



DIY Universal Robot Gripper

by [DIY Hacks and How Tos](#) on April 6, 2014

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Intro: DIY Universal Robot Gripper

There are a lot of different kinds of robot grippers (end effectors). The most common strategy when designing a robot hand is to try to replicate the human hand. However, in 2010 researchers at Cornell University and University of Chicago developed a unique approach. They created an amorphous gripper that was able to mold itself to the object that it wanted to pick up. This kind of gripper is much more versatile.

In this project, I am going to show you how to make your own DIY universal gripper for your robots.



Step 1: Background: How It Works

This gripper works because of a process that is called "jamming." When a granular material such as coffee is compressed, it becomes very rigid. As the pressure increases so does the amount of friction between the individual grains. This effectively locks the grains in place.

You may have observed this phenomenon while handling bags of coffee grounds. A vacuum packed bag of coffee grounds is rock hard as long as the seal remains intact. But as soon as the seal is broken, the coffee become soft and pliable and can be poured like a fluid. This process happens with many granular materials such as rice, couscous and even sand.

We are utilizing this process to make an amorphous robot gripper. A balloon is filled coffee grounds and attached to an air hose. When balloon is slightly pressurized the grounds are loose and easily rearranged. By pressing the balloon against an object, the grounds will move around it and take its shape. But when the air is sucked out of the balloon, the grounds are compressed and grip the object. The rubber surface of the balloon also helps to keep a hold of the object.

Here is a video from Cornell University that explains the process:

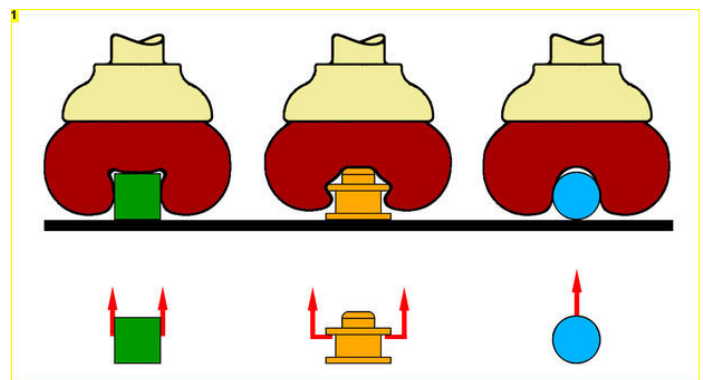
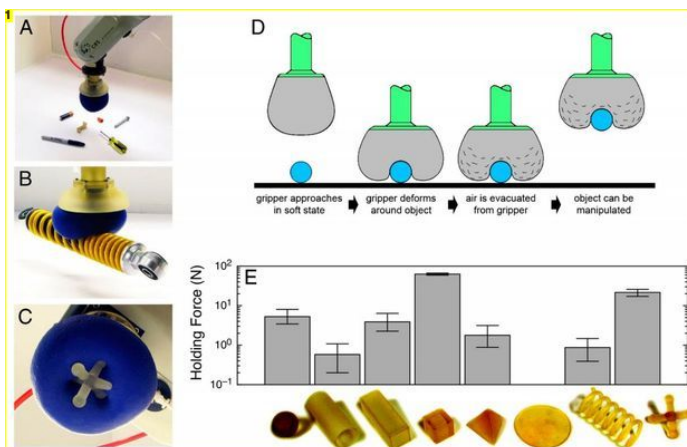


Image Notes

1. Credit: John Amend, Cornell University

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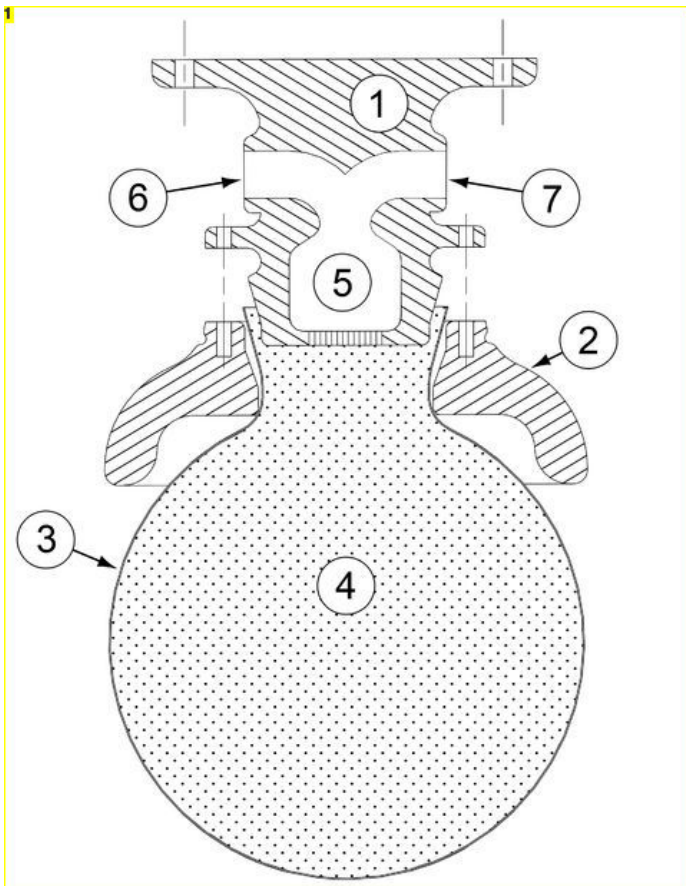


