

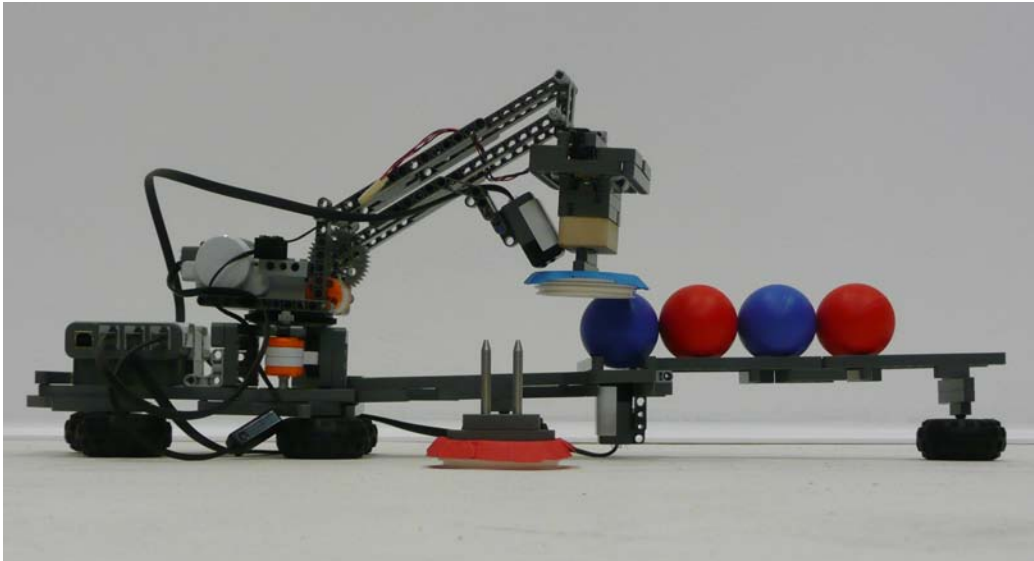
MagnoBot Tutorial

DC403 - Lego beyond Toys

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MagnoBot Tutorial

Introduction



MagnoBot is a robot that is able to (de)attach parts to its arm, in order to hit a colored ball with a matching colored tool. In the picture above, one can see that the Lego arm has a blue tool attached, and hits a blue ball.

MagnoBot is made using the Lego NXT kit and uses 2 solenoids¹ (type 330-5241), which are magnetic latching solenoids. This tutorial shows a step by step approach to actually build one yourself. Good luck!

Parts

Next to a Lego NXT kit to build the robot arm (based on the NXT robot arm²), you need some other (non-Lego) parts, being:

1. two magnetic latching Solenoids (*type 330-5241*)
2. two Tools (*two parts that hold the solenoid plungers*)
3. a Holder (*a system that holds the 2 solenoids*)
4. a Guider (*a system to guide the solenoid plungers into the solenoid*)
5. a Buffer (*a system that buffers the rotation/translation when guiding the solenoid plungers into the solenoid*)

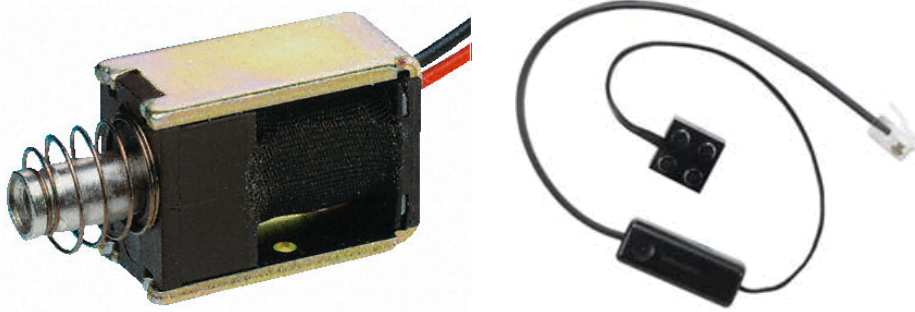
In the next pages of this tutorial is described how these parts can be created.

