IMPROVEMENT AND OPTIMISATION OF LIGHT-GYROPLANE PERFORMANCE

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Abstract

Computational studies on improvement and optimisation of light-gyroplane performance have been conducted. The investigations focused on two stages of gyroplane flight: cruise flight and jump takeoff.

In the cruise flight, the improvement of performance was achieved through aerodynamic design and optimisation of main rotor. Initially the family of airfoils was designed and optimised, especially for gyroplane-rotor-blade applications. Based on these airfoils, the rotor-optimisation process has been conducted. The design parameters described distributions of: chord, twist and airfoils along the rotor-blade span. The optimisation objective was to minimise drag force generated by the rotor, for assumed flight velocity and lift force (balancing assumed weight of the gyroplane). As the result of optimisation, two alternative rotors were designed, differing in blade shape and manufacturing technology. Performance benefits of one of these rotors have been already confirmed in flight tests.

Separate investigations aimed at performance improvement in conditions of "jump takeoff" of the gyroplane (similar to helicopter takeoff). Initially, different blade-mass models were investigated from point of view of successfully-performed takeoff. The essential investigations focused on numerical optimisation of flight-control procedure during the jump takeoff. The design parameters described strategy of changes of main-rotor-pitch and blade-collective-pitch angles during the jump takeoff. The optimisation, conducted using the gradient method, aimed at maximising of the altitude of gyroplane flight, at the time when it reached assumed distance from a takeoff point.

Applied optimisation methodologies and methodology of simulation of autogyro flight as well as the results of conducted optimisations have been discussed.