CIRQUE Du Robot

The SmartSensor Lite from CATCAN Creative gets put through its paces

Arduino-like results from the Arduino-compatible PIC-based Pinguino

Combat Zone
Identifying unknown brushed DC motors
Affordable 2.4 GHz
Using Li-poly or Li-ion batteries safely
Brushed DC Motor Tutorial

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Real Transformers in Phase 1

No, it’s not an illustration from a toy package or a movie poster. This is the desired end product of the Transformer (TX) program kicked off by the folks at the Defense Advanced Research Projects Agency (DARPA, www.darpa.mil) last fall. Some $3 million in funding has been awarded to several research participants — notably AAI Corp. (www.aaicorp.com) and Lockheed-Martin (www.lockheedmartin.com) — to look into the concept of building a sort-of Humvee/jump jeep/gyroplane concoction that can travel over any kind of terrain. Basically, a CarterCopter driven by a gas turbine propeller and fitted with foldable wings and rotor mast. The guidance and flight control systems are to allow semi-autonomous flight, so even someone with no pilot training can perform VTOLs, transition to forward flight, and modify the flight path as needed.

Specs call for the vehicle to travel at least 250 nautical miles in any land/air combination while carrying up to 1,000 lb. Phase 1 involves 12 months of conducting “trade studies to develop and mature propulsion systems, adaptable wing structures, advanced lightweight materials, the advanced flight control system, the air/ground configuration designs, and energy distribution systems.” If all goes well, the project will move on to an unspecified second phase.

This Gripper Sucks

Every once in a while an idea comes along that’s so simple it’s brilliant, and a case in point is a universal robotic gripper emerging from researchers at Cornell University, the University of Chicago, and iRobot Corp. Whereas most gripper designs tend to be variations on the human hand and fingers, this one is basically a vacuum cleaner attached to a balloon filled with ground coffee. In operation, you just press the balloon against an object which causes it to deform and fit around a portion of the target. You then suck the air out of the balloon, and the coffee undergoes a “jamming transition” that turns its behavior from that of a fluid to that of a solid, i.e., the grounds can no longer slide past each other. The result is a gripping action that works with virtually any shape. Releasing the object is simply a matter of turning off the vacuum. According to Prof. Hod Lipson, the universality of the gripper makes future applications seemingly limitless, including implementation as feet on a bot that can walk up walls.

So, why didn’t you think of that?

For a more detailed explanation of this gripper, check out the GeerHead column in this issue.

Free Robot Art

As occasionally noted in these pages, when artists and robots tangle, the bots usually come out on top. An exception, however, is some pretty neat images collected and posted by graphic designer Eric Shafer at creativefan.com/40-brilliant-robot-artworks/. No copyright information is included for most of them, but it’s a fair guess that you can download anything you like and use it as a desktop theme or something like that.
Getting A Grip
Fingerless Robot Hand Grabs, Carries, Pours, and Writes

What can you do with a latex balloon, some coffee grounds, and suction? You can create a universal jamming robotic gripper hand that can pick up anything. This unconventional approach to an end effector/manipulator skirts the many issues that come with developing a humanoid robot hand.

With multi-fingered humanoid hand research, there are challenges such as how to actuate the many finger joints, how to apply force sensing to delicate objects can be held firmly without breaking or damaging them, and how to address the great mass of algorithms and computations necessary to calculate the force applied to each object by each finger.

As such, fingered hands are extremely intricate due to hardware complexities, actuation complexities, and the need for expansive software-based intelligence to perform the sub-tasks that lead to gripping and lifting with fingers.

As a result, humanoid finger-based hand research and development has proven expensive. Roboticists have invested themselves heavily to create universal gripping hands — hands that can pick up anything — using this model.

