The Underwater Magic Carpet: A Movable Underwater Platform Based on Bionic Cownose Ray

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This research is aimed to design a novel movable underwater platform that could cover the disadvantages that prevail in traditional propeller driven submersibles. Cownose ray, a fish species with less-than-one-wave Median and Paired Fin (MPF) propulsion pattern, has been selected as the bionic prototype due to its characteristics of high efficiency, high mobility and low hydrodynamic noise. Firstly, the swimming pattern of cownose rays was observed through multiple videos, and the major objective of the research was determined as designing and constructing an underwater platform that resembles the movement of cownose rays with bionic technology. Based on the analysis of the body structure and swimming pattern of the cownose ray, a kinetic model of movement was established to theoretically identify the objectives in designing the prototype. Then, an ingenious less-than-one-wave MPF propulsion system was designed according to the results from theoretical analysis, and the 3-D model of the prototype of the bionic robot was portrayed. Moreover, the construction, processing, debugging and empirical testing of the bionic fish was completed to ensure the practical quality of the design combined with the adjustments in both mass and rigidity of this robot. The empirical test results demonstrate that the underwater platform is able to fully imitate the moving pattern of the cownose ray, and could even perform highly maneuverable tasks such as in-place rotation. Such platform could be applied in various practical fields, including scientific studies on marine organisms, investigations on seafloor structure, and monitoring of underwater devices in aquaculture.

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