¹ <http://be02.rs-online.com/web/search/searchBrowseAction.html?method=getProduct&R=3305241>

² http://www.nxtprograms.com/robot_arm/steps.html

Parts (1/5): Two Solenoids

Next to a Lego Buy 2 solenoids (type 330-5241). Make sure it is the magnetic latching solenoid type, this is necessary because this specific type has its plunger latched magnetically in position, until a negative electrical pulse is applied. This means that it is designed for low duty cycle applications, such as this battery powered NXT robot.



Once you have two solenoids, attach them in series to a NXT-to-RCX converter cable. This specific type of solenoid uses a de-attach voltage of about 4.2 Volts. In series this sums up to 8.4 Volts, which is close to what comes out of one of the output ports of the NXT brick. Cut the converter cable open and solder the two solenoids in series. You can try if the solenoids work by programming the following in the NXT (in Lejos):

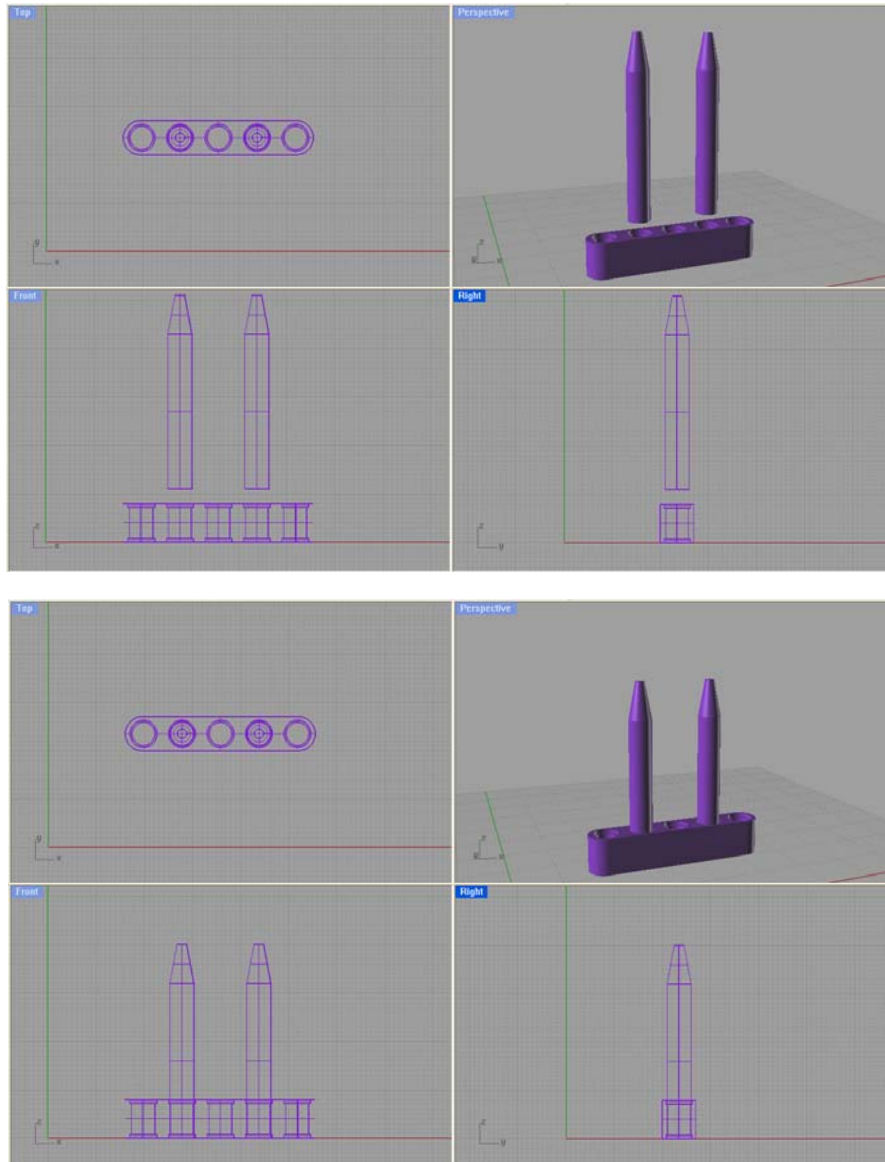
```
Motor.A.setSpeed(900); // sets the speed of Motor A
Motor.A.forward(); // makes Motor A go forward
try { Thread.sleep(1000); } catch (InterruptedException e) {}
Motor.A.stop(); // stops Motor A
```

