IDIOMA: INGLÊS

Área 2

* Indica uma pergunta obrigatória

1. E-mail *

2. ÁREA *

Marcar apenas uma oval.

◯ 2 - CIÊNCIAS EXATAS E DA TERRA, ENGENHARIAS

3. NOME DO CANDIDATO *

4. NÚMERO DA INSCRIÇÃO *

5. NÚMERO DO CPF *

Leia o texto e responda as questões a seguir em Português. Todas as questões dever ser respondidas de acordo com o texto. As respostas digitadas neste formulário eletrônico constituirão o ÚNICO documento válido para correção da prova.

Engineers design soft and flexible 'skeletons' for muscle-powered robots

Original written by Jennifer Chu

Our muscles are nature's perfect actuators -- devices that turn energy into motion. For their size, muscle fibers are more powerful and precise than most synthetic actuators. They can even heal from damage and grow stronger with exercise.

For these reasons, engineers are exploring ways to power robots with natural muscles. They've demonstrated a handful of "biohybrid" robots that use muscle-based actuators to power artificial skeletons that walk, swim, pump, and grip. But for every bot, there's a very different build, and no general blueprint for how to get the most out of muscles for any given robot design.

Now, MIT engineers have developed a spring-like device that could be used as a basic skeleton-like module for almost any muscle-bound bot. The new spring, or "flexure," is designed to get the most work out of any attached muscle tissues.

The researchers found that when they fit a ring of muscle tissue onto the device, much like a rubber band stretched around two posts, the muscle pulled on the spring, reliably and repeatedly, and stretched it five times more, compared with other previous device designs.

The team sees the flexure design as a new building block that can be combined with other flexures to build any configuration of artificial skeletons. Engineers can then fit the skeletons with muscle tissues to power their movements.

"These flexures are like a skeleton that people can now use to turn muscle actuation into multiple degrees of freedom of motion in a very predictable way," says Ritu Raman, the Brit and Alex d'Arbeloff Career Development Professor in Engineering Design at MIT. "We are giving roboticists a new set of rules to make powerful and precise muscle-powered robots that do interesting things."

When left alone in a petri dish in favorable conditions, muscle tissue will contract on its own but in directions that are not entirely predictable or of much use.

To get a muscle to work like a mechanical actuator, engineers typically attach a band of muscle tissue between two small, flexible posts. As the muscle band naturally contracts, it can bend the posts and pull them together, producing some movement that would ideally power part of a robotic skeleton. But in these designs, muscles have produced limited movement, mainly because the tissues are so variable in how they contact the posts. Depending on where the muscles are placed on the posts, and how much of the muscle surface is touching the post, the muscles may succeed in pulling the posts together but at other times may wobble around in uncontrollable ways.

Raman's group looked to design a skeleton that focuses and maximizes a muscle's contractions regardless of exactly where and how it is placed on a skeleton, to generate the most movement in a predictable, reliable way.

The researchers first considered the multiple directions that a muscle can naturally move. They reasoned that if a muscle is to pull two posts together along a specific direction, the posts should be connected to a spring that only allows them to move in that direction when pulled.

"We need a device that is very soft and flexible in one direction, and very stiff in all other directions, so that when a muscle contracts, all that force gets efficiently converted into motion in one direction," Raman says.

As it turns out, Raman found many such devices in Professor Martin Culpepper's lab. Culpepper's group at MIT specializes in the design and fabrication of machine elements such as miniature actuators, bearings, and other mechanisms, that can be built into machines and systems to enable ultraprecise movement, measurement, and control, for a wide variety of applications. Among the group's precision machined elements are flexures -- spring-like devices, often made from parallel beams, that can flex and stretch with nanometer precision.

She and Culpepper teamed up to design a flexure specifically tailored with a configuration and stiffness to enable muscle tissue to naturally contract and maximally stretch the spring. The team designed the device's configuration and dimensions based on numerous calculations they carried out to relate a muscle's natural forces with a flexure's stiffness and degree of movement.

The flexure they ultimately designed is 1/100 the stiffness of muscle tissue itself. The device resembles a miniature, accordion-like structure, the corners of which are pinned to an underlying base by a small post, which sits near a neighboring post that is fit directly onto the base. Raman then wrapped a band of muscle around the two corner posts (the team molded the bands from live muscle fibers that they grew from mouse cells), and measured how close the posts were pulled together as the muscle band contracted.

The team found that the flexure's configuration enabled the muscle band to contract mostly along the direction between the two posts. This focused contraction allowed the muscle to pull the posts much closer together -- five times closer -- compared with previous muscle actuator designs. When they varied the frequency of muscle contractions (for instance, stimulating the bands to contract once versus four times per second), they observed that the muscles "grew tired" at higher frequencies, and didn't generate as much pull.

The researchers are now adapting and combining flexures to build precise, articulated, and reliable robots, powered by natural muscles.

Adaptado de: *https://www.sciencedaily.com/releases/2024/04/240408130824.htm* **para fins educacionais.**

6. **QUESTÃO 01 – Quais são os benefícios de usar músculos como atuadores em robôs?** *

7. **QUESTÃO 02 – Que problema os engenheiros enfrentam ao usar atuadores movidos a músculos em robôs?** *

8. **QUESTÃO 03 – Qual é o novo dispositivo desenvolvido pelos engenheiros do MIT e qual a sua finalidade?** *

9. **QUESTÃO 04 – Como a flexão melhora o desempenho muscular em comparação com designs anteriores?** *

10. **QUESTÃO 05 – Quais são as futuras aplicações desta tecnologia de flexão na robótica?** *