

## Balancing Robot

by [vahid\\_you2004](#) on August 8, 2008

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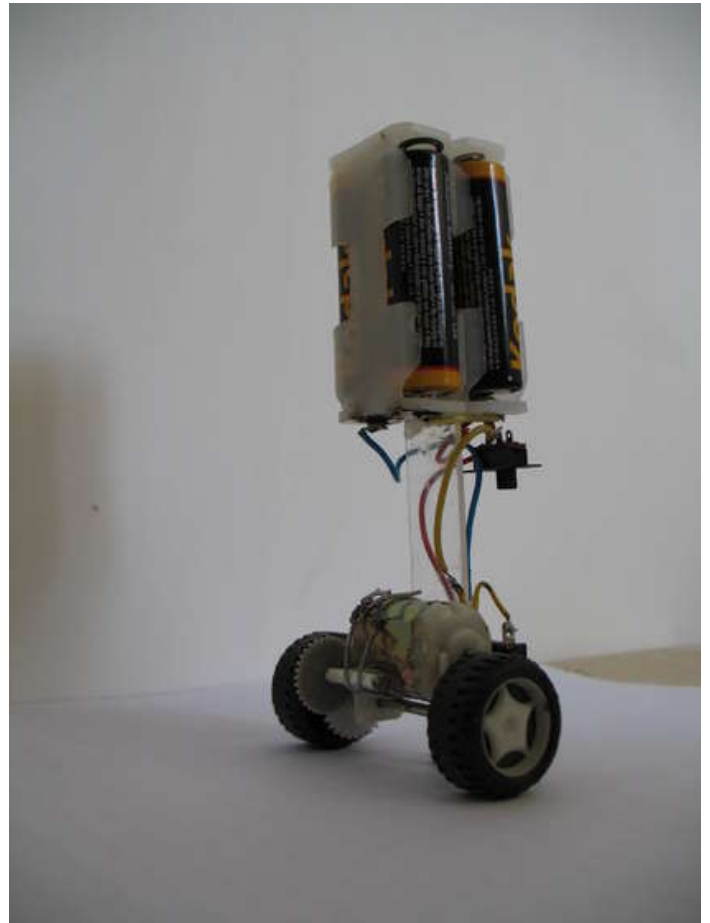
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**Intro: Balancing Robot**

This is a very simple robot that uses a simple switch as a sensor and stands on only two wheels with inverted pendulum mechanism. When the robot is going to fall the motor starts and moves the robot to the direction it is going to fall, so the motor torque about the center of gravity that is higher than the motor makes the robot balanced.

You can also find this tutorial on [my homepage](#)



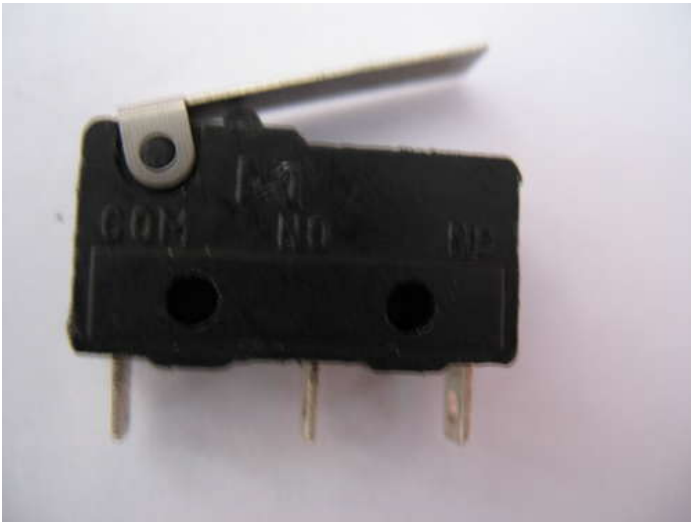


### step 1: Things you need

To make this robot you need following parts and tools:

- small electric motor
- some gears  
(or a motor with gearbox)
- a shaft
- two wheels
- some sheets of plastic to make bearings and the robot neck
- two battery holders
- 4 AA batteries
- one button cell
- one SPDT (single pole double throw) switch with a metal lever
- one toggle switch for the on/off switches
- one nail
- some wire
- soldering iron
- some glue



