Proceedings of the Eighteenth (2008) International Offshore and Polar Engineering Conference
Vancouver, BC, Canada, July 6-11, 2008

ISBN 978-1-880653-70-8 (Set); ISBN 1-880653-68-0 (Set)

A Study on Characteristics of a Flexible Body for a Fish Type Robot

Masashi Terada, Hirofumi Sumoto
Graduate School of Engineering, Kyushu University
Fukuoka, JAPAN

Satoru Yamaguchi
Department of Marine Systems Engineering, Kyushu University
Fukuoka, JAPAN

ABSTRACT

The purpose of this study is to determine the characteristics of a fish type robot body. The robot surveyed is untethered and formed of a flexible urethane. The motion mechanism of the robot is composed of a shape-memory alloy type artificial muscle. The mechanism mimics the swimming motion of a subcarangiform fish. The characteristics of the flexible body and techniques to control posture of the robot are discussed. The flexural rigidity of the body was examined by an experiment about the elastostatic bending of the body. The output moment of the motion mechanism was estimated using the results of an experiment.

KEY WORDS: biomimetic; fish type robot; under water vehicle; artificial muscle; flexible body

INTRODUCTION

The shape and swimming method of fish vary as they adjust to their environment and it is well known that fish can swim fast and are highly maneuverable in water. Therefore, it is believed that studies on the swimming of fish can suggest new and effective propulsion methods for underwater vehicles and robots. The vehicles and robots with these propulsion methods may contribute to ocean observation, developments and environmental protection.

A great deal of research on the hydrodynamic performance of fish swimming in a steady state that includes turning and positioning with the control of median and/or paired fins (MPF) or body and/or caudal fin (BCF) propulsion has been conducted, and fish-like underwater vehicles have been developed (*Anderson*, 1998; *Kato et al.,* 2006; *Nakashima et al., 2000; Triantafyllou et al.*, 1997). On studies of the vehicles propelled by BCF, *Kumph* (1998) developed a fish type robot which mimicked a chain-pickerel and attempted to realize transient fish motions such as sudden acceleration and sharp turning. These vehicles used a multi-joint system such as a crank mechanism or tendon drives activated by electric servomotors. But the multi-jointed robot requires advanced control techniques for pliant motions and a large space for the complex structure of the motion mechanism.

Based on the background, the authors have developed a fish type robot using a motion mechanism composed of a shape-memory alloy type artificial muscle which needs neither advanced control techniques nor a complex structure. It was confirmed that the robot which mimics the swimming motion of a subcarangiform fish can realize transient fish motions well in still water (*Yamaguchi,* 2006). However, the robot was tethered as shown in Fig.1 and the swimming of the robot was often prevented by long cables connected to outside control systems; this limited its activity because of the length of the cables. The robot was not able to keep a bent posture because of the characteristic, to be described later, of a shape memory alloy type artificial muscle. Moreover, the characteristics of the flexible body and the output moment by the motion mechanism should be examined in detail for advanced motion control of the robot.

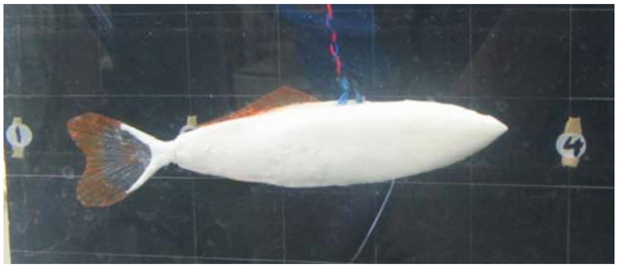

Fig.1 Picture of the fish type robot in a tank (body length, 185 *mm*; height, 38 *mm*; width, 15 *mm*)

This paper reports development of an untethered fish type robot, and discusses the techniques to keep an arbitrary posture of the robot. Characteristics of the flexural rigidity of the flexible body are examined by an experiment, and output moment of the motion mechanism is estimated based on experimental results.