Image Notes

1. Credit: John Amend, Cornell University



Step 2: Materials

Here are the tools and materials that you will need for this project:

Materials:

- Balloons
- Plastic Funnel
- Coffee Grounds
- Duct Tape
- Air Hose/Tubing
- Thin Cloth
- Small Plastic Tube (optional)

Tools:

- Air pump for pumping air into and out of the balloon
- Knife



Step 3: Fill the Balloon With Coffee

The first thing that you need to do is fill the balloon with coffee grounds. To do this, attach the balloon to the end of a short tube or pipe. Then insert the funnel into the other end. Scoop about a tablespoon of grounds into the funnel and it will pour down into the balloon. Then remove the funnel and blow into the tube to partially inflate the balloon. This will allow all the grounds to fall to the bottom of the balloon. As you slowly let the air back out, the grounds will remain trapped in the balloon. Then insert the funnel back into the tube and repeat the process.

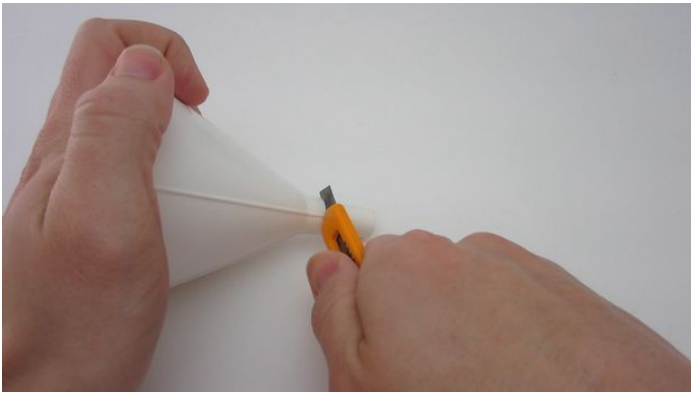
Continue adding coffee. Periodically, set the balloon inside the funnel to check its size. You want the balloon to stick out about one inch past the edge of the funnel. Once you have enough coffee grounds in the balloon, you can remove the balloon from the tube.



Step 4: Cut the End of the Funnel

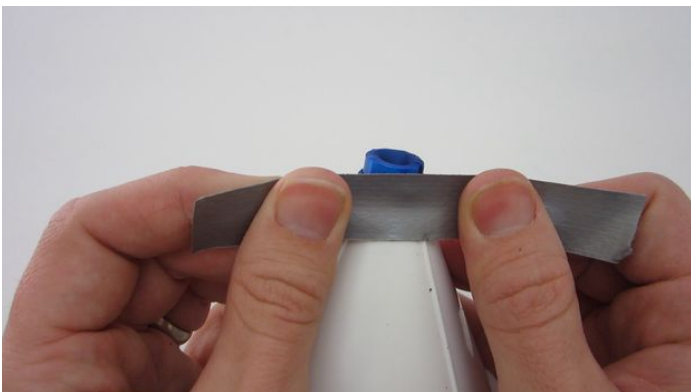
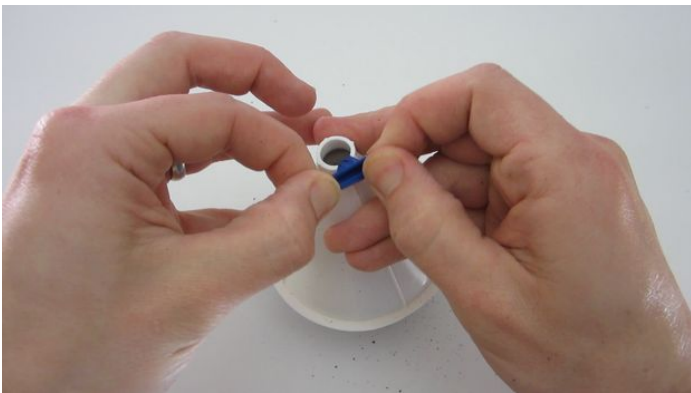
Now we need to put the balloon in the funnel and insert the neck of the balloon through the narrow opening. Unfortunately most kitchen funnels have a narrow section that is several inches long. This makes the process very difficult.

