Analysis and Mathematical Modeling of Thunniform Motion

Mr. Witoon Juwarahawong, Dr. Saroj Saimek

Introduction

This thesis aims to study motion of fish-robot in the thunniform style (movement in ¼ of body length). Our main objective is to study relationship between a propulsive (thrust) force and oscillating angles of peduncle and flapping tail (known as heaving and pitching, respectively). Equation of motion of the robot with propulsive forces will be studied under quasi-steady flow.

Problem

We cannot define the exact parameters (C_D, C_L, etc). And the fact the parameters of fish swimming are varying by body-shape. In the experiment, we assume the parameters of swimming are not varying by body-shape effect.

Methodology

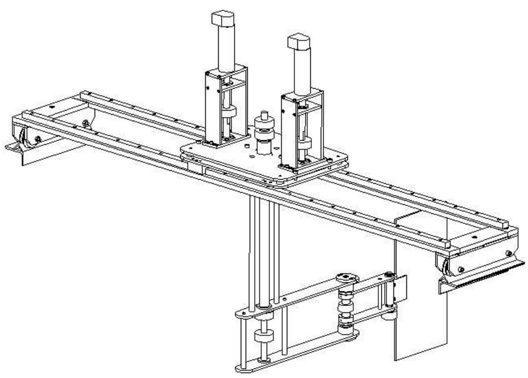

Fig 1. Show the Swimming Machine

Construction of Robot is similarly to the three-link robot, which composes of body, peduncle and flapping tail. The robot has five degrees of freedom. Three degrees of freedom are longitudinal motion, lateral motion and rotation in range of ±45 degrees in Z-axis and two degrees of freedom in the propulsion system are heaving and pitching. The robot can move in the X-Y plane by the oscillation of the peduncle link and flapping tail. The angle of the peduncle link motion and flapping tail motion is called the heaving angle and pitching angle respectively**.** The relationship between a heaving angle and pitching angle is important to define the pattern and path of swim. This relationship is used to predict the thrusting force by Mathematical Model.

Result

In the simulation result, when the robot starts swimming, the robot needs high heaving and pitching angles (lagged angles are 45 degree or higher) to generate high thrust. For steady swimming the robot need low heaving and pitching angles (lagged angles are 45 degree or lower) to generate thrust in order to balance drag force.

Future Work

Develop the experiment and new model to support the parameter in non-linear term.

References

[1.] Kristi A. Morgansen, Patricio A. Veta, Joel W. Burdick, “Trajectory stabilization for a planar carangiform robot fish,” California Institute of Technology, 2001.

[2.] R.J. Mason and J.W. Burdick. “Experiments in Carangiform robotic fish locomotion,” In *Proceedings of IEEE International Conference on robotics & Automation,* pp.428-435, 2000.

King Mongkut's University of Technology Thonburi
Address: 91 Pracha U-Tid, Bangmod, Bangkok 10140 Thailand
Tel. No. +66 (0) 2470-9691, 2470-9339 Fax +66 (0) 2470-9703 http://fibo.kmutt.ac.th