Application of Biomimetic Concepts for Low-Reynolds Flights

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Abstract

For exploring efficiently the planet Mars, a project for building an airplane for flying in the Martian atmosphere has been launched by the JAXA. However, because of the density of this atmosphere is very low compared to Earth (approximately 0,020 kg/m^3 for Mars and 1,2 kg/m^3 for Earth, both values are at ground level), the current conditions of the flight of this plane imply low-Reynolds numbers, which cause the streams to be “laminar” or “transition” flows. Therefore, as on Earth flying planes is normally done in high-Reynolds numbers flows, some studies on low-Reynolds flights have shown that the current models of wing used perform very poorly in such conditions. Indeed, the more the Reynolds number is decreased, the more the lift capacity of the wings is decreasing. That is why the aim of this study is to design new shapes of airfoils for the plane, in order to improve their aerodynamic characteristics in “laminar” or “transition” flows.

Nevertheless, as we look for new designs for those airfoils, we have chosen to study the shape of the wings of the dragonfly. Indeed, considering the size of those wings and the maximum speed a dragonfly can reach, those insects are constantly flying in low-Reynolds flows on Earth, and, because of that, the shape of those wings seems to be adapted to the conditions of flight of the Mars airplane. However, the design of those wings is very complicated and possessed a lot of specific characteristics. Therefore, in order to design a new airfoil for the Mars airplane, those characteristics will be studied separately to understand and see their effects on the aerodynamic properties of a wing. Not only separate tests will be conducted, but also grouped tests will be done to check the effects of a combination of those different and singular characteristics.