This program would release the solenoid plungers, wait for 1000 milliseconds and then stop the power, allowing the plungers to be latched magnetically to original position.

Parts (2/5): Two Tools

For the MagnoBot, the plungers of the solenoids are attached to a Lego beam of size 5. However, the plungers of this kind of solenoids have a diameter of 5 mm, meaning they could easily fit in any size of Lego beam.

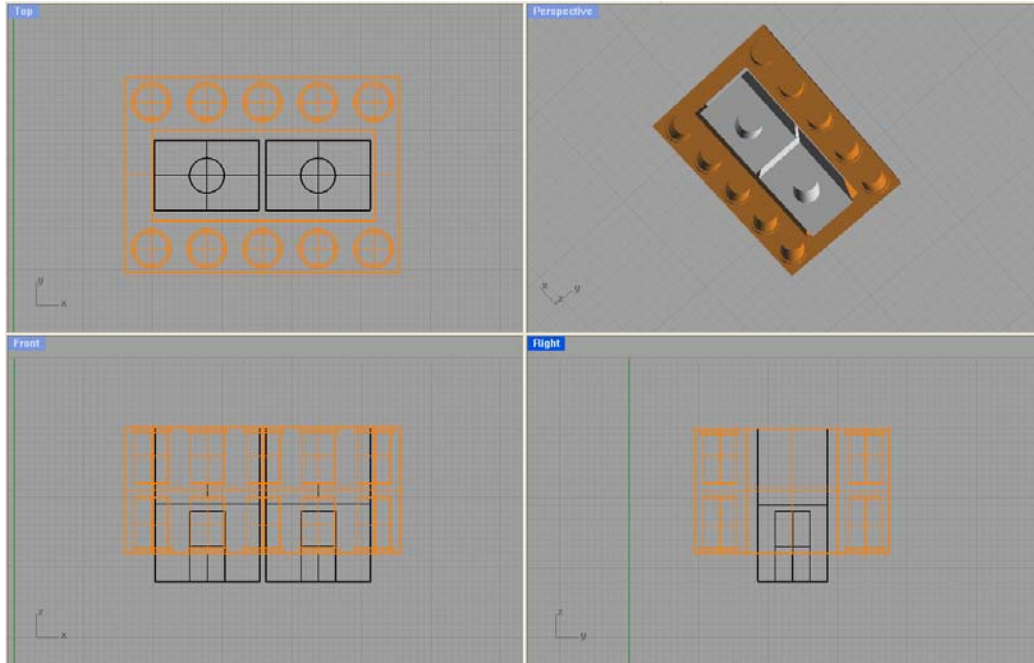
The problem is that you cannot use the original plungers, since are too short when using the guiding system. Get yourself a metal axis (diameter of 5 mm), cut them in size and file the tops (or mill them if you have a milling machine). You can get the correct sizes from the pictures; each block in the grid equals 1mm.



Push your self-made plungers in the Lego beam and you're done making a Tool. The first picture shows the separate parts, in the second the parts are attached.

