Biomimetic Fish Based on the Black Marlin

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Research Question

Is the actuation pattern of the Black Marlin biomimetic fish more efficient and powerful than constant actuations of the biomimetic fish?

-The idea of mimicking biomimetic fish has been made, but the pattern of actuation of animals has not been closely analyzed.

-By analyzing the footage of the black marlin's movement, I found that it had a movement pattern of one large actuation of its body followed by three smaller actuations.

Black Marlin's patterned actuation, https://www.youtube.com/watch?v=XRiLBMSrjCo

Methodology

-Fabrication of biomimetic fish based on the black marlin. A skeleton was fabricated with 3d printing and encased in high quality silicone.

-A toy boat was modified so that it could actuate the biomimetic fish.

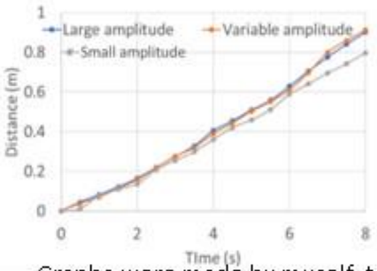
-Actuate the black marlin biomimetic fish with constant large actuations, constant small actuations, and a patterned actuation (1 large 3 small actuations) copying the actuation pattern of the Black Marlin.

-Analyze the footage from the experiments to find velocity and relative power efficiency and sound levels.

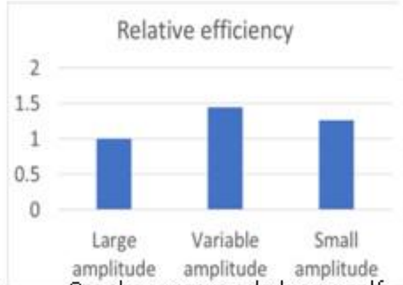
Data Analysis and Results

-The distance graph shows that the variable amplitude had a similar level of velocity with the large amplitude, but a much higher relative power efficiency.

-The power efficiency was 83% , while the noise levels were ambient in the biomimetic fish actuation system, much smaller than the propeller-based one.



Graphs were made by myself, taken from my data.



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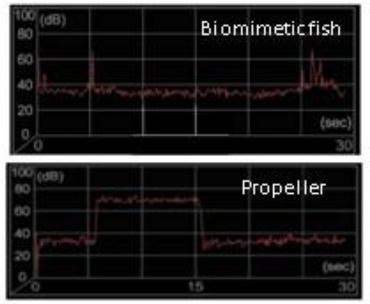

Results of noise level graphs were recorded by myself.

Discussion and Conclusion

-The variable actuation pattern of the Black Marlin biomimetic fish is proven to be much more power efficient than the large amplitude actuations, while having the same velocity output.

-The power efficiency was 83% that was much higher than the 20-40% of normal commercial boats. This is due to the added mass effect-based resonance resulting from the caudal fin and the variable actuation.

Photo was taken by me.

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