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Title

Aerodynamic Analysis of Tandem Tilt-Wing eVTOL Aircraft in Cruise Phase

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Abstract

Urban Air Mobility (UAM) has gained significant attention in recent years as a revolutionary mode of transportation in populated areas. This mobility is expected to improve the convenience and rapidness of the transport of passengers and cargo. There are three main requirements for the UAM: a capability of take-off and landing on limited areas, low acoustic noise for flying over urban areas, and high lift-to-drag ratio for longer cruising range and reduced environmental impact. As the aircraft to meet these requirements, electric vertical take-off and landing (eVTOL) aircrafts have been developed. Some of the eVTOL concepts are expected to achieve low-noise flight by distributed electric propulsion (DEP). Furthermore, the winged eVTOL concepts have better lift-to-drag ratio than other concepts. The tandem tilt-wing eVTOL aircraft further adds to this advantage by requiring less motor power for take-off and landing, making it as a leading concept for UAM.

Despite its potential benefits, the aerodynamics of the tandem tilt-wing eVTOL aircraft is not well understood yet and presenting significant challenges that must be overcome to bring the concept to life. At NASA Langley, the Langley Aerodrome No. 8 (LA-8) was built as a test aircraft model to obtain the basic aerodynamic data needed for the design and analysis of tandem tilt-wing eVTOL aircrafts [1]. Wind tunnel experiments of the LA-8 by Ronald et al. revealed that the aircraft showed complex and unstable aerodynamic characteristics even on cruise condition (tilt angle of 0 degrees). These characteristics were expected to be caused by the complex configuration including the wing tilt mechanism and the interferences of wing and slipstreams induced by the multiple number of propellers [2,3].

The objective of this research is to clarify the relationship between aerodynamics and flow field around a tandem tilt-wing eVTOL aircraft on cruise condition, to comprehend its complex aerodynamics. This was achieved through the use of unsteady RANS simulations performed on a LA-8-based model. Wind tunnel experiments was also conducted to validate the simulation results and obtain aerodynamic coefficients in various conditions.

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