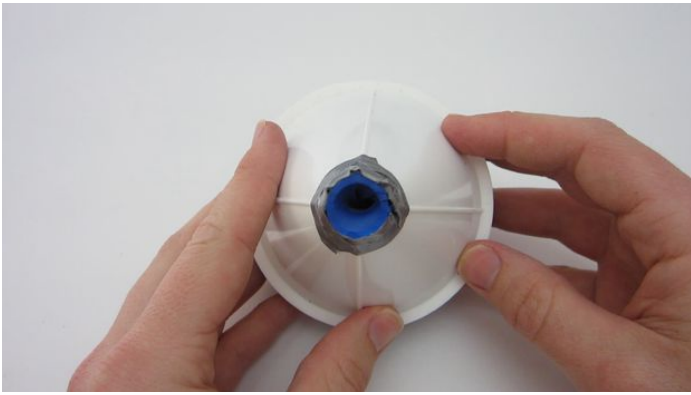
So to make it easier, I cut the narrow section of the funnel so that it is only 1/2 inch long. You can do this with any sharp knife. After cutting the funnel try to smooth off any rough edges.



Step 5: Attach the Balloon to the Funnel

Insert the neck of the balloon through the funnel and wrap it around the opening on the other side. To hold it in place, I applied small strips of duct tape.





Step 6: Attach Fabric to the Opening of the Balloon

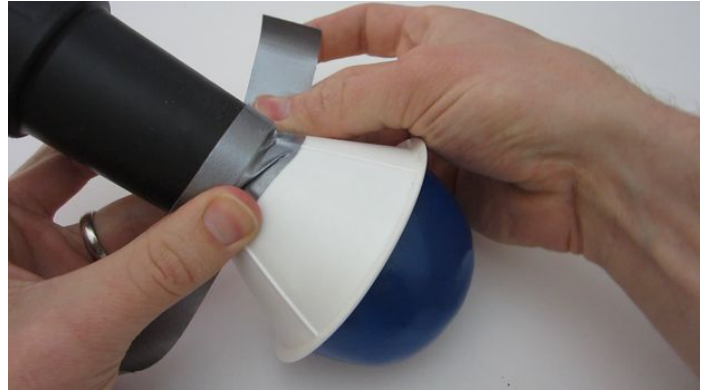
We want the coffee grounds to stay inside the balloon. To prevent them from falling out, I attached a small piece of fabric to the opening. This will act as a rough filter. You want to use a fabric that breathes easily so that the air pump will be able to quickly move air in and out of the balloon.

Tightly wrap the fabric around the opening of the funnel. Then secure it in place with small strips of duct tape.



Step 7: Attach the Air Hose to the Funnel

Now you need to attach the air hose to the funnel. The easiest way to do this is to hold the funnel up the air hose and attach them together with several layers of duct tape. You want to make a (mostly) air tight seal. So feel free to use as much tape as you want.



