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DESIGN OF A SOLAR-POWERED UNMANNED MARS EXPLORATION AIRCRAFT CONSIDERING ENERGY-OPTIMAL PATH

Abstract

Deep space exploration is a great significant task for human beings not only to understand the origin and evolution of the earth, but also to study the formation and development of the solar system. Among other planets in the solar system, Mars has many similarities with the earth. Human exploration of Mars has a history of more than 50 years, and it will remain as the most cutting-edge scientific research direction in the next few centuries. Compared with Mars rovers, unmanned aerial vehicles (UAV) have a higher flight speed, which can greatly improve detection efficiency. On the other hand, UAVs can deal with complex Martian terrains, such as craters and ancient highlands. Based on these characteristics, a solar-powered UAV for exploration flying in the Martian atmosphere is proposed. The advantage of solar-powered aircraft is that they have long flight endurance and are suitable for long-period-large-area monitoring missions. Considering the low density of the Martian atmosphere, the design of aircraft requires minimal wing loads. At the same time, the airfoil was optimized by method genetic algorithm in order to fit the high-speed and low Reynolds number flight conditions in the Martian atmosphere, as a result, a modified high-lift airfoil is obtained. Further, considering the change of total energy in a day and night non-stop flight within during a given cruising radius, the Particle Swarm Optimization (PSO) method is used to optimize the flight path, in order to minimize the mass of battery by using the energy-optimal path.