BIO-INSPIRED FLOW OPTIMIZATION

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ABSTRACT

For centuries, engineers have sought inspiration from nature in designing their systems. The thesis of this work is that along with the imitation of biological forms we need to consider bio-inspired algorithms for optimizing engineering devices.We make a distinction between designs that involve a-priori defined, well structured processes and natural processes where tinkering and experimentation over thousands of years lead to an ever evolving structure or organism.

In fluid mechanics, bio-inspired optimization processes can be recognized in the flying machines starting with the imitation legend of Icarus, the first sacrificial flight by Otto Lilienthal and considering todays modern aircraft and insect inspired micro-air-vehicles. However, we consider that there is further room for innovation in engineering designs by developing algorithms based of concepts such as natural evolution[1], and bacteria chemotaxis[2].

We present a systematic framework for developing such algorithms with an emphasis on their acceleration by incorporating adaptive learning algorithms[3].We demonstrate the effectiveness of bio-inspired algorithms in fluid mechanics over a range of problems including the automated selection of actuators for drag reduction in a cylinder flow[4], the optimization of combustion in turbomachinery [5] and the reverse engineering of single [6] and multiple anguiliform swimmers.

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