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Photogrammetry-based reverse engineering method for aircraft airfoils prediction

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Abstract. Airframe internal and external specifications are the product of intensive intellectual efforts and technological breakthroughs distinguishing each aircraft manufacturer. Therefore, geometrical information characterizing aircraft primary aerodynamic surfaces remain classified. When attempting to model real aircraft, many members of the aeronautical community depend on their personal expertise and generic design principles to bypass the confidentiality obstacles and sketch real aircraft airfoils, which therefore vary for the same aircraft due to the different designers' initial assumptions. This paper presents a photogrammetric shape prediction method for deriving geometrical properties of real aircraft airframe by utilizing their publicly accessible static and dynamic visual content. The method is based on extracting the visually distinguishable curves at the fairing regions between aerodynamic surfaces and fuselage. Two case studies on B-29 and B-737 are presented showing how to approximate the sectional coordinates of their wing inboard airfoils and proving the good agreement between the geometrical and aerodynamic properties of the replicated airfoils to their original versions. Therefore, the paper provides a systematic reverse engineering approach that will enhance aircraft conceptual design and flight performance optimization studies.

Keywords: aerodynamics; aircraft design; airfoil aerodynamics; conceptual design; numerical simulation; other relevant topic

1. Introduction

Recent progress in computational equipment and capabilities has encouraged many individuals, previously not included in the official aerospace community such as freelance engineers, researchers, hobbyists and students to get involved in the innovative aeronautical research. Today, interest in designing and simulating manned/unmanned aerial vehicles and scaled-down real aircraft models is growing. When starting a real aircraft designing or re-engineering project, the first obstacle facing the independent designers worldwide is how to acquire well-validated geometrical data describing the selected commercial/military aircraft airframe or its parts such as fuselage, wing and etc. (Sun *et al*. 2020). This difficulty is attributed to the fierce competitiveness requisites in the aviation market necessitating complete confidentiality of similar information. As a result, freelance or amateur designers depend on their own expertise and professional skills aided by generic aircraft design and performance principles to generate the required geometries to be

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