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From parcel delivery and nursing to rehabilitation: new fabric muscle provides strength assistance to desired body parts

- KIMM's fabric muscle weaving technology transforms regular clothes into strength-assistant robot suits -

- Comfortable and affordable wearable robots achieved by attaching fabric muscles to arms and thighs -

☐ A new fabric muscle weaving technology has been developed to be utilized by wearable robots performing everyday tasks such as parcel delivery, nursing, and construction, and even rehabilitation training. The fabric muscle is soft and light like regular clothes, and can be conveniently attached to desired body parts to provide strength assistance.

□ Dr. Cheol-Hoon Park, principal researcher of the Department of Robotics and Mechatronics under the Advanced Manufacturing Systems Research Division at the Korea Institute of Machinery & Materials (President Sang Jin Park; KIMM), succeeded in developing a suit-type wearable robot powered by thin and light fabric muscle.

□ Wearable robots can be classified into hard-type wearable robots with a hard frame like the Iron Man suit and soft-type wearable robots that are more flexible like the suit of Spider-Man. Recently, suit-type wearable robots have come under the spotlight as they are as comfortable as regular clothes, and offer strength assistance only when required by wearers.

□ The research team created fabric muscle to develop a suit-type wearable robot that is as soft and light as Spider-Man's suit, and capable of muscle-like behavior. First, coil springs were fabricated using shape-memory-alloy wires with a thickness of 40 ㎛, and then the fabric muscle was made by weaving it like fabric. The fabric muscle can be cut and folded like actual cloth, and conveniently provides strength assistance when attached on desired body parts.

□ A palm-sized piece of the shape-memory-alloy-based fabric muscle weighs only 6.6 g, which is about the weight of a paper cup. Similar to how our muscles contract and relax during movement, the fabric contracts and generates force when current is supplied. It can produce a force large enough to carry 10 kg, or 1,500 times of its own weight.

□ The team attached the fabric muscle to arms and legs, and instructed wearers to perform tasks such as standing up, climbing stairs, and carrying heavy objects. The results showed that the wearers were able to perform the given tasks at only 50% of strength needed without the fabric muscle.

□ Since the fabric muscle consists of shape-memory-alloy-based springs, there is a possibility of mass production using existing looms.

□ The team is planning technology transfer of the fabric muscle and suit-type wearable robot, and hopes to improve the performance of the fabric muscle by making the shape-memory-alloy coil springs thinner.

□ Principal researcher Cheol-Hoon Park said, “The fabric muscle weaving technique can be applied to not only wearable robots for delivery workers and care workers, but also to healthcare including home rehabilitation devices and massagers. It will significantly reduce manufacturing costs, and is expected to broaden the spectrum of industries, from robotics to fashion.”

□ Currently, the team filed applications for seven domestic patents and two PCT patents related to the technology. The study was supported under the Alchemist Project of the Ministry of Trade, Industry and Energy.

[List of Attachments] (images and videos sent separately)

- Attachment 1: Fabric muscle weaved from thin string-like shape-memory-alloy springs (photo)
- Attachment 2: Fabric muscle providing strength assistance to a mannequin (photo)
- Attachment 3: Suit-type wearable robot powered by fabric muscle (photo)
- Attachment 4: Demonstration of characteristics of weaved fabric muscle (video)
- Attachment 5: Demonstration of fabric muscle (video)
- Attachment 6: Status of patents

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The Korea Institute of Machinery and Materials (KIMM) is a non-profit government-funded research institute under the Ministry of Science and ICT. Since its foundation in 1976, KIMM is contributing to economic growth of the nation by performing R&D on key technologies in machinery and materials, conducting reliability test evaluation, and commercializing the developed products and technologies.

The research was supported under the Alchemist Project of the Ministry of Trade, Industry and Energy, conducted by the Korea Institute of Machinery and Materials (KIMM).

- Attachment 1: Fabric muscle weaved from thin string-like shape-memory-alloy springs (photo)

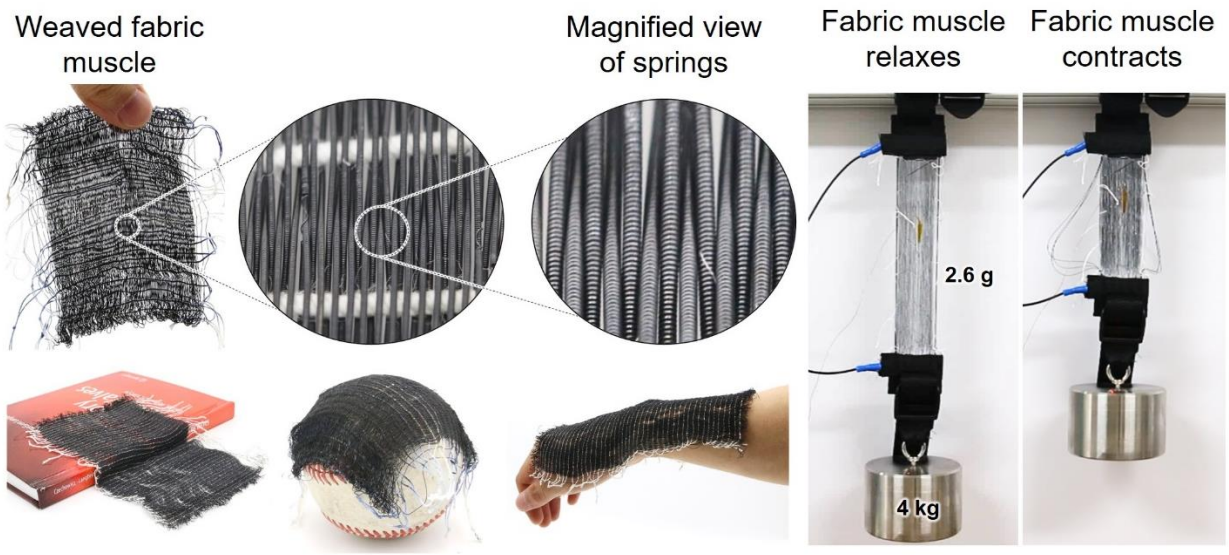

Photo description: Fabric muscle developed by the research team led by Dr. Cheol-Hoon Park of KIMM. Shape-memory-alloy springs were weaved in the same method as fabric, and the resulting light and soft fabric muscle is capable of carrying up to 1,500 times of its own weight.