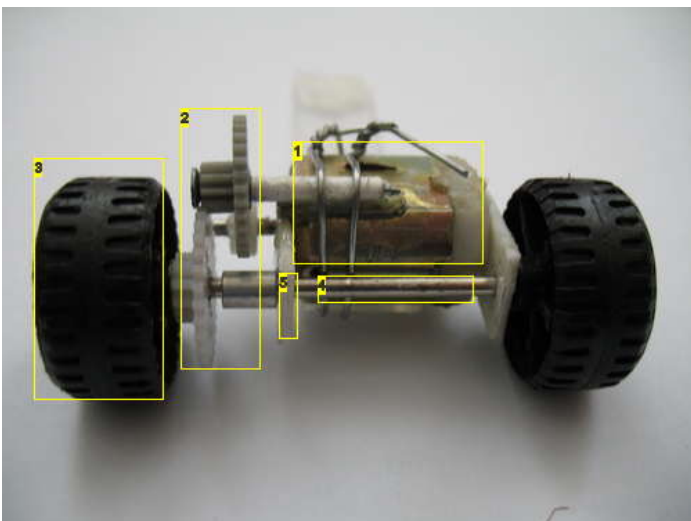


## step 2: Motor, Gears, Shaft, and Wheels

In this step you must make a system to moves the robot you can make it easily by adding some gears to a simple small motor, then connect it to a shaft and assemble it two wheels.

You can also use a motor and gearbox.

It does not matter how you make it.



### Image Notes

1. Motor
2. Gears

- 3. Wheel
- 4. Shaft
- 5. Bearing

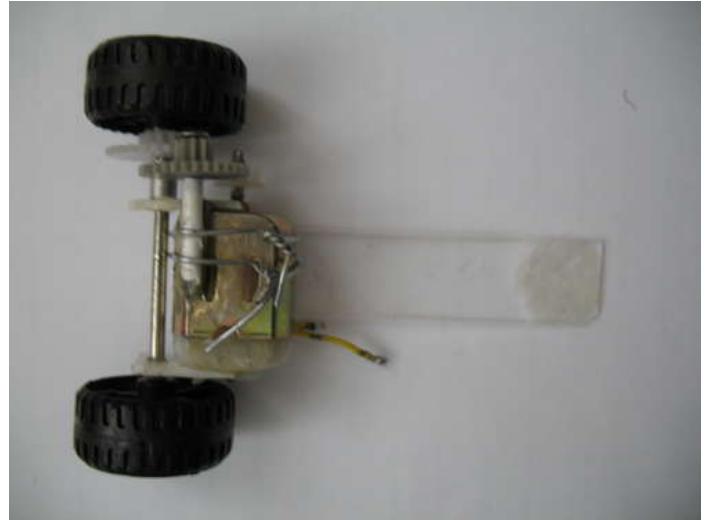


**Image Notes**  
1. Plastic Sheet

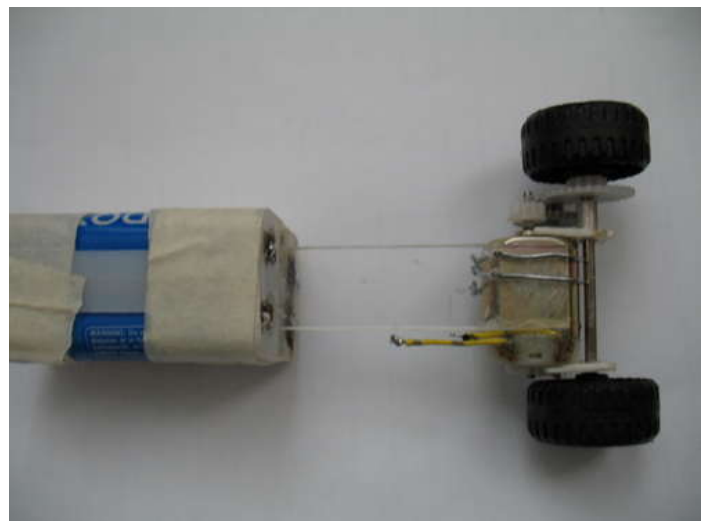
### step 3: Attach robot neck and head

Use glue to attach a sheet of plastic to the motor.

Then put some glue on one side of battery holders and attach them to the top of the plastic sheet.



