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Concept Design of Multi-winding type Gravity Compensation Mechanism for High Torque Compensation

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***Abstract*— In this study, we introduce a multi-winding type gravity compensation mechanism for high torque compensation. The tendon-driven gravity compensation mechanism using a wire wound several times is compact and lightweight, and will be applied to joint compensation of wearable robots in the future. We verified the feasibility of the proposed compensation mechanism through experiments.**

I. Introduction

Many robots are being developed to help people with weak bodies, such as the disabled and the elderly. It is very important to help disabled people with sit-to-stand function. In order to handle the weight of a person, a large torque is applied to the joint, and we must overcome this by using active or passive actuators. According to the demand for small, light and invisible assistive devices, it is necessary to develop a wearable type robot to satisfy the demand and therefore, it is essential to use a small motor using a tendon driven mechanism. Therefore, the size of the motor can be reduced, and the development of an actuator is not directly attached to the joint is also required.

Gravity compensation mechanisms using the Hooke's law have been mainly developed[1] and energy is stored in the spring as much as the displacement of the spring, and torque is compensated using it. Gravity compensation mechanisms have been developed through many studies, but they are still large and can compensate for small torques. In addition, the compensation error through experiment is quite large. We propose a multi-winding type gravity compensation mechanism to compensate for the large torque of the wearable robot joint.

II. Multi-winding type Gravity Compensation Mechanism

The multi-winding type gravity compensation mechanism is a tendon-driven compensation mechanism that uses a gas spring as an energy storage device and is designed as shown in Fig. 1. Since the goal is to help people perform sit-to-stand movements, the joint torque must be calculated while standing and sitting. The knee torque, which is expected to be a large torque, was first calculated and it shows that the proposed mechanism follows and compensates for it well in Fig. 2.

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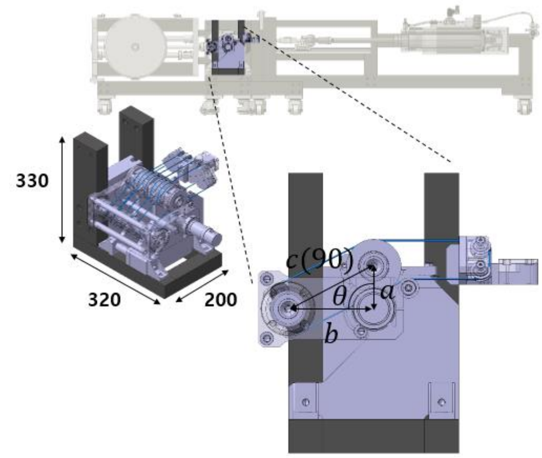

Fig. 1. Multi-winding type gravity compensation mechanism.

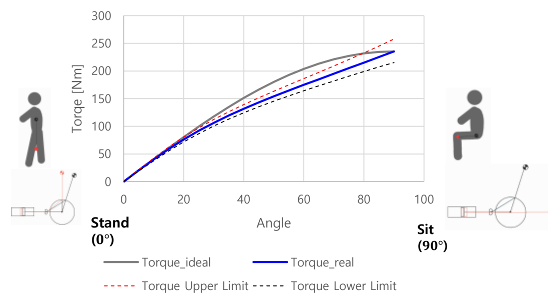

Fig. 2. Validation of feasibility of compensation mechanism

III. Conclusion

The multi-winding type gravity compensation mechanism showed the possibility of torque compensation in the test bed. We plan to make it compact and lightweight so that joint torque compensation of wearable devices can be performed efficiently in the future.

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References

[1] Kim, H. S., Song, J. B. Multi-DOF counterbalance mechanism for a service robot arm. IEEE/ASME Transactions on Mechatronics 2014; 19(6):1756-1763.Kim, H. S., Song, J. B. Multi-DOF counterbalance