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Development of an oscillating fin type actuator for underwater robots

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Abstract. We are focusing our attention on bio-inspired technologies and have been developing an oscillating fin type actuator for underwater robots using artificial muscles. Our research aims at the development of a fin type actuator imitating mechanisms of underwater creatures by using an electroconductive polymer as the driving source/s. We expect that this actuator takes the place of a screw propeller for missions that need precise and silent control. In this paper, we introduce the concept of the development of the actuator and the results of the performance evaluation test of the developed electroconductive polymer.

Keywords: Artificial muscle; Electroconductive polymer; Biomimetics; Fin type actuator

1. Introduction

Generally, almost all ships and underwater vehicles use a screw propeller as their actuator. However, it is not easy to employ screw propeller type actuators for precise control without producing a large amount of noise. We have been approaching this technical problem by developing a new type of actuator. The actuators are expected to take the place of the screw propeller for the missions that need precise and silent control in future.

In this research, we pay attention to the bio-mechanism of underwater creatures, especially ribbon-like fins using precise control. Bio-mechanisms of creatures are adapted to the environment as a result of evolution. If the motor control mechanism of the creatures can be introduced into underwater robots, it is possible that a high performance actuator will be developed.

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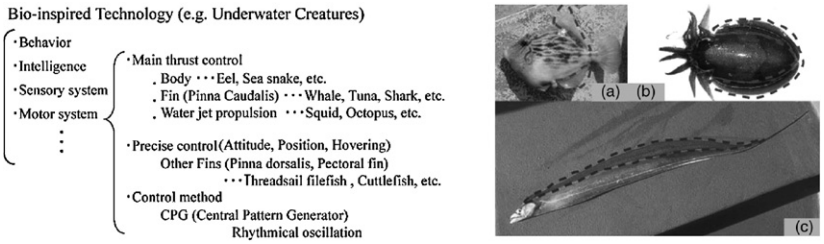

Fig. 1. Tree diagram of bio-inspired technology (e.g. underwater creatures) (A). Fish models for Biomimetics in this research. ((a): Thread-sail file fish, (b): cuttlefish, (c): ribbon fish), photo by http://fishing-forum.org/zukan/index.htm (B).

We aim to develop an actuator by imitating functions of underwater creatures with the capability of precise and silent control. The first step of our research is the development of artificial muscles as the driving source. In this paper, the concept of the development of the actuator and the electroconductive polymer are described. We have carried out performance evaluation tests of the developed artificial muscles.

2. Fish fin

Underwater technology has much potential to learn from underwater creatures. Fig. 1A shows bio-inspired technology from underwater creatures. We pay attention to precise control using ribbon-like fins that can induce impellent by wave propagation. For example, a Thread-sail file fish can hover like a helicopter even if there is a tidal current [1]. Fig. 1B shows some typical creatures which employ oscillating fins. They can swim precisely by switching wave propagation order. A forward (or backward) impellent is obtained by sending the wave backward (or forward). The direction of waves can be transferred to the other direction very quickly. If a new actuator can realize this ability, fin actuators could be controlled more smoothly.

3. An electroconductive polymer of artificial muscles

Artificial muscles have smooth expansion and shrinkage motion like biological muscles. There are various materials used for artificial muscles, for example, IPMC (Ionic Polymer

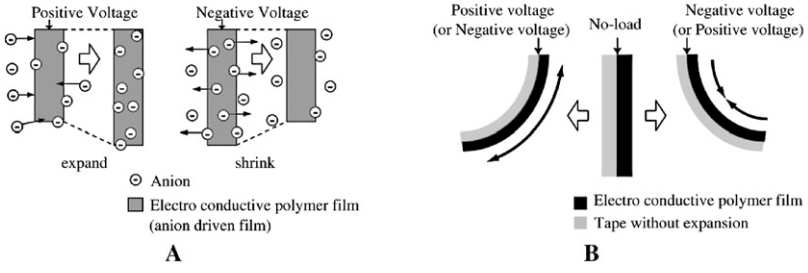

Fig. 2. Principle of motion of electroconductive polymer as artificial muscles (A). One of the bending motion methods (B).