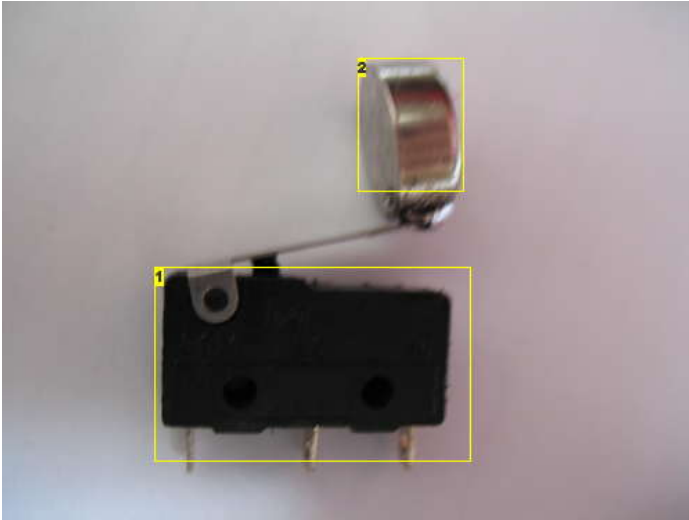
**Image Notes**  
1. Plastic Sheet



#### step 4: Making the sensor

Solder a button cell to the SPDT switch lever.

Make the nail head hot on a flame and put it on the plastic sheet on the motor in a position that when the robot stands vertically the button cell touches the ground. Then attach the switch to the robot with glue.



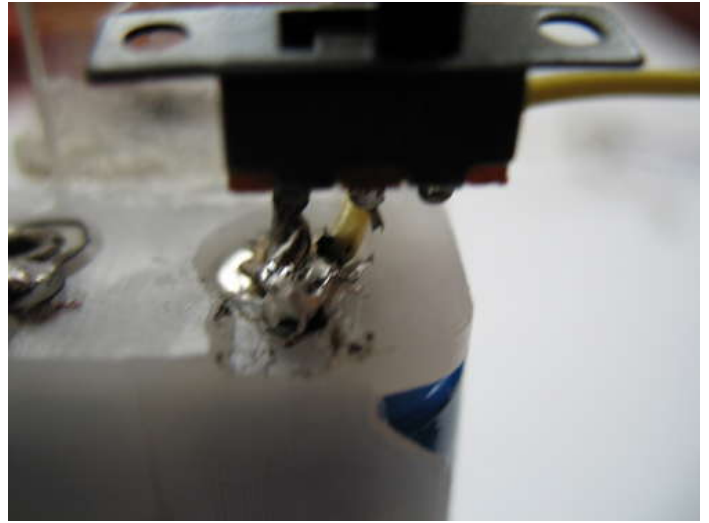
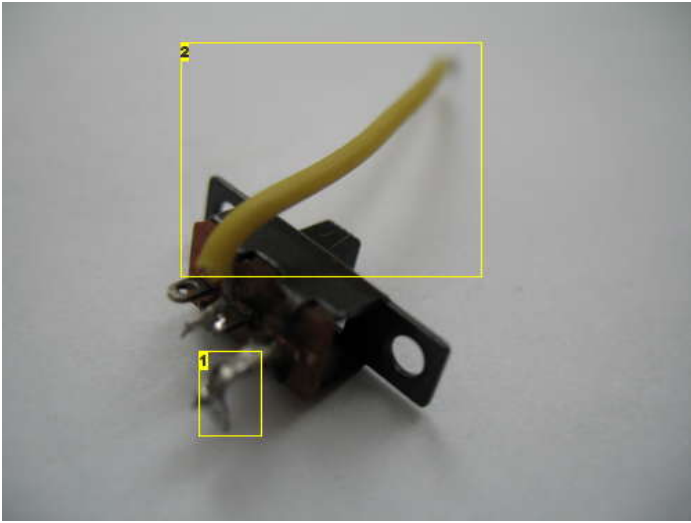
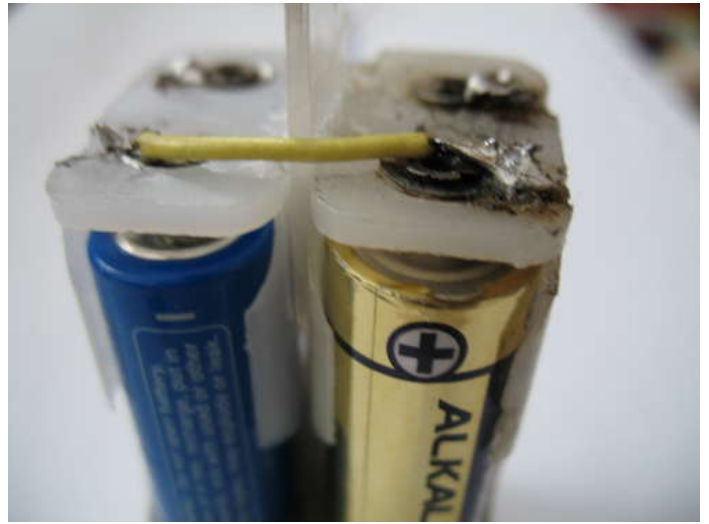
#### Image Notes

1. SPDT Switch
2. Button Cell



#### step 5: Connecting the switch

Solder a wire from positive pole of one of battery holders to the negative pole of the other battery holder and attach the toggle switch to it. Then attach the other side of the switch to the motor.