On the other hand, researchers and roboticists at Cornell University, the University of Chicago, and iRobot Corporation, have applied mechanical engineering and particle science to the complex problem of a universal robot gripper. Between them, Cornell’s John Amend and Hod Lipson, Chicago’s Heinrich Jaeger, and iRobot’s Chris Jones

See how the universal jamming gripper safely grasps and lifts an egg without breaking it. (Now, if they can only teach one or two hands to crack the egg and whip up a nice dish ...)

Here, the hand grips and lifts a spring device (such as an actuator or shock absorber) which has a less predictable surface to work with.
have come up with a hand that is not human-like at all.

With their granular gripper, the mass of latex and coffee grounds surrounds and presses an object to get its grip, then a vacuum is created to harden the coffee grounds and latex in the new shape, securing the gripper’s control of the item.

**Turn Up the Jams**

Researchers based the universal jamming gripper on a jamming phase: “If a collection of granular material is loosely packed, it can flow like a liquid. If, instead, the granular material is more densely packed, it behaves like a solid, and we call this the jammed state,” explains Eric Brown, postdoctoral scholar from the University of Chicago.

“The transition between these two states is very sharp and is called the jamming transition. The difference in density between the two states is very small. This is analogous to the sharp phase transition between water and ice if the temperature is reduced,” Brown illustrates.

With the surface of the gripper covering only one-fourth of the surface (sometimes less) of an object, the attending vacuum can tighten the hand on or around a cup, pen, screwdriver, or most anything. The hand comes up against the object, taking shape around it. Once the hand is in place, the vacuum or suction is applied and the grasp of the gripper is complete.

“For our tests, everything was pre-positioned because we were not testing any sensors. We did some tests on the tolerance to positioning and found the gripper had no loss of gripping capabilities if it was off target by as much as a quarter of the gripper size,” says Brown.

“For autonomous robot applications, this suggests even something rudimentary like a web cam may be all the sensing that is necessary. For other applications like assembly line or manually operated grippers, no sensing may be necessary at all,” Brown notes.

**Adjust the Volume Slightly**

By decreasing the overall volume of the balloon by as little as one half of one percent, the roboticists can turn the malleable balloon into a rigid form around part of an object that is enough to grip and lift it up. “There is less space between the particles of coffee grounds and less space volume inside the balloon,” says Brown.

Just a small amount of vacuum is enough to turn the soft, pliable latex and coffee grounds into a rigid confine about the item’s surface. The gripper can hold and carry multiple items that are in close proximity to one another, as well. A pump known as a Venturi aspirator sucks the air out of the gripper. A red tube runs from the gripper to the pump to accomplish this.

“We used a variety of pumps for different
Gripper prototypes. We focused on the gripper because different pumps could be used for different applications,” says Brown. The connection to the pump requires a filter to prevent the coffee grounds from leaving the gripper.

The scientists attached the gripper to a robotic arm in a fixed position. The arm selected for the gripper is a CRS A46S model. “The model is convenient for pick and place testing. We only performed tests to evaluate the grip performance, and not to evaluate characteristics with a specific arm, as different arms could be chosen for different applications,” says Brown.

The gripper can lift items many times its own weight and size. This is due in part to the geometry involved when the gripper presses so firmly against the object’s surface. It is also because of the friction between the gripper and the object. “The gripper picks up objects using friction when it pinches them, even if it doesn’t wrap very far around those objects. This is similar to someone palming a basketball with one hand,” explains Brown.

Conclusion

With all the complexities involved with a humanoid hand, it’s amazing how a simple yet out of the box answer may be the right one after all. SV

Resources

Gripper home page
http://csl.mae.cornell.edu/jamming_gripper

Universal gripper video
www.news.cornell.edu/stories/Oct10/Hod.Lipson.gripper.mov

Eric Brown home page
http://home.uchicago.edu/~embrown

John Amend home page
www.johnamend.com

Hod Lipson home page
www.mae.cornell.edu/lipson

Heinrich Jaeger home page
http://jfl.uchicago.edu/~jaeger/hmj

iRobot Corporation
www.irobot.com