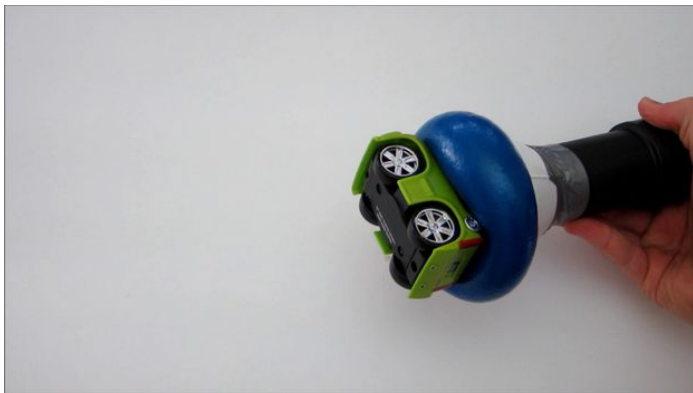
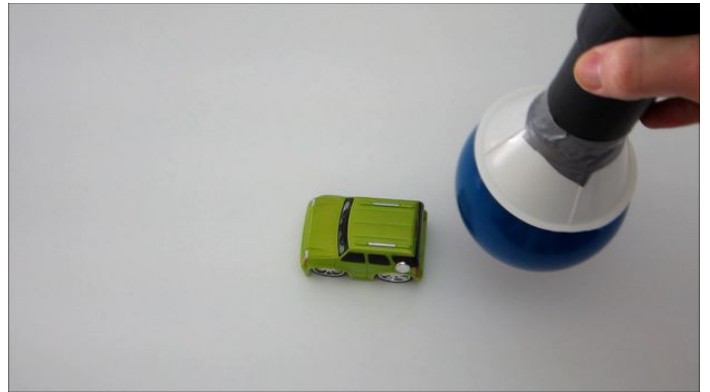
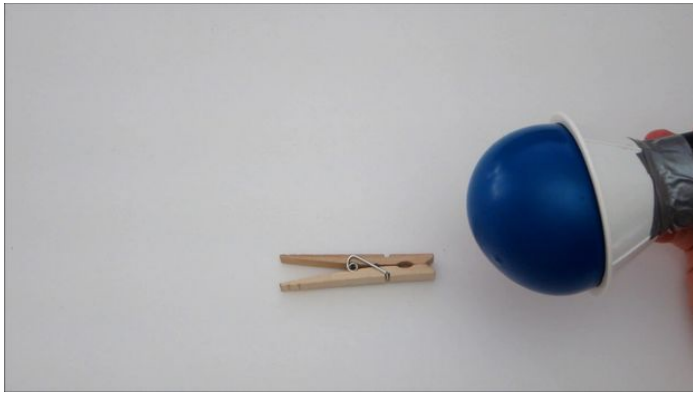
Step 8: Use the Universal Gripper to Pick Up Objects

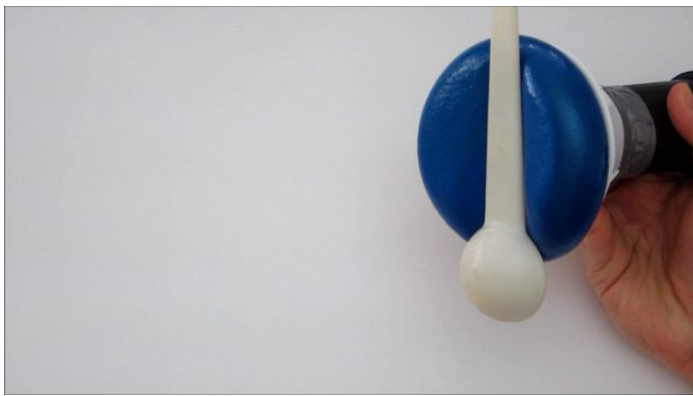
Now you are ready to use your universal gripper to pick up objects.

Start by partially inflating the balloon. This will make the grains loose so that they will freely move around the object. Then gently press the balloon on top of the object. Now suck the air out of the balloon. Continue pressing down on the object as the balloon deflates. The balloon will shrink and the grains will be lock in place around the object.

When all the air is sucked out of the balloon, you should be able to pick up the object. As long as the vacuum is maintained, the universal gripper should continue to hold the object firmly. To release the object, simply break the seal and let some air back into the balloon. The object will then fall from the gripper. If you quickly blow air back into the balloon the gripper will forcefully eject the object. You can use this to shoot small objects across the room.

This kind of gripper is ideal from pneumatically powered robots. All you have to do is hook the gripper up to the robot's air line and you will be able to manipulate a wide variety of objects with ease.





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Comments

3 comments

[Add Comment](#)



Jdsardone says:

Very cool idea, and simple to make.

Apr 16, 2014. 3:13 PM [REPLY](#)

Also, so as not to confuse people, in step 1, first paragraph you say "As the pressure increases so does the amount of friction between the individual grains. This effectively locks the grains in place."

But I think you mean as pressure **decreases** (aka vacuum forms) the friction goes up, locking the grains in place"



DIY Hacks and How Tos says:

I guess my wording was a little ambiguous. What I meant was "as the grains are pressed against each other (which happens as a result of the change in air pressure)."

Apr 16, 2014. 7:38 PM [REPLY](#)



texagon says:

simple yet effective, great idea.

Apr 16, 2014. 5:10 PM [REPLY](#)