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Characterizing a Parameterized Winglet on a Small-Scale UAV

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Overview

The study focused on the investigation of the relationship between the parameters that define a winglet's geometry and the performance of the wing on a small-scale UAV. The developed algorithm generates a 3D model and runs an aerodynamic simulation for each point in the defined domains of the parameters; the simulation data is input to a curve fitting algorithm.

Conceptual Framework

Geometrical parameters define a winglet, each affecting performance differently (Fig.1). The performance has been shown to be sensitive to the cant angle and span of the winglet. The twist angle has a much smaller impact, and is not considered. Future work would involve integrating more parameters such as: taper ratio, and blending radius to the winglet model.

Key Findings

Figures 1 and 2 detail the parameters of the winglet in the model. Performance was calculated between a span of 0.8 and 0.95, a cant angle of 40 and 60 degrees, a sweep angle of 0 to 40 degrees, and a thickness ratio of 0.154 (airfoil parameters define a NACA 0012). A polynomial was fit to the data and evaluated using its R-squared value [2], which was 0.7161.

Impact

Understanding the relationship between the winglet parameters and the aircraft performance can significantly speed up aircraft design. This can be done by integrating the fitted function with a Multidisciplinary Design and Optimization (MDO) framework to search for the optimal values of the aircraft parameters.

