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Ankle Joint Support Suit with Fabric-type Artificial Muscles for Elderly

Jeongae Bak, Kyungjun Choi, Seong Jun Park, Sung-Hyuk Song, Cheol Hoon Park, *Member, IEEE*

***Abstract*— In this study, an ankle joint support suit applying shape memory alloy-based fabric-type artificial muscles was introduced. We wear the developed suit and conduct a walking experiment to verify its effectiveness.**

I. Introduction

As aging populations rapidly increase and the number of elderly individuals living alone rises in countries such as Korea and Japan, there is a great deal of interest in the development of wearable robots that can assist in their mobility. The movement of the ankle is very important when walking, so a robot that can assist ankle strength is needed to improve the walking ability of elderly people. However, to ensure that elderly individuals can comfortably wear wearable robots in their daily lives, they must be as lightweight as pants. To achieve this, a new type of actuator is required, rather than conventional motors or pneumatic actuators. We have developed an ankle joint support suit using a shape memory alloy (SMA)-based fabric artificial muscle that can generate an actuating force of 10 kgf with a lightweight mass of 10 g. In this study, we describe the design of an ankle support suit and its assistive effect on the ankle during walking.

II. Fabric Muscle and Ankle Joint Support Suit

A. SMA spring-based fabric muscle

Shape memory alloy springs have a contraction strain of over 40%, which is much larger than the 5% contraction strain of SMA wire, and can generate a large force in proportion to the contraction strain. In previous research, it was confirmed that greater force could be generated by forming these springs into bundles. A soft actuator based on this SMA spring bundle, SMA spring-based fabric muscle(SFM), is like clothes and has soft, flexible, rollable and foldable characteristics.

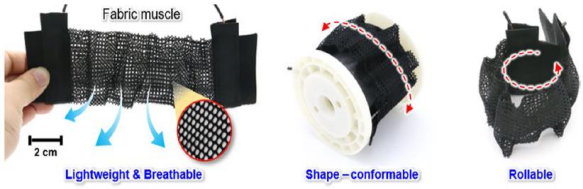

Fig. 1. SMA spring-based fabric muscle (SFM)

B. Ankle joint support suit

Using SFM, we designed an ankle joint support suit as shown in Fig. 2. It consists SFM, support bands(for shin, ankle and instep), and connecting parts. In particular, the instep support band is a structure that supports the back of the heel without a separate device.

When a person walks, the soleus and the gastrocnemius mainly extension and flexion, helping to rotate the ankle joint. Therefore, s-EMG sensors were attached to the soleus and the gastrocnemius of the subject's calf to measure changes in the muscles while walking. The results of a walking experiment while wearing the developed ankle joint support suit are shown in Fig. 2, and the results of the experiment measuring no-suit, unassisted, and assisted states were compared. As a result of the comparison, it can be seen that the output signal of s-EMG is lowest when the suit is worn and in an assisted state.

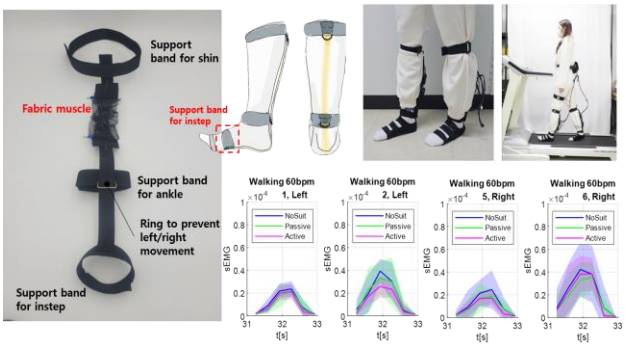

Fig. 2. Design of an ankle joint support suit and experimental results while walking

III. Conclusion

The developed ankle joint support suit has the advantages of being slim and light, easy to put on and take off, and comfortable to wear. As a result of a walking experiment while wearing it, it was confirmed that the output of sEMG signals at the soleus and gastrocnemius muscles of the calf decreased. This means that the developed ankle joint assist suit helps a person's ankle rotation when walking. In the future, the design and control method will be developed to further improve the strength assistance effect.

Acknowledgment

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References

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All authors are is with the Advanced Robotics Research Center, Korea Institute of Machinery & Materials, Daejeon 34103, Republic of Korea (corresponding author to provide phone: +82-42-868-7936; fax: +82-42-868-7135; e-mail: jabak@kimm.re.kr).