Parts (3/5): Holder

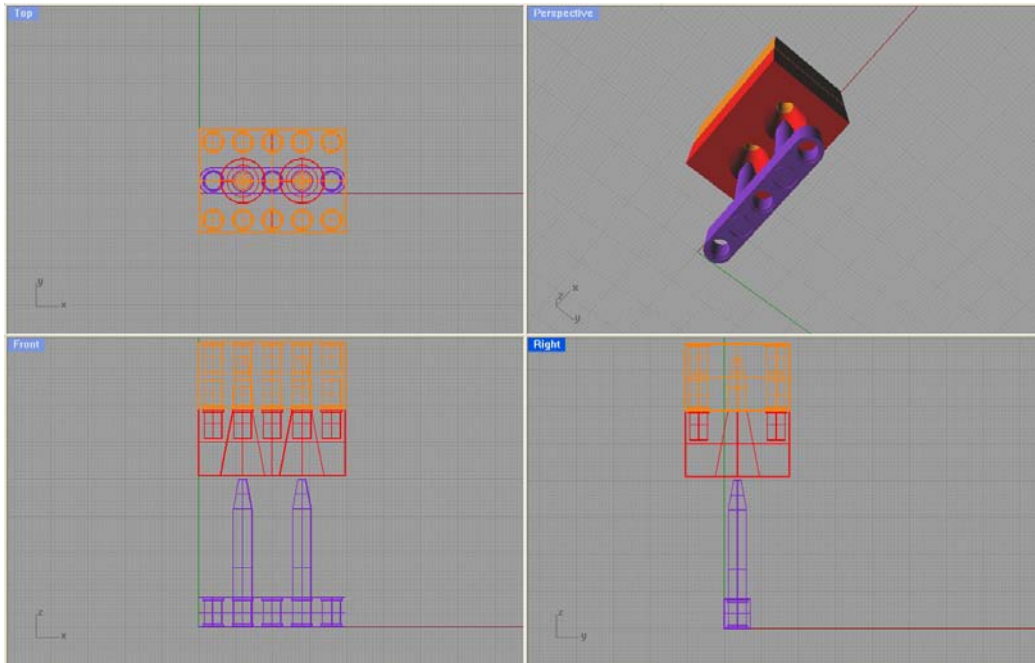
The two solenoids need a system to carry them in. That system is a simple construction that holds the two solenoids next to each other, and has some possibilities for other Lego parts to attach to. Build the system as shown below, again the grid shown is in millimeters.



If you take a close look at the picture, you can see some space between the holder and the solenoids. Try to fill this space with flexible material (e.g. foam), so that the solenoids have a little flexibility when sliding over the plungers that have a fixed position in the tool. This way, we can prevent jams and friction caused by sliding construction that is too stiff.

