Concept of the UAV with the hybrid propulsion system

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Abstract:

In the past years, number of unmanned aerial vehicles rapidly increased. A wide range of UAV applications in both civil and military domains can be listed. The market demand for new solutions drives designs of UAV in unconventional configurations.

This paper shows a conceptual design of a UAV with a hybrid propulsion system. The system consists of two engine types - rocket engine and electric engine; each engine is dedicated to a different phase of a mission. The mission profile includes the following phases: take-off assisted by the rocket engine, climbing and acceleration, deacceleration to speed suitable for electric motor operation, engaging the electric propulsion then monitoring phase and finally the landing (Figure 1). This design incorporates features of fast flight into the monitoring zone and moderate flight endurance due to electric propulsion. To ensure those capabilities, specifically very fast flight and high g-force loaded take-off, the aircraft is designed in a tailless configuration. The rocket engine is installed in the rear section of the fuselage while the electric engine placed in the aft section. The UAV can be controlled by the elevons as well as rudders located in the side plates.

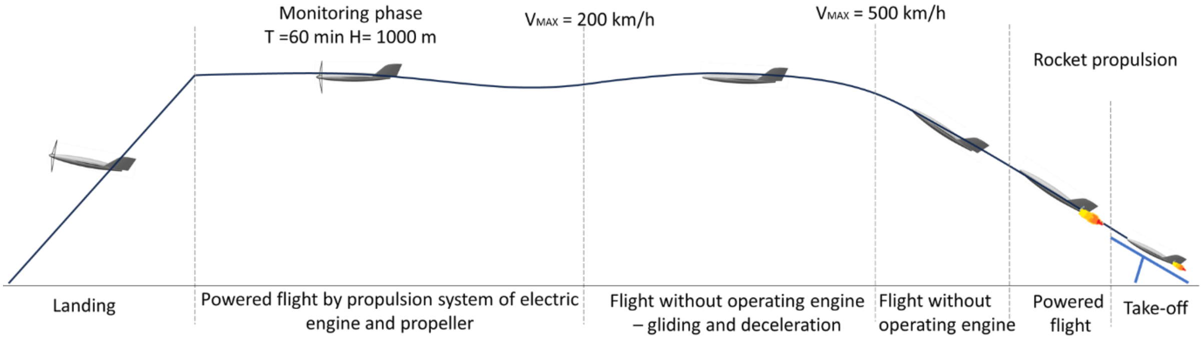

Figure 1 UAV mission profile

This study encompasses an analysis of aerodynamics, stability, control, and conceptual structure project. The aerodynamic computations were performed with the use of PANUKL [1] and MGAERO software [3]. Obtained outcomes were utilized in the preparation of input data needed for dynamic stability study as well as for flight simulations. The dynamic stability analysis was performed by the use of SDSA package [2], where typical modes of motion were investigated. Moreover, the PANUKL results (Figure 2) were used to estimate the aerodynamic loads that were necessary to design the airframe structure. The exemplary results of the structural analysis are presented in Figure 3 and Figure 4. The composite technology and 3D printing technique [4] were utilized in the structural project. The ultimate goal of the project is to manufacture and fly the UAV demonstrator. The results presented in this paper are the first milestone necessary to achieve this aim.

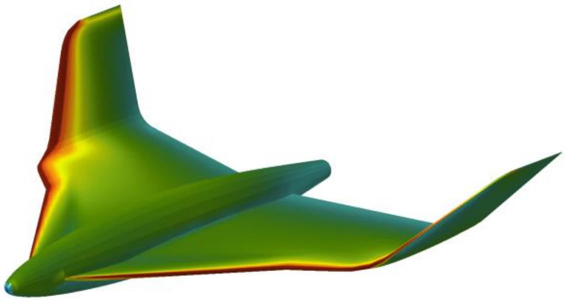

Figure 2 Pressure distribution obtained by the PANUKL in case of Ma=0.35, α=10^o and β=10^o

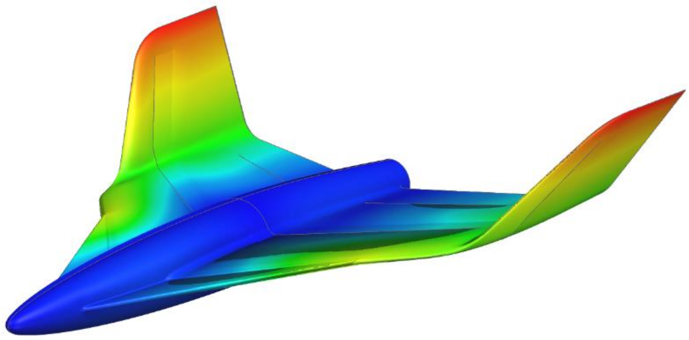

Figure 3 Displacement due to aerodynamic load

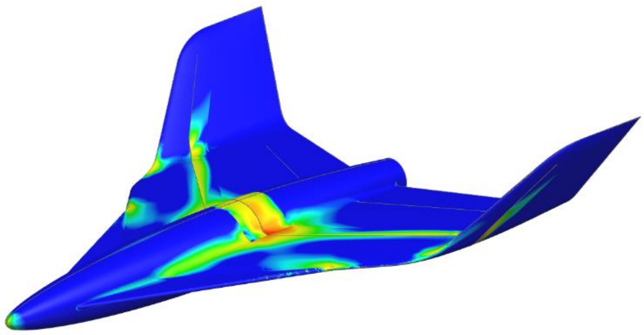

Figure 4 Strength Ratio distribution

References

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[2] Goetzendorf-Grabowski T. SDSA - Simulation and Dynamic Stability Analysis application. https://www.meil.pw.edu.pl/add/ADD/Teaching/Software/SDSA , 2020. (Accessed on 08/07/2024)

[3] MGAERO A Cartesian Multigrid Euler Code for flow Around Arbitrary Configurations - User's Manual Version 3.1.4, 2001.

[4] Mieloszyk J., Tarnowski A., Kowalik M., Perz R., Rzadkowski W. (2019), "Preliminary design of 3D printed fittings for UAV", Aircraft Engineering and Aerospace Technology, Vol. 91 No. 5, pp. 756-760. doi: 10.1108/AEAT-07-2018-0182