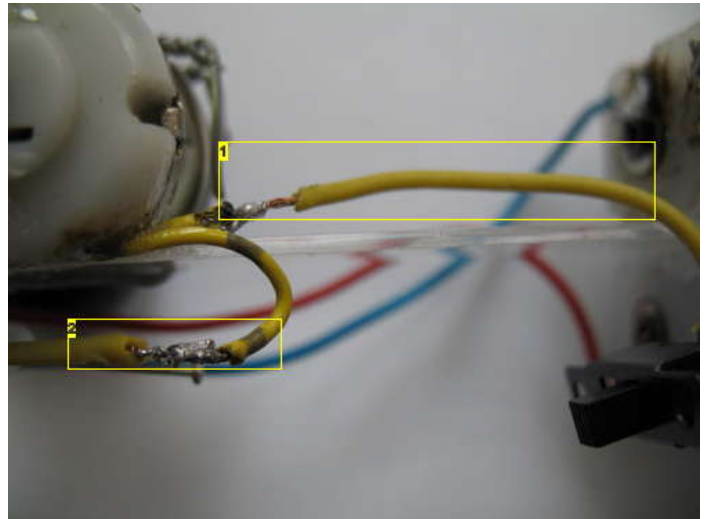


**Image Notes**

- 1. Solder this leg to battery holder
- 2. Solder this leg to the motor

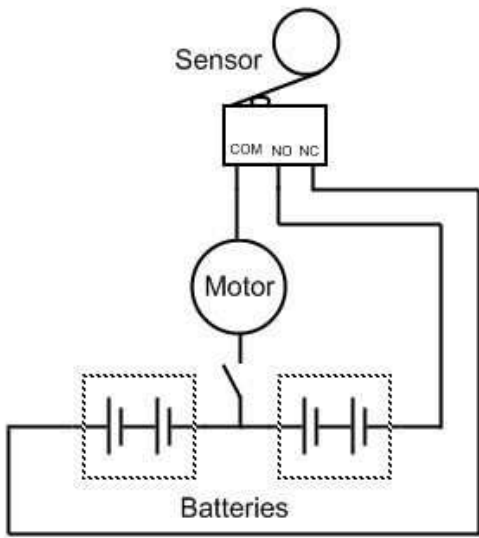
**step 6: Wiring**

Now it is time to solder the robot wires.  
Note that you must solder the wires in a way that robot moves to the direction that is going to fall.