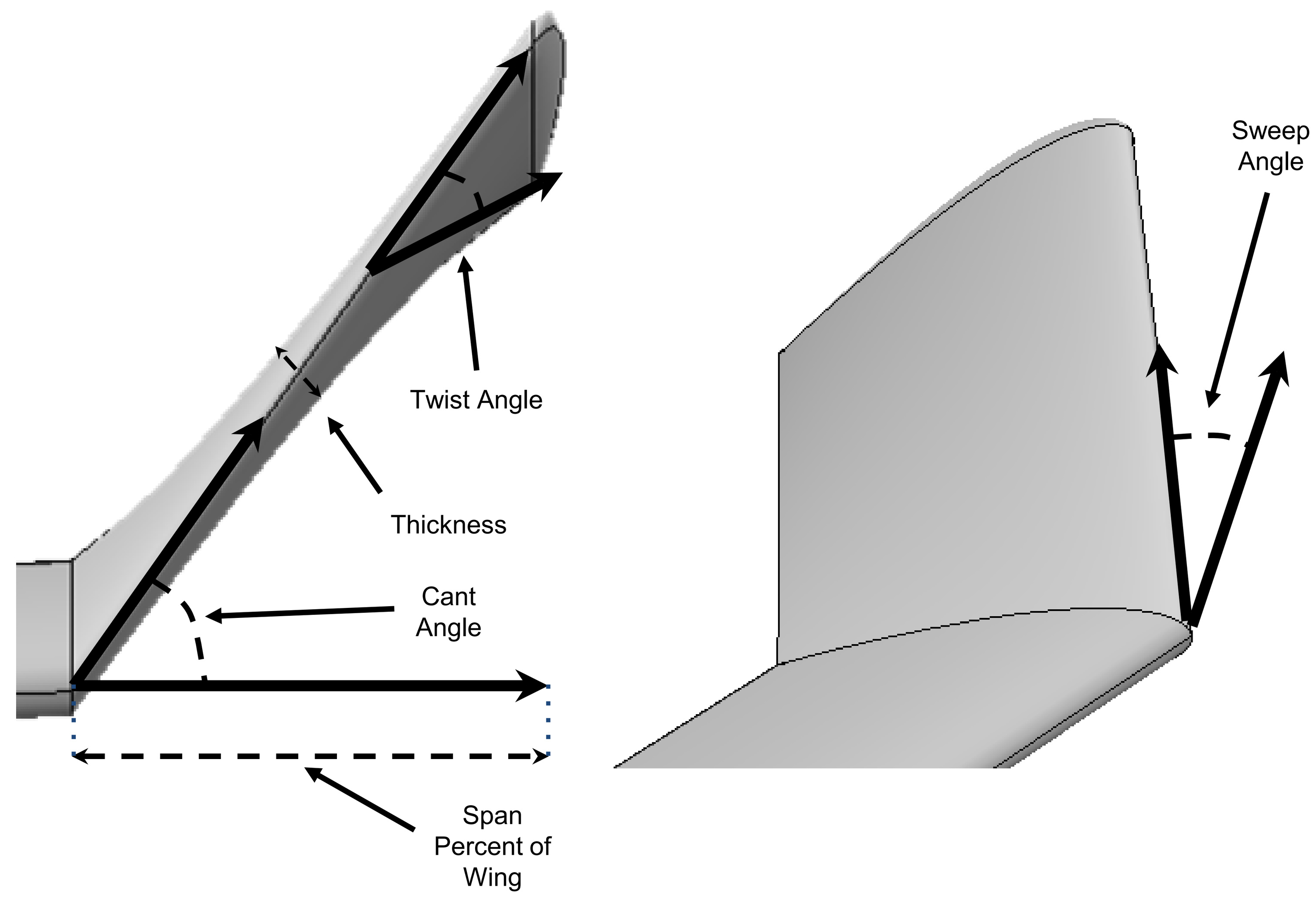

Fig. 1 — Geometrical parameters that define a winglet in the small scale UAV 3D model.

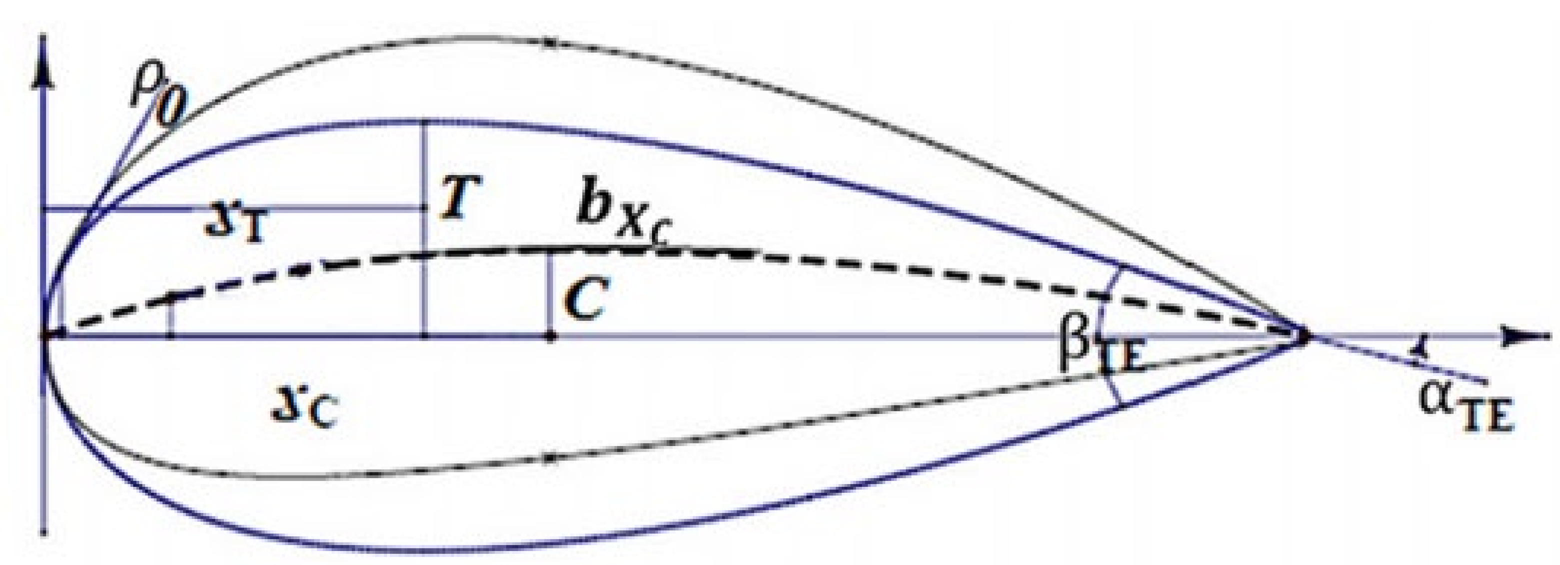

Fig. 2 — Geometrical parameters from the IGP method of parameterizing an airfoil as defined in [1].

