



**srhadaham** says:  
adding solar panels would be cool because in the movie he charges up with solar

Oct 29, 2008. 10:46 AM [REPLY](#)



**bleachworthy** says:  
Oh My God... Best... Hack.... EVAR!!!

Oct 28, 2008. 5:22 PM [REPLY](#)



**lasermaster3531** says:  
SUH-WEET!!!!!!  
This is the best wall-e hack i have ever seen!!!  
(albeit the only one but still...!)

Oct 28, 2008. 6:03 PM [REPLY](#)



**Nameless37** says:  
make this into a wifi robot, put a webcam in the eyes, and a microphone, then put the motors and make it move around

Oct 28, 2008. 12:41 PM [REPLY](#)



**djsures** says:  
wifi robots are controllable, this is a robot pet. it has free will ;)

Oct 28, 2008. 1:13 PM [REPLY](#)



**alex-sharetskiy** says:

Very nice!

total cost?

Oct 28, 2008. 7:00 AM [REPLY](#)

---



**djsures** says:

just in parts? i guess if you add up the prices on the parts list ... i had added a link to each item, should be easy to add up .

Oct 28, 2008. 10:44 AM [REPLY](#)

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**gmjhowe** says:

Great work! I hate the picture where he is splayed out across the desk!

Oct 28, 2008. 8:18 AM [REPLY](#)

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**jeff-o** says:

That is one epic hack! Very nice work.

Oct 27, 2008. 8:28 PM [REPLY](#)

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**threecheersfornick** says:

Wall-e toys? Isn't that like the definition of oxymoron?

Oct 27, 2008. 4:34 PM [REPLY](#)

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