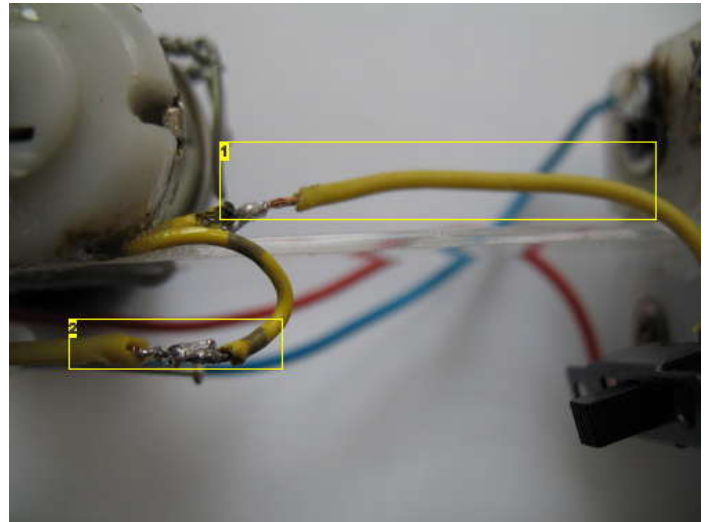


**Image Notes**

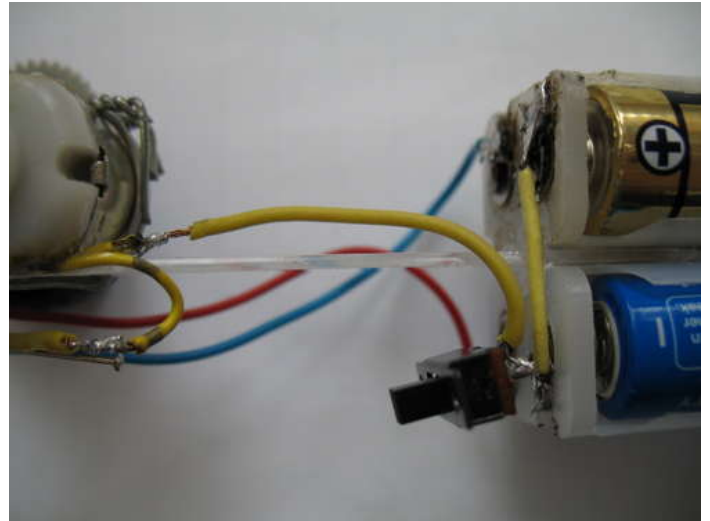
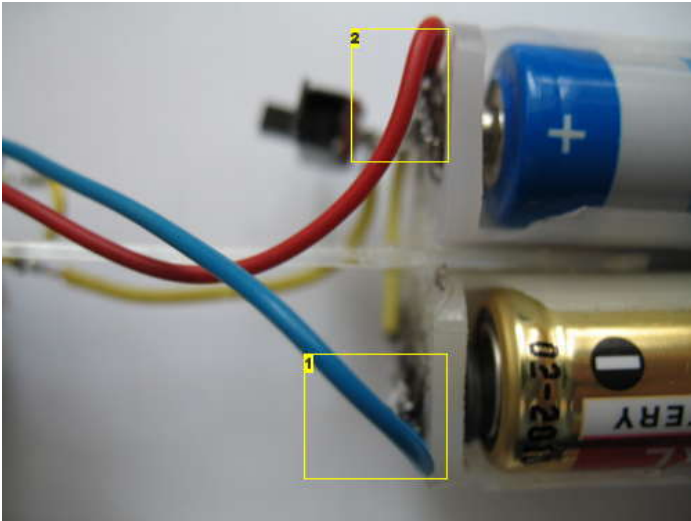
- 1. From the switch



## Balancing Robot Circuit

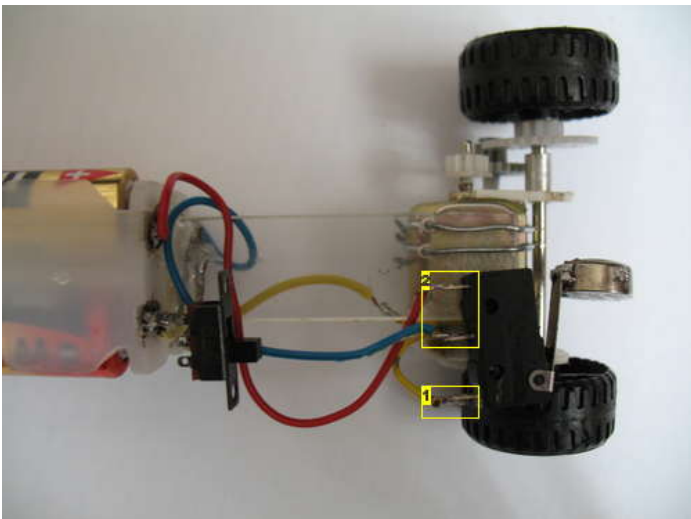


2. From the sensor



### Image Notes

1. From the sensor
2. From the sensor



### Image Notes

1. To the motor
2. From the batteries

### step 7: Testing

The robot is now completed and it is time to test it.

Put 4 batteries into the battery holders and turn on the switch.