Parts (4/5): Guider

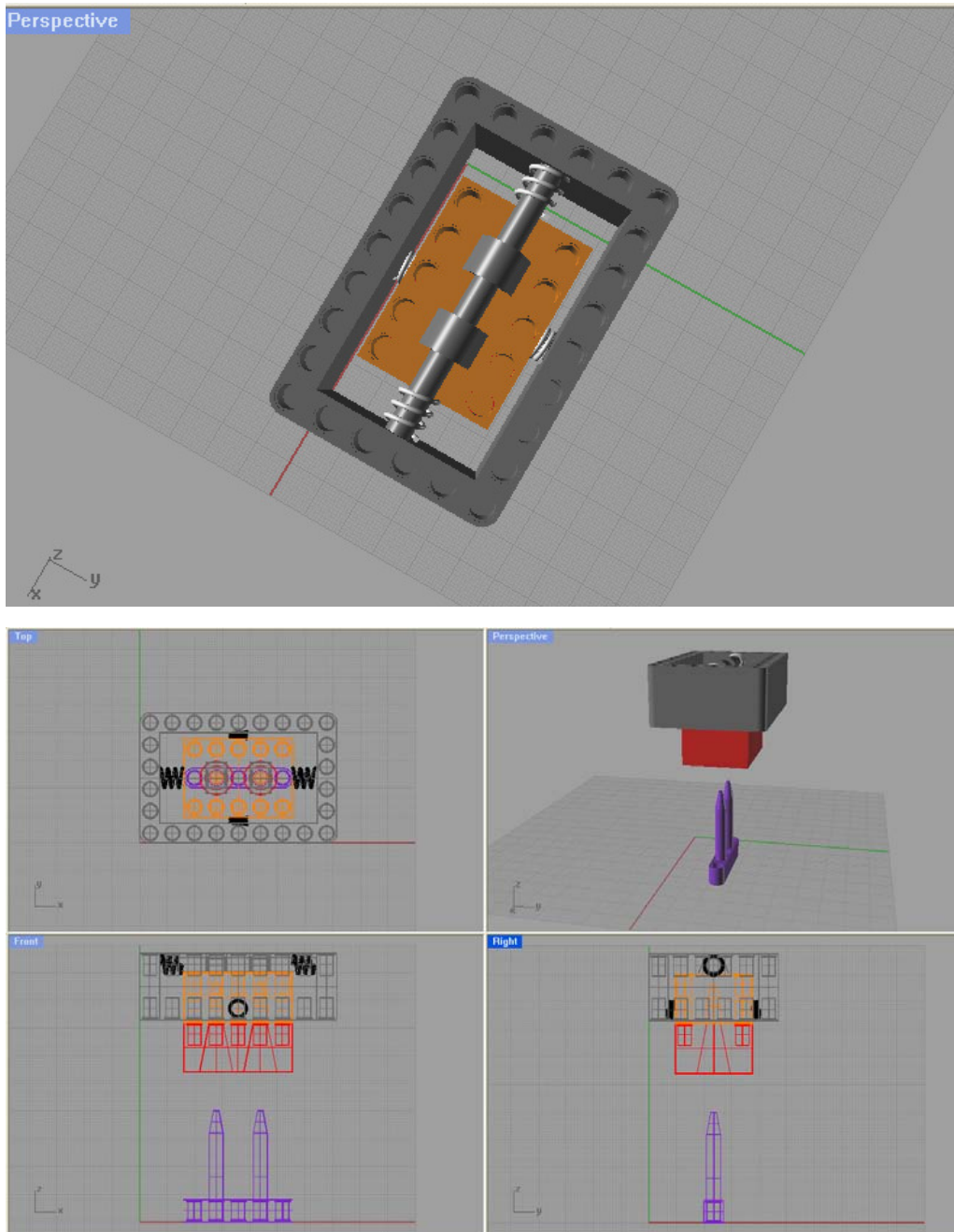
For the mechanical arm (with the Holder attached) to actually attach the Tool (with its plungers) is quite a delicate procedure. To make this easier, the Holder is equipped with a guiding system (the Guider). The Guider makes it easier for the plungers to slide into the solenoids. In the picture below we see such a guiding system (the red part in the picture, again the grid is in millimeter).



Basically, the Guider is a hollow cone shape that guides the plungers more easily in the solenoids.

Parts (5/5): Buffer

Whenever the Tool is a few millimeter out of position, the Guider (which is attached to the Holder) should slide the Tool into position. However, when the Holder is a stiff construction, this would have no effect. The Holder should have the possibility to adjust its position a few millimeters to the position of the Tool. For that purpose, there is a buffer construction build in; the Buffer. The Buffer is a construction that holds the Holder with springs, so that the Holder can change its position a bit, but always returns to its original position. In the picture below we see the buffering system (the grid is in millimeter).



Final Word

When you have all the parts together, you should be able to assemble your very own MagnoBot. However, the MagnoBot was only a way to show you that it is possible to analyze a certain situation (in this case, there is a red/blue ball), and then grab the appropriate tool (in this case, a red/blue slamming device). You can imagine there can be a myriad of ways to make use of this principle. You only need one arm, and you can think of an unlimited number of attachable tools, with unlimited actions. Good luck!