Development of Turtle-like Submergence Vehicle

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Swimming of aquatic animals has become one of interesting research topics in the field of marine engineering. In this research work a submergence vehicle based on sea turtles was developed. This vehicle has two fore fins with two degrees of freedom; flapping and feathering motions, and flaps for propulsion and/or maneuvering. Hind fins were also equipped, and a buoyancy controller for the vehicle was designed.

Swimming experiments were held at Fish Robot Experiment Basin at National Maritime Research Institute. In the experiments this vehicle swam at 0.06 m/s when fore fin frequency was 0.53 Hz. As the results were rearranged using swimming number, which normalizes the velocity by its own body length per flapping period, the vehicle performed maximum swimming number, 0.24, when the frequency was 0.35 Hz.

Performance of the vehicle was also estimated using the blade element theory. By applying the theory against our vehicle, its velocity is estimated as around 0.18 m/s when fin frequency is 0.53 Hz. Two of the reasons of difference between the theory and the experiment are that the theory ignores wing-tip loss so that it gives the higher estimation than expected, and that the vehicle could not perform its full potential at the experiment.

This vehicle still has many problems. For example, fin motion is not yet optimized. By coping with these issues, the vehicle will provide better performance, and will be used to evaluate the usefulness of submergence vehicles with flapping fins.

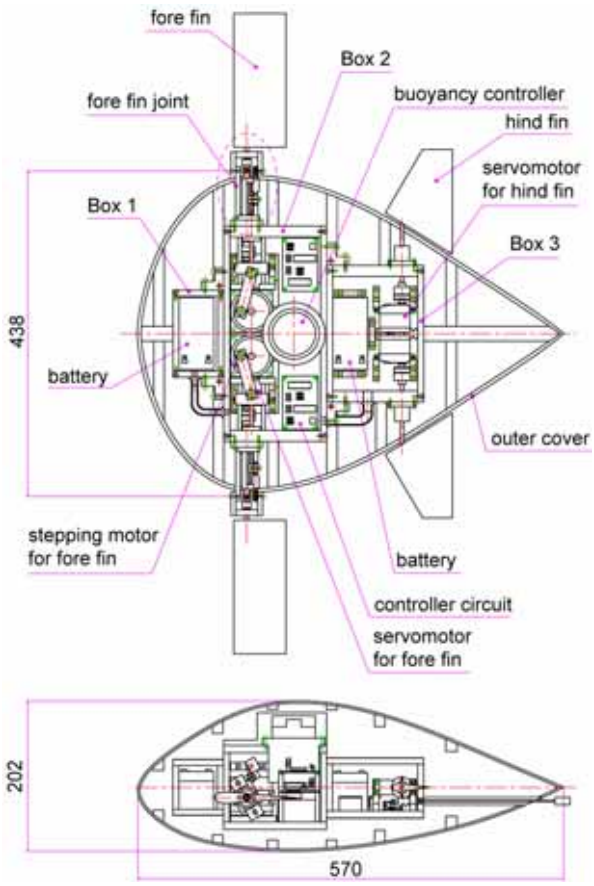

Fig. 1: Structure of Turtle-like Submergence Vehicle

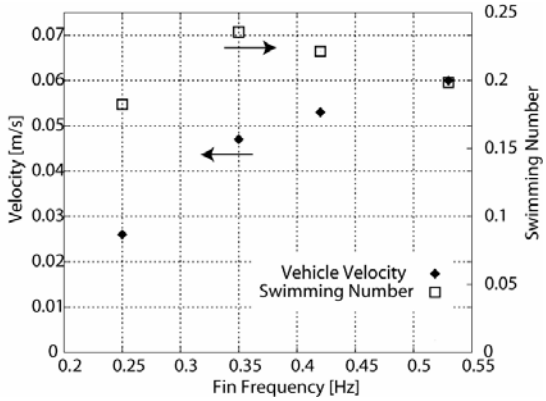

Fig. 2: Swimming Velocities and Swimming Numbers as Functions of Flapping Frequencies

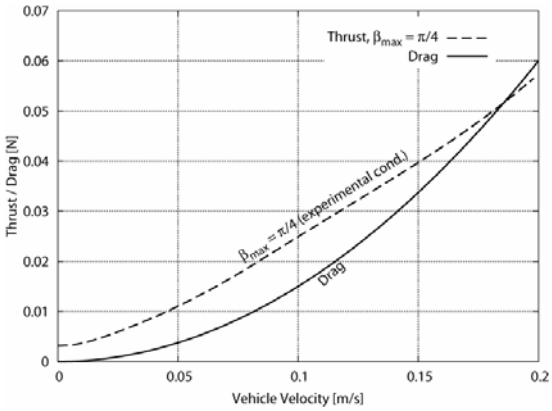

Fig. 3: Thrust and Drag Forces as Functions of Vehicle Velocities. Flapping Frequency is 0.53 Hz.