Aerodynamic analysis using Computational Fluid Dynamics methods in the development process of an aerobatic aircraft

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Abstract:

The main purpose of this work was to obtain, using Computational Fluid Dynamics methods, a reliable information on aerodynamic properties of a new generation aerobatic aircraft. Unusual aerodynamic layout of this airplane allows it to perform an aerobatic manoeuvres that are impossible to perform by other airplanes. On the other hand, the aerodynamic analysis of this type of aircraft is particularly complex process. Fortunately, a massive improvement of computational fluid dynamics methods and the rapid increase of computational resources made it possible to simulate a lot of phenomena appearing during the flow of fluid around object. Therefore, an aerodynamic analysis was performed using specialized software based on solving partial differential equations using the Finite Volumes Method. What is more important, to perform tests in wind and water tunnels, scaled models of an airplane have been prepared using the modern and fast manufacturing technologies, including 3D printing and CNC machining. The aerodynamic analysis results were presented in the form of diagrams showing aerodynamic force and moment components as a function of the angle of attack. During research an influence of particular structural parts of an airplane on aerodynamic characteristics have been analysed. The qualitative results of a flow around the plane have been presented. Visualization of pressure distribution have been extended with path lines of the flow. What is more, the obtained results have been compared with the results of experimental tests carried out in the wind tunnel. It will also prove that adopted method is sufficient for solving this type of problems. In addition, the resulting aerodynamic characteristics can be used at the stage of determining loads acting on the structure of the airplane during the flight.