Title:
Swaying Robot Fish Design and Prototyping

Authors:
Waipik Lau, wplau@mae.cuhk.edu.hk, The Chinese University of Hong Kong
Ruxu Du, rdu@mae.cuhk.edu.hk, The Chinese University of Hong Kong
Zhong Yong, yong.zhong@siat.ac.cn, Guangzhou Institute of Advanced Technology

Keywords:
Biomimetic, wire-driven mechanism, robot fish

DOI: 10.14733/cadconfP.2014.118-119

Introduction:
Inspired by the snake skeleton configuration and octopus muscle arrangement, the wire-driven mechanism can well mimics the wave-like body motion of fish, snake and octopus [1,2,3]. Moreover, with different wire configuration and arrangement, the wire-driven mechanism can make different motions in 3D. In previous works, models of oscillatory form and undulatory form have been built, based on the structure of fish red muscle which runs in a parallel orientation with respect to the long axis of the fish [4]. These models provide robots with a high-efficient propulsion and excellent maneuverability under water.

However, due to the nature of parallel wire pairs, models can only give lateral movement, while real fish propulsion is not purely lateral flapping. For every flapping, the fish has its own caudal fin twisting pattern in order to stabilize the swimming body, to adjust its swimming motion and to obtain maximum propulsion efficiency. Unfortunately, there is not any robot fish providing a twisting motion. In light of this, we build a swaying robot fish to study the swaying motion with two wire pairs.

Main idea:
Wire-driven mechanism is composed of a backbone and a number of wire pairs, which is used to transmit force and motion from motors. In models of oscillatory form and undulatory form, parallel wire pairs are used to guide bending. It is inspired by fish red muscle, which is used during steady swimming. The pair of parallel wire is configured just besides, and parallel to, the backbone of caudal fin. Each pair of parallel wire, controlled by a motor and guided by eyelets along the backbone, is responsible for one degree of freedom (DOF) bending, and thus, provides lateral bending.

To provide the fish with twisting motion, we arrange the pairs of wires distant from the backbone, instead of parallel to the backbone. This configuration can provide torsion and sway the body when the upper pair and lower pair wire are driven with a phase shift.

Conclusion:
Undoubtedly, wire driven mechanism is an unactuated design. By making good use of the design, we rearrange the wire pair configuration and design the world first robot fish having both bending and twisting motion. The twisting properties improve the accuracy of swimming direction. A fine tuning of the position of the fish can also be obtained. This model can maximize the manoeuvrability and propulsion efficiency of wire-driven propulsor.

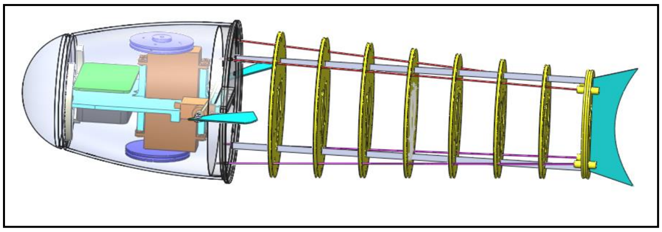

Fig. 1: CAD design of the robot fish.

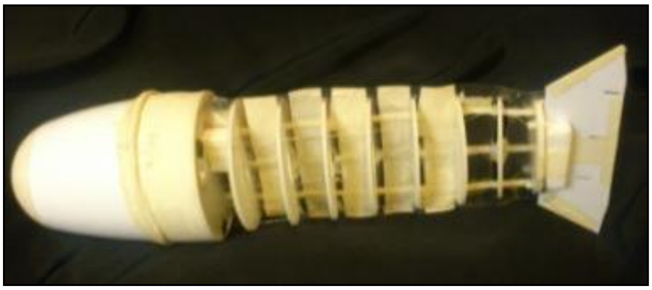

Fig. 2: Prototype of the twisting robot fish.

References:

[1] Du, R.; Li, Z.: Design and Analysis of a Biomimetic Wire-Driven Robot Arm, Proceedings of the ASME 2011 International Mechanical Engineering Congress & Exposition, IMECE2011, Denver, Colorado, USA. 2011.

[2] Du, R.; Li, Z.; Liao, B.: Robot tadpole with a novel biomimetic wire-driven propulsor, IEEE International Conference on Robotics and Biomimetics (ROBIO), 2012, 557-562.

[3] Du, R.; Li, Z.: Design and Analysis of a Biomimetic Wire-Driven Flapping Propeller, The Fourth IEEE RAS/EMBS International Conference on Biomedical Robotics and Biomechatronics, Roma, Italy, June 24-27, 2012, 276-281 .

[4] Gemballa, S.; Vogel, F.: Spatial arrangement of white muscle fibers and myoseptal tendons in fishes, Comparative Biochemistry and Physiology-Part A: Molecular & Integrative Physiology, 133(4), 1013-1037. http://dx.doi.org/10.1016/S1095-6433(02)00186-1

Proceedings of CAD'14, Hong Kong, June 23-26, 2014, 118-119