New soft motor more closely resembles real muscles (w/ video)

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(PhysOrg.com) -- "When you pick up a spoon with your fingers, you are able to move it from side to side and rotate it too by moving thumb and forefinger in opposition," Iain Anderson tells *PhysOrg.com*. Your hand is a soft machine. To be able to mimic the hand, we need soft technology."

Anderson is a scientist at the Biomimetics Laboratory at the Auckland Bioengineering Institute in New Zealand. Anderson’s lab works with dielectric elastomer artificial muscles, developing technology designed to more closely mimic the movements of muscles. “We’ve been researching artificial muscles for a few years now, and we wanted to see if we could create a machine without any hard bits – a machine that mimics the same degree of freedom you see when you move your hand.”

With the creation of a bearing-free motor, Anderson worked with others from the Biomimetics Laboratory, including Tony Chun Hin Tse, Tokushu Inamura, Benjamin O’Brien, Thomas McKay, and Todd Gisby. Their work can be seen in *Applied Physics Letters*: “A soft and dexterous motor.”

Anderson says that the idea for an artificial muscle membrane motor came from his students a few years ago. They showed him an interesting motor. “They were working on this quietly amongst themselves. When they got it running they showed me. This had a rigid central orbiting bearing that was pushed side to side by one membrane and up and down by another,” Anderson explains.

The motor consisted of two different membranes pushing on the same gear, with a shaft supported by rigid bearings. Anderson continues: “So we could get the gear to orbit by combining motion from both membranes and when the orbiting gear supported by the membranes came into contact with a gear on the shaft, the shaft rotated.”

Taking the idea further, Anderson had the idea of making the gear flexible so it could grip the shaft, like a thumb and forefinger grips a spoon. “This breakthrough made the bearings redundant, opening the door to multi-degree-of-freedom motion.” These degrees of motion include the abilities to tilt and rotate, in addition to simply moving the shaft up and down or side to side.

In order to make the motor, Anderson and his group take a special polymer material and stretch it so it becomes a really thin membrane. They create a rubbery gear from the same material and then place the gear at the center of the membrane. Then, sections of the membrane are painted with carbon grease. This grease, when conducting electricity, forces the membrane to change shape and this causes the gear to deform, moving the shaft. “We use selective actuation to turn the shaft.”

Artificial muscles are not new, Anderson points out. He says that SRI pioneered much of the technology used in artificial muscles today. SRI also produced an artificial muscle rotary motor. This first artificial muscle rotary motor, though, “had a lot of hard bits in it. But by using the membrane approach we have been able to make a rotary motor with fewer hard bits.”

The ultimate goal is to create soft machines that are completely free of hard bits. There are advantages to soft motors, Anderson says. “They are lightweight and have the advantage of reduced mass. Their flexibility makes them less likely to break. Additionally, living things are mostly soft. If we want them to interface with living things, it makes sense to have them soft."

Anderson says that the next step is improve the control they have over the motor, as well as create a mechanism that allows the motor to automatically adjust to a heavier load – in much the way that your arm adjusts to keep your hand from lowering a glass of water as you fill it. "We're into soft generators as well," he continues. "We're trying to make the world soft."

More information: -- Iain A. Anderson, Tony Chun Hin Tse, Tokushu Inamura, Benjamin M. O'Brien, Thomas McKay, and Todd Gisby, "A soft and dexterous motor," *Applied Physics Letters* (2011). Available online: link.aip.org/link/doi/10.1063/1.3565195
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