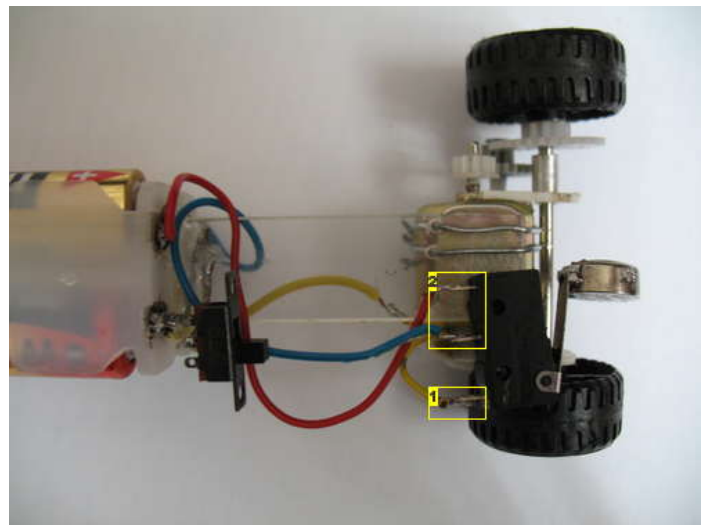
Try to change the position of the sensor to make the robot works better.

If the robot works inverted swap the red and blue wires on the sensor or on the battery holders.



CLICK TO PLAY VIDEO 



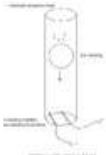


**Image Notes**  
 1. To the motor  
 2. From the batteries

## Related Instructables



**How To Modify A Hitec HS-65HB Servo W/Kryptonite Gears For Continuous Rotation** by Zeitron



**Tilt Sensor: cheap, easy, nontoxic** by leevonk



**How to build a simple robotic arm from Lego Mindstorms** by roksraka



**BiPed robot V-3** by alex.v



**eyeRobot - The Robotic White Cane** by shrimpy



**Robotics - The Best of Instructables Volume 1 (guide)** by StumpChunkman



**The Chaos Machine (Double Pendulum)** by sbtroy



**Tilt Sensor Tutorial** by adafruit

## Comments

50 comments [Add Comment](#)

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**robot lover4evr** says:

Jan 7, 2010. 7:01 PM [REPLY](#)

I like this. Reminds me of my youth, building a line following robot with a car battery and two window regulator motors from an old Lincoln. It would be interesting to try it with tilt switches (\*\*MERCURY is BAD kids\*\*) and perhaps make two stages of power, voltage divider between cells for those times when it tilts beyond a certain range the additional voltage is switched on. Also would be neat to try a magnetic pendulum with reed switches.

Good Job.



**stephenniall** says:

Mercury is Cool !

Feb 13, 2010. 11:28 AM [REPLY](#)



**robot lover4evr** says:  
it's true.

Feb 13, 2010. 1:57 PM [REPLY](#)



**ForgetMyProfile** says:

Feb 4, 2010. 2:31 PM [REPLY](#)

It seems to me that the center of gravity is high which causes the robot to have to react faster than it is capable of due to the circuitry delays, inefficiency of the wheels to move as quickly as needed.

I have two Segways (a blast, by the way) and they stand up on their own. It's fun to watch them "dance"..

I literally had to go to the factory in NH to take a class on how to ride these models. Yes, long time ago.

What they suggested this: to stabilize my units when first riding it, add some weights to the saddle bags on either side. It not only helped me when learning, it helped the Segway stay upright without excess movement

So what I'll suggest (lol) to you is this: get the center of gravity lower by moving the batteries down or adding weight to the bottom of the plastic. That should allow the bot to stay upright without falling over.

LET ME KNOW HOW THAT WORKS.

Robb  
Grand Rapids, MI



**AIKaswa** says:

Dec 22, 2009. 11:44 AM [REPLY](#)

where would i find a single pole double throw switch



**vahid\_you2004** says:  
Electronic devices shop

Dec 25, 2009. 3:55 AM [REPLY](#)



**milsorgen** says:  
aka radioshack

Jan 6, 2010. 3:24 PM [REPLY](#)

ive also pulled one out of a computer, and several other interesting looking switches. mostly out of the optical drives, front panels and a somewhat of floppy drives, but if you keep your eyes open...



**dingo27** says:

Dec 25, 2009. 9:00 AM [REPLY](#)

This is awesome! So simple, but i wouldnt reccomend soldering a battery, it may explode



**Mikishiwa** says:

Dec 7, 2009. 10:23 AM [REPLY](#)

will it be possible to make this robot drive straight without balancing in one spot continuously? For example using this [www.instructables.com/id/Tilt\\_Sensor\\_cheap\\_easy\\_nontoxic/](http://www.instructables.com/id/Tilt_Sensor_cheap_easy_nontoxic/) as a switch, so it will be able to balance in two directions an maybe drive 2-5 metres without falling.



