INSPIRING NEXT GENERATIONS

How do bats fly?

Understanding Flapping Flight

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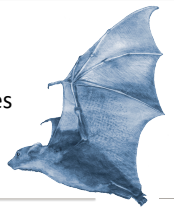
Why study flapping flight?

→ Characterizes all biological flight: birds, bats, insects
→ Efficient for small size flying/hovering vehicles
→ Relevant to design of UAVs and MAVs

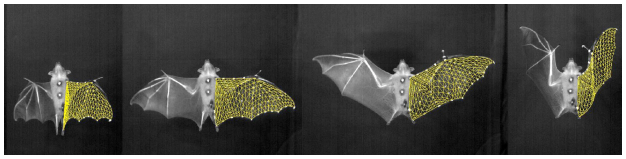
Why bats?

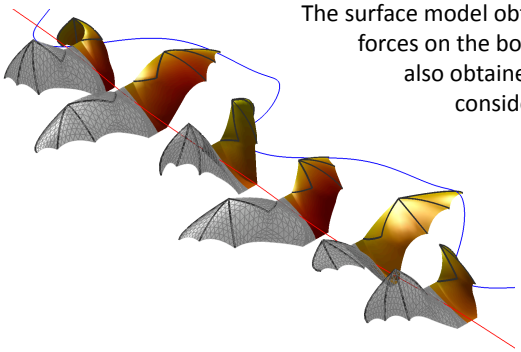
→ Extremely maneuverable
→ Efficient flapping flight vehicles
→ Morphing wing structure
→ Large variety of sizes



Our goal is to understand the aerodynamic and structural characteristics of bat flight and to determine the applicability of similar strategies in vehicle design

Our collaborators at Brown University provide videos of bats in flight. The video data is processed using motion-capture techniques, and a 3D reconstruction is then extracted. These representations of bat flight provide an accurate shape which can be analyzed and serves as a basis for comparison with numerical simulations.

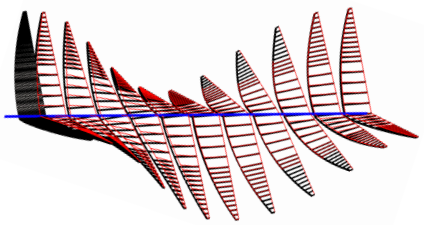




The surface model obtained from the videos is used to determine the aerodynamic forces on the body based on a potential flow model. The shape of the wake is also obtained and characterizes the flight under the particular conditions considered (bat size and weight, flight speed and acceleration, etc).

In order to understand the advantages and disadvantages of flapping flight we are developing the computational capabilities to analyze and design flapping-wing flight vehicles. The procedure incorporates a multi-fidelity toolset, starting with a simple wake-only analysis and ending with validation and refinement using full-blown Computational Fluid Dynamics (CFD).

This approach allows us to consider simpler models of flapping and understand how various parameters (frequency, amplitude, membrane stiffness, etc.) affect the flight characteristics. One of our design methods involves numerically predicting an efficient wake vorticity distribution for a flapping wing, and use inverse design approaches to determine the shape characteristics (angle of attack, camber, stiffness, etc.) of the morphing wing which produced that particular wake and which could be used in a small flying vehicle.



Have you ever dreamed of flying and hovering like a bat?

Collaborators: Brown University, University of Maryland, Oregon State University
Funding sources: Air Force Office of Scientific Research (AFOSR), National Science Foundation (NSF), Natural Science and Engineering Council of Canada (NSERC), Singapore-MIT Alliance (SMA)

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