Planetary Exploration using Biomimetics

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Mars flight is much more difficult than on Earth because the rarified atmosphere requires a vehicle to fly within a very low Reynolds number/high Mach number regime. This is compounded by size restrictions to fit and deploy from an aeroshell capsule. This proposed project examines the concept of using an entomopter for future Mars atmospheric flyer exploration missions.

An entomopter uses biomimetics and advanced circulation control techniques to achieve substantially higher lift than possible through conventional design. According to conventional aerodynamics, some insects couldn't generate sufficient lift to maintain flight. However, in 1994, Charles Ellington of the University of Cambridge determined that a micro-scale vortex, at the wing's leading edge, was the source of the missing lift.

As size and the flight Reynolds number increases, this effect diminishes. A Mars aircraft with a 1 meter wingspan, would operate at a similar Reynolds number as terrestrial insects. Using the enormous lift producing mechanism of the entomopter may be an effective way to design vehicles capable of flying in the Martian atmosphere. Another advantage is that the reduced Mars gravitational force enables substantially lighter structures.

DARPA-sponsored work on biomimetics recently performed at the Georgia Tech Research Institute is investigating defense applications of mechanical insect systems and designing a prototype terrestrial entomopter. GTRI has confirmed that this concept, on a preliminary level, appears feasible for a Mars application and may, in fact, be easier to accomplish due to vehicle scaling. It would greatly enhance mission capability allowing the vehicle to take off, fly slowly or hover, and land.

Combining and building on this research, we have organized a collaborative team to investigate the application of biomimetics for planetary exploration.