World Academy of Science, Engineering and Technology
International Journal of Marine and Environmental Sciences
Vol:18, No:04, 2024

Hydrodynamic Analysis of Fish Fin Kinematics of Oreochromis Niloticus Using Machine Learning and Image Processing

Authors : Paramvir Singh

Abstract : The locomotion of aquatic organisms has long fascinated biologists and engineers alike, with fish fins serving as a prime example of nature's remarkable adaptations for efficient underwater propulsion. This paper presents a comprehensive study focused on the hydrodynamic analysis of fish fin kinematics, employing an innovative approach that combines machine learning and image processing techniques. Through high-speed videography and advanced computational tools, we gain insights into the complex and dynamic motion of the fins of a Tilapia (Oreochromis Niloticus) fish. This study was initially done by experimentally capturing videos of the various motions of a Tilapia in a custom-made setup. Using deep learning and image processing on the videos, the motion of the Caudal and Pectoral fin was extracted. This motion included the fin configuration (i.e., the angle of deviation from the mean position) with respect to time. Numerical investigations for the flapping fins are then performed using a Computational Fluid Dynamics (CFD) solver. 3D models of the fins were created, mimicking the real-life geometry of the fins. Thrust Characteristics of separate fins (i.e., Caudal and Pectoral separately) and when the fins are together were studied. The relationship and the phase between caudal and pectoral fin motion were also discussed. The key objectives include mathematical modeling of the motion of a flapping fin at different naturally occurring frequencies and amplitudes. The interactions between both fins (caudal and pectoral) were also an area of keen interest. This work aims to improve on research that has been done in the past on similar topics. Also, these results can help in the better and more efficient design of the propulsion systems for biomimetic underwater vehicles that are used to study aquatic ecosystems, explore uncharted or challenging underwater regions, do ocean bed modeling, etc.

Keywords : biomimetics, fish fin kinematics, image processing, fish tracking, underwater vehicles
Conference Title : ICMSE 2024 : International Conference on Marine Science and Engineering
Conference Location : Athens, Greece
Conference Dates : April 04-05, 2024