**vahid\_you2004** says:  
To move this robot you need more complicated controlling system than a simple switch, you must also have some motor sensors and a microcontroller to measure motor speed and control its torque and speed.  
For more info search "balancing robot" on internet.

Dec 12, 2009. 3:44 AM [REPLY](#)



**chengtianzheng** says:  
Here, the best design!

Dec 2, 2009. 12:42 AM [REPLY](#)



**chengtianzheng** says:  
nice working,thank you!

Dec 2, 2009. 12:39 AM [REPLY](#)



**ewiemers** says:

Oct 27, 2009. 8:08 AM [REPLY](#)

The problem isn't the center of gravity, it's stability. The switch will work as a measurement device so long as the robot is VERY close to vertical. If you get much past that narrow threshold, the robot doesn't add more torque to the motor to compensate. If you want it to be more stable, you'll have to use some analog device to measure the tilt-angle and another circuit to control motor torque through input voltage. A simple sensor would be a multi-turn potentiometer.



**vahid\_you2004** says:  
You're right.

Oct 28, 2009. 7:05 AM [REPLY](#)

High CG object has high moment of inertia, so it needs more moment to move and has more stability. Because of these you must choose the longest robot and consider your motor power.

The more complex controlling system, the more stability. but the most important feature of this robot is that *it is simple* (according to the the others comments)



**Binary Ninja** says:

Sep 9, 2009. 2:38 PM [REPLY](#)

For a future robot you may want to put the weight lower so it has a lower center of gravity.



**rimar2000** says:

Sep 12, 2009. 2:39 PM [REPLY](#)

No, the center of gravity must be higher. You played to hold a stick upright in the palm of your hand? The longer, is easier to keep it vertical.



**TwistedmindZ** says:

Sep 22, 2009. 9:28 AM [REPLY](#)

well the higher the weight is the more torque it creates for the motor to overcome to stay balanced. When you are holding a stick upright torque isn't a problem relative to your size. So i too think lower center of gravity would make it more stable.



**vahid\_you2004** says:

Sep 23, 2009. 6:41 AM [REPLY](#)

Making the neck longer or putting the weight higher both of them raises the CG. Balancing a high CG object is easier than a low CG object but It need more power to balance a high CG object than a low CG object because a high CG object has more moment of inertia.



**rimar2000** says:

Sep 23, 2009. 7:38 AM [REPLY](#)

I don't agree with you. Sorry I can not do the test, but I am sure.



**rimar2000** says:

Sep 22, 2009. 10:14 AM [REPLY](#)

Well, but, have you tried?



**TwistedmindZ** says:

Sep 22, 2009. 11:16 AM [REPLY](#)

yes i have done it with a broom stick before and i know what you are referring to but that's because the mass of the long stick is a lot larger than one that is shorter so we can feel when it is starting to move off of center of balance. that is the principle on how those segway scooters works except it uses gyros to feel for the imbalance. that self balancing robot on the other hand doesn't have gyros but switches which sense it falling kind of late. lets put is this way it's a lot easier to correct it (the stick) as long as you are near the perfectly balanced point than when the stick is at 20 degrees and falling.



**rimar2000** says:

Sep 22, 2009. 1:00 PM [REPLY](#)

I do not propose to do it with a broomstick, I suggest you do it higher without significantly increasing its mass. Two or three times higher should be a little better. The project is very interesting, worth a little more experience.



**BobmanJCT** says:

Oct 29, 2009. 8:46 AM [REPLY](#)

This might be a bit of an old comment I'm replying to, but I don't think making it taller would help.

Making it taller increases the centre of gravity, as we've established. And this does indeed make it more stable, when for example, balancing on the hand.

This is because the taller object has to fall further to change its angle by the same amount as a short object - Which means we get longer to correct it.

HOWEVER

We also have to move further to correct it. This amount of movement needed to correct it gets exponentially larger the further it falls.

Try correcting a piece of balancing bamboo that is at 45 degrees to the vertical. Then try a much, much shorter stick. The shorter stick takes far less push to correct. Remember, here we are using tiny motors, so we can't get that much correcting movement.

Of course, make it too short and it simply takes too long to correct it, so it will fall regardless. But as you see in the video, it falls over when it goes past a narrow threshold of angle to the vertical. By shortening the stick, we make it less stable in this threshold, but widen the threshold, if that makes sense. Making it taller would just narrow the threshold. Since the problem is that it obviously already goes beyond this angle, then falls over, it would make sense to widen that angle - Ergo, make it shorter.

