Theoretical Approach in the Development of Multi-Modal Sensory Feedback Controller for the SMA Actuator

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INTRODUCTION - Shape Memory Alloy (SMA) is known as a metal that keeps its geometry - after it is deformed, it regains its original geometry by heating at higher ambient temperature, and, in the field of engineering, it is used as an actuator because of light weight, high tensile force, easy heating by giving electrical current directly to SMA. However, SMA has the characteristic of large hysteresis so that it causes slow response problem. Thus, establishment of temperature-regulation system for quick response of SMA is a major issue on development of SMA actuator. Therefore, in our research, we propose two methods: heat sinking mechanism and high current pulse control.

HEAT SINKING MECHANISM is proposed as an efficient cooling mechanism. This is based on the assumption that increase of heat-radiation area by covering a SMA wire with high heat transfer materials causes cooling down the SMA wire in the mechanism more efficiently than a normal SMA wire. Therefore, we built a SMA wire, which is inserted into a metal tube and filled up with silicon grease, as known high transfer semi-solid material, in the tube (fig.1). For the verification, we have built a thermodynamic model in simulation (fig.2) and the experimental equipment in real world. As results, the mechanism in both virtual and real world realized more quick response.

HIGH CURRENT PULSE CONTROL is proposed as an efficient temperature control algorithm. This is based on assumption that surplus heat energy causes low response speed in SMA. Thus, we applied high current pulse (50Hz) as a control algorithm to a SMA wire for the purpose of preventing from overheating (fig.3). As a result, the control realized 2Hz oscillatory response of a SMA wire (the experimental equipment is the same as fig.2). Moreover, we applied the SMA actuation system to a robot hand and, as results, it achieved motions. It indicates that the SMA actuation system has potential in weight-saving, miniaturization, mobilization of the robot hand.

Keywords: Shape Memory Alloy, heat sink, high current pulse control, robotic finger actuation

References

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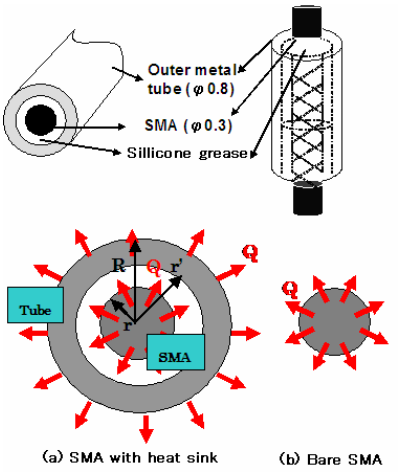

Fig.1 proposed heat sink with the SMA wire.

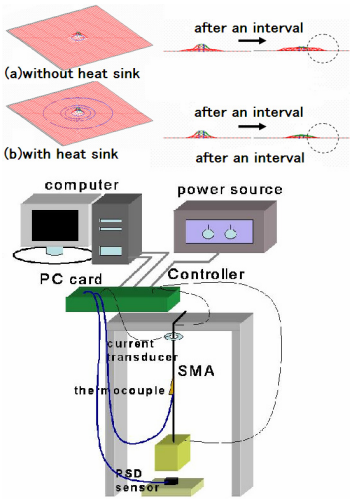

Fig.2 Heat transfer model based on FEM and Experimental equipment

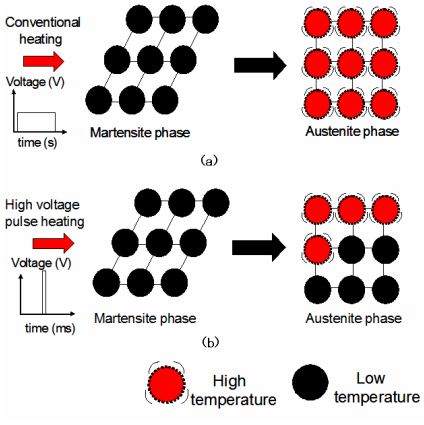

Fig.3 High current pulse control