Feather-inspired Distributed Flow Control

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Abstract

Flow control is the attempt to favorably modify a flow field's characteristics compared to how the flow would have developed naturally along the surface. Natural flyers exploit flow control to maintain maneuverability and efficiency under different flight and environmental conditions. Here, we present examples of avian-inspired flow control devices based on various feather systems, namely the coverts and the alula. For each of these systems, we have created a simplified engineering analogy and evaluated the performance of the bioinspired flow control device using wind tunnel experiments, including force and flow field measurements. Results show that the bioinspired flow control devices can mitigate stall, enhance lift, and reduce drag. The flow field measurements also reveal tunable fluid-structure interaction mechanisms. The performance advantages and the tunable effects of these bioinspired flow control devices make them suitable for small-scale uncrewed aerial vehicles. Furthermore, our experiments can also answer key biological questions about the role of these feathers in bird flight. For example, our results show that several rows of covert-inspired feathers are more beneficial than a single row, proposing a new hypothesis about the presence of multiple rows of covert feathers on bird wings.

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