- Attachment 2: Fabric muscle providing strength assistance to a mannequin (photo)

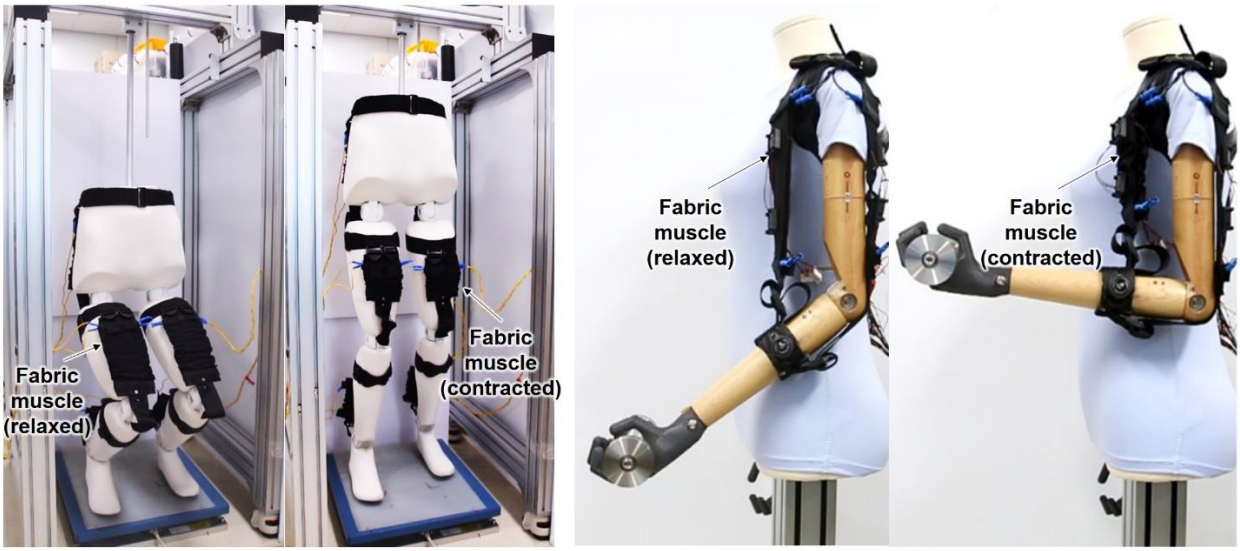

Photo description: Dr. Cheol-Hoon Park's team gives a demonstration of the fabric muscle providing strength assistance to a mannequin. The force generated by the fabric muscle allows the mannequin to stand (left) and carry heavy objects (right). Similarly, the fabric muscle can be attached to body parts requiring strength assistance.

- Attachment 3: Suit-type wearable robot powered by fabric muscle (photos)

Photo description: The fabric muscle developed by Dr. Cheol-Hoon Park's team transforms regular pants into a suit-type wearable robot. The fabric muscle can be attached to desired body parts for use as "wearable muscles."

Photo description: Applications of the fabric muscle developed by Dr. Cheol-Hoon Park's team. The fabric muscle can be used to assist wearers in sitting and standing, climbing stairs, and rehabilitation training involving repetitive movement of arms and legs.

- Attachment 4: Demonstration of characteristics of weaved fabric muscle (video)

- Attachment 5: Demonstration of fabric muscle (video)

- Attachment 6: Status of patents (table)

No.	Name of invention	Application No.	Date of application	Country
1	Wearable motion detector for wearer's motion intent sensing, motion detection method thereof, wearable robot thereof, and control method thereof	2020-0024874	2020-02-28	Republic of Korea
2	Manufacturing method of shape-memory-alloy-based springs	2020-0029517	2020-03-10	Republic of Korea
3	Soft actuator, wearable robot comprising same, and manufacturing method thereof	2020-0060752	2020-05-21	Republic of Korea
4	Muscular assistance wearable robot module driven by fabric-type soft actuator, and wearable robot comprising same	2020-0070840	2020-06-11	Republic of Korea
5	Joint rehabilitation device powered by fabric-type soft actuator	2020-0187675	2020-12-30	Republic of Korea
6	Soft actuator comprising air cooling device, wearable robot comprising same, and massage device comprising same	2021-0039742	2021-03-26	Republic of Korea
7	Fabric weaved using SMA springs, fabric-type soft actuator comprising same, wearable robot comprising same, and massage device comprising same	2021-0040993	2021-03-30	Republic of Korea
8	Soft actuator comprising cooler, wearable robot comprising same, massage device comprising same, and method for controlling same	PCT/KR2020/004037	2020-03-25	PCT
9	Soft actuator, soft actuator assembly comprising soft actuator, and wearable robot comprising soft actuator or soft actuator assembly	PCT/KR2020/017746	2020-12-07	PCT