Study on soft actuators for various environments

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Actuator is an important mechanical element that add motion to mechatronics and robots. A typical example is electric motors that rotates by electromagnetic force. There are various types of actuators depending on drive energy source, driven mechanism and direction of motion. Among them, research on soft actuators, soft mechanism and soft robots has become active in recent years.

Soft actuator are fabricated with mainly flexible materials such as rubber and driven by compressible fluid. The actuators have human-like softness due to flexibility of materials and the compressibility of driving fluids. Our laboratory is researching pneumatic actuators.

In general, soft actuators have been applied to robots that used in an environment close to humans, such as nursing care robots, power assist suits, and service robots, because of their high flexibility. However, our research motivation is to apply flexibility of soft actuators to extreme environment where humans cannot enter.

There is one problem with using soft actuators in extreme environments. Previous soft actuators were made of rubber and resin materials. These materials has low extreme environmental resistance. Therefore, these actuators can be driven only in limited environments.

To solve the problem, our soft actuator can be fabricated by only polyimide films. Polyimide is a kind of super engineering plastic and has high stiffness and high extreme environmental resistance. Flexibility is realized by using polyimide as a film. Because it has the high resistance, it is difficult to weld two polyimide materials. In this study, we have succeeded in developing welding method for two the films and fabricated the actuator by using the welding method.

Figure 1 shows an actuator for ultralow temperature. The actuator bends like a finger by applying gas pressure. The actuator driven at liquid nitrogen temperature is shown in Fig. 2. The actuator was driven stably at ultralow temperature.

In this presentation, the soft film actuator developed in our laboratory will be introduced.

Fig. 1. Soft actuator for ultralow environment

Fig. 2. Bending motion of soft actuator at liquid nitrogen temperature

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