CONCEPTUAL DESIGN OF SOLAR-POWERED HIGH-ALTITUDE LONG ENDURANCE AIRCRAFT

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ABSTRACT

The design of high-altitude unmanned aerial vehicles is one of the most current research topics today in the field of aviation. The possible purposes of such flying platforms are numerous, from communication hubs, terrain observations, performing various measurements in the upper layers of the atmosphere, to various military uses. However, these are complex systems that involve many unresolved scientific and research challenges such as: the necessity of extremely low airframe weight, low air pressure and density cruising at high altitudes where air pressure and density are much lower than in the Earth's vicinity, sub-zero temperatures, exposure to increased radiation, low Re implying accentuated viscosity effects and decreased aerodynamic characteristics, assuring complete flight autonomy, need to generate the required energy for flight solely from solar energy, adequate sizing and control of rechargeable batteries, etc.

At the beginning, the initial mission requirements, mission profile, assessment of daily power consumption and battery mass as well as methodologies for the initial estimation of aircraft structural mass and wing loads are discussed. Then a novel high-lift airfoil specially designed for low-Re high-altitude flight through multi- objective optimization was designed by using genetic algorithm. Subsequently, aerodynamic analysis of the wing carried out by the methods of computational fluid mechanics, specifically by solving Navier-Stokes equations averaged by Reynolds statistics and closed by a 4-equation turbulent model is shown. Finally, static analyses of the behavior of wing structures under the combined action of calculated aerodynamic and gravitational loads were performed, as well as dynamic, modal analyses (important for knowing the response of the structure in non-stationary operating conditions) using the finite element method.

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