That might not have been the best way to phrase it, I'll try again if it doesn't make sense



**rimar2000** says:

I understand. Your reasoning is interesting, but I don't agree with you.

Oct 29, 2009. 10:07 AM [REPLY](#)

I think the best way out of the question is do the test, which is not within my reach for now.



**BobmanJCT** says:

I may try making it at some point.

Oct 29, 2009. 11:09 AM [REPLY](#)

I think there are other problems with it too, however.

Like how it is over-correcting the imbalance causing it to fall over, and that the wheels are very small and the motor is mounted above the centre of them. Obviously centre of gravity affects these, but I think it would be best to first fix these.



**rimar2000** says:

I don't understand what is the problem with these circumstances.

Oct 29, 2009. 12:50 PM [REPLY](#)

Moreover, if you lengthen the body and enlarge the wheels, you will be as now. You will have made a model no longer, just a bigger one.



**rimar2000** says:

Excellent work: simple, cheap, effective. A suggestion: Make it taller. You played to hold a stick upright in the palm of your hand? The longer, is easier to keep it vertical.

Sep 12, 2009. 2:41 PM [REPLY](#)



**sharlston** says:

thats cool i may attempt it

Sep 7, 2009. 1:22 AM [REPLY](#)



**I am Silas.** says:

Wow!

Sep 4, 2009. 6:33 PM [REPLY](#)



**yoda-iz-my-idol** says:

put =smart=s paper instructables robot on it

Aug 22, 2009. 12:29 PM [REPLY](#)



**joker12je** says:

why you didn't use a spdt switc with had a weel alredy?

Jun 14, 2009. 12:08 PM [REPLY](#)



**Procrastination** says:

he didn't have one.

Jul 29, 2009. 1:06 PM [REPLY](#)



**entenie-1995** says:

He can buy one.

Aug 18, 2009. 4:17 AM [REPLY](#)



**Procrastination** says:

well... if you already have one why go buy another? A simple modification saves you a buck or 2.

Aug 19, 2009. 7:30 PM [REPLY](#)



**entenie-1995** says:

:)

Aug 20, 2009. 8:22 AM [REPLY](#)



**bjornacorn** says:

How did you add the words across the picture. "Balancing Robot"














Aug 8, 2009. 9:54 PM [REPLY](#)



**vahid\_you2004** says:

There is a lot of programs for editing pictures. I used Paint.NET.

Aug 11, 2009. 6:44 AM [REPLY](#)

- 
-  **coilsinamotor** says: Aug 8, 2009. 6:46 PM [REPLY](#)  
that idea is great ,I made one and it works great
- 
-  **tallfuzzyone** says: Aug 8, 2009. 11:28 AM [REPLY](#)  
lol half-life 2, love this song.
- 
-  **112251919112** says: Jul 20, 2009. 12:24 PM [REPLY](#)  
it fell alot in video.
- 
-  **vishnu\_ad1993** says: Apr 16, 2009. 8:49 AM [REPLY](#)  
come on brother!!! you do great things i love it dude!!!!!!!!!!!!
- 
-  **Sagar Gondaliya** says: Apr 20, 2009. 2:38 PM [REPLY](#)  
yay i'm not the only indian dude on this site. thnx
- 
-  **n33r** says: Jun 17, 2009. 2:19 AM [REPLY](#)  
yes its not only u :D Btw R u From Gujarat ?
- 
-  **Sagar Gondaliya** says: Jun 17, 2009. 6:13 PM [REPLY](#)  
yea! u?
- 
-  **n33r** says: Jul 16, 2009. 5:14 AM [REPLY](#)  
Yer Me too m From ahmedabad
- 
-  **Marche** says: Jun 29, 2009. 2:18 PM [REPLY](#)  
Way to use the Half Life 2 Sound Track in your video :P
- 
-  **alex-sharetskiy** says: Jun 8, 2009. 7:41 AM [REPLY](#)  
awesome!
- 
-  **sciguy77** says: Jun 7, 2009. 12:49 PM [REPLY](#)  
This is a great little bot, but could you please explain a little more what the nail does and where it goes?
- 
-  **venkboy** says: Jun 3, 2009. 11:25 PM [REPLY](#)  
Gonna make this now. Too good and too simple. I think I will use two switches one for each side of the tilt.
- 
-  **ROB0\_Ninja** says: Jun 2, 2009. 3:58 AM [REPLY](#)  
HL2 SOUNDTRACK IN THE VID!!!!
- 

[view all 196 comments](#)