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Numerical analysis of propeller effects on wing aerodynamic: tip mounted and distributed propulsion

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Abstract

The purpose of this investigation is determinate the effects of propeller on wing aerodynamic, both for a propeller mounted in the middle of the wing, and for tip mounted propeller. Especially, it is investigated how a tip-mounted propeller can decrease wing induced drag, and how distributed propulsion can increase the high-lift aerodynamic. Analyses are carried out using a Virtual Disk Model on CFD software, showing a good agreement comparing numerical results with experimental data obtained by previous works. Wing tip engine with propeller, has been employed on a general aviation aircraft wing with an installed thrust to accomplish with cruise performance, reducing the induced drag. Distributed propeller engines on the wing allows improving of low speed performance, increasing the aircraft lift coefficient. Induced drag can be reduced of about 2-3% a low cruise lift coefficient, until 8-10% at relative high cruise lift coefficient. Maximum achievable lift coefficient could be increased of about 20-30% in clean configuration, and more than 50% in flapped configuration.

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*Keywords:*aircraft propeller simulation, tip propeller effects, distributed propulsion

1. Introduction

This paper aims to provide an overview of the aerodynamic effects of tip mounted propeller and distributed wing propulsion on a commuter aircraft wing. Two of most promising fields to improve aircraft performance, enhancing the capabilities in the design of novel aircraft configurations, are the morphing technologies Della Vecchia et al. (2017) and hybrid-electric, distributed propulsion.

Especially for the electric propulsion, the benefits of such an adoption are applicable in the following areas: (i) safety, (ii) emission, (iii) community noise, (iv) operating costs Moore et al. (2013). Ongoing development, research, and eventual production projects, are focusing on the low-power, low-range, limited utility platforms dedicated to the flight training market, as seen in the Airbus E-Fan Airbus (2015) and Pipistrel Alpha Electro Grady (2015) and NASA Sceptor X-57 Borer et al. (2016). These are stepping-stone platforms by their parent companies for entrance into larger, more powerful aircraft.

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