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Department of Mechanical Engineering
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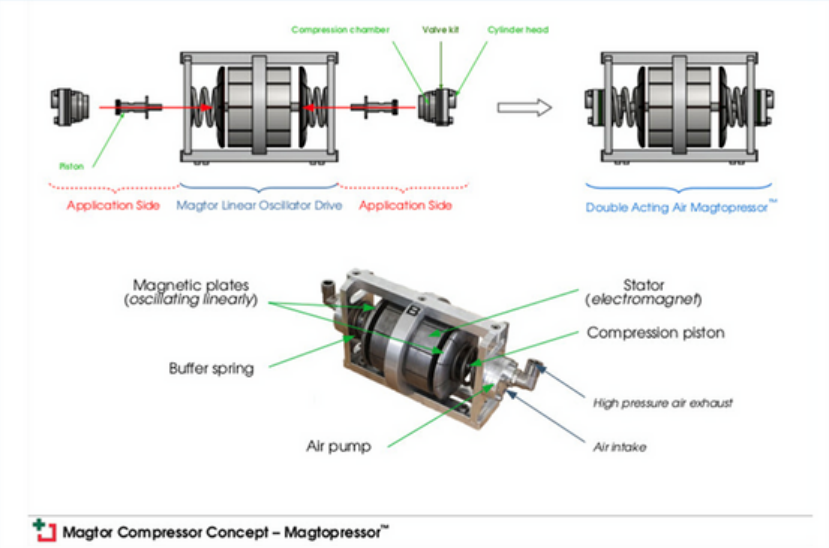
DESIGN AUTOMATION ROBOTICS ENERGY

A Linear Motor to Cut Cooling Costs



A majority of the world's energy use goes to cooling homes and refrigerating food. In the coming decades more and more of the world will cool air for comfort and convenience, to the tune of some half a billion cooling units each year. All those air conditioners and refrigerators are dependent on their compressors, and a tiny increase in compressor efficiency could have a huge effect on reducing energy use worldwide.And yet, compressors have hardly evolved in a century.

But now Magtor Ltd., a small European company headquartered in Malta, has chucked out the rotary drive at the heart of compressors as we know them and replaced it with a linear motor. The result is a compressor that is more than 30 percent more efficient than its traditional competitors, according to company officials.

Their first prototype, connected to a crank shaft, convertedthe linear motion back to a rotary motion. Eventually, though, they noticed that the force profile of their motor was a perfect match for a compressor.That profile is the result of a clever, and deceptively simple, arrangement of magnets, shaft, and stator. Two magnetic plates, aligned and facing each other, are connected by a shaft. A stator at the center switches the plates between attraction and repulsion.But to achieve repulsive interaction between an electromagnet and a permanent magnet requires a lot of electricity. That's why these devices were not explored much.

Overcoming this obstacle is one of the breakthroughs behind the Magtor motor. The interaction distance is huge compared to other electromagnetic motors where the space between magnets is kept to a minimum—usually something like a millimeter—and the motor can start and stop easily. Where a rotary motor requires a significant power spike to start up, the linear motor needs no such kick. It delivers a force that is constant but with an uptick at the end of a stroke, perfectly matching the needs of a compressor. It does not require a control mechanism to get going.The Magtor motor also needs no lubrication and the only contact points are found within the compression chambers. So not only is it more efficient than what's currently available, it's also likely to have much greater longevity.

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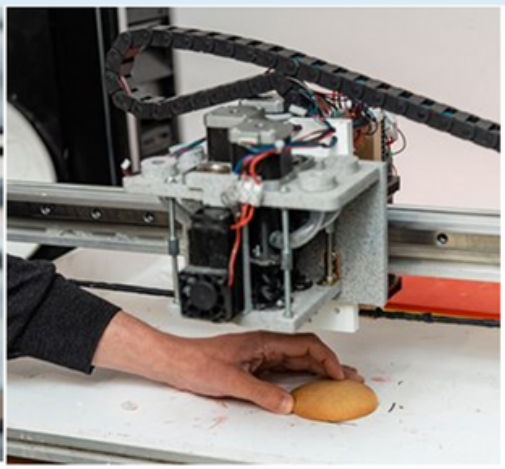
The Magtor motor uses a double-cylinder geometry with the magnetic interactions occurring only at the edges of the magnetic plates. These are always kept in alignment with the edges of the electromagnet. This gives the unit a precise flux guidance, and an incredibly tight magnetic field, so the motor needs no shielding.

Already industry members have been calling the Magtor offices, hoping to use the motor in the next generation of cooling products. But there's still work to be done. The linear compressor is, at the moment, not enclosed within a shell and mufflers or silencers are not incorporated into the pumps, so it's loud.

3D Printing Serves Up Main Course

Infrared lasers can brown the surfaces of food while blue lasers can cook items all the way through. Photo: Columbia University Creative Machines Lab



3D printers can extrude raw ingredients, but a new system developed at Columbia University cooks food on the spot. Photo: Columbia University Creative Machines Lab

Hod Lipson of the Columbia University Creative Machines Lab believes a new printer his team developed could revolutionize food the way Apple's iPod changed how the world accesses and listens to music. The team's concept is still a bit half-baked, but it is heating up. Literally.

The lab's digital food team has been printing food ingredients in a variety of combinations for the last 16 years. The end product was edible but raw. Jonathan Blutinger, a doctoral student in Lipson's lab, dreamed of transforming the printer into a full kitchen appliance that could cook a delicious meal at the touch of a button. But there was a problem: The printer extruded ingredients but couldn't cook them.

Blutinger and the team recently solved that. They can now cook food using infrared and blue lasers.The team stumbled upon the solution by accident. The researchers had been using infrared lasers in the lab for cutting acrylic and fiberboard for different projects and wondered what would happen if they used it on dough. The laser nicely browned the outside but didn't cook the inside. The team then tried a blue laser, thinking that a laser on another wavelength might produce different results. It cooked the dough through perfectly, just like an oven, but didn't brown it.After attaching the lasers to the printer, the team was able to adjust them for extremely precise cooking. But the printer still needed a way to control the whole process.

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In regular 3D printing, makers typically design their end-product using CAD software, converting the 3D model into an STL (standard tessellation language) file and then passing it through a slicer engine to convert it to a G-Code file. That file contains the language that tells a printer how to build something, including the thickness, layers, extrusion rate and other specifications.

Printing food made up of many ingredients requires much more complex software than is needed for printing the one or two feed stocks used in most 3D printing applications. Almost every ingredient, for example, has a different elasticity. Peanut butter prints very differently than cream cheese. The geometries of food ingredients, such as powders, pastes, and grains, are completely different from a rectangle or cylinder. Room temperature fluctuations of just a few degrees can affect the whole process. The software has to be able to predict, control, and compensate the ingredients in real-time.

The lab is far from optimizing its food-printing software, but has developed a strong enough foundation to print and cook a number of different dishes, including chicken, salmon, hamburgers, and a seven-ingredient dessert that included layers of peanut butter, Nutella, and Graham cracker, which Blutinger claims as his favorite 3D-printed dish yet.

Department News

Mr. RevikumarThampy V. R., Assistant Professor of ME and Mr. Baiju V, Assistant Professor of ME joined the department in November 2021 following the latest round of general transfer of employees of the IHRD.

Team AAGNEYA participated in the Indian Karting Race 6th season held at the Buddh International Circuit, Greater Noida, UP (11 - 15 January 2022). The event was organized by the Indian Society of Innovative Engineers. 25 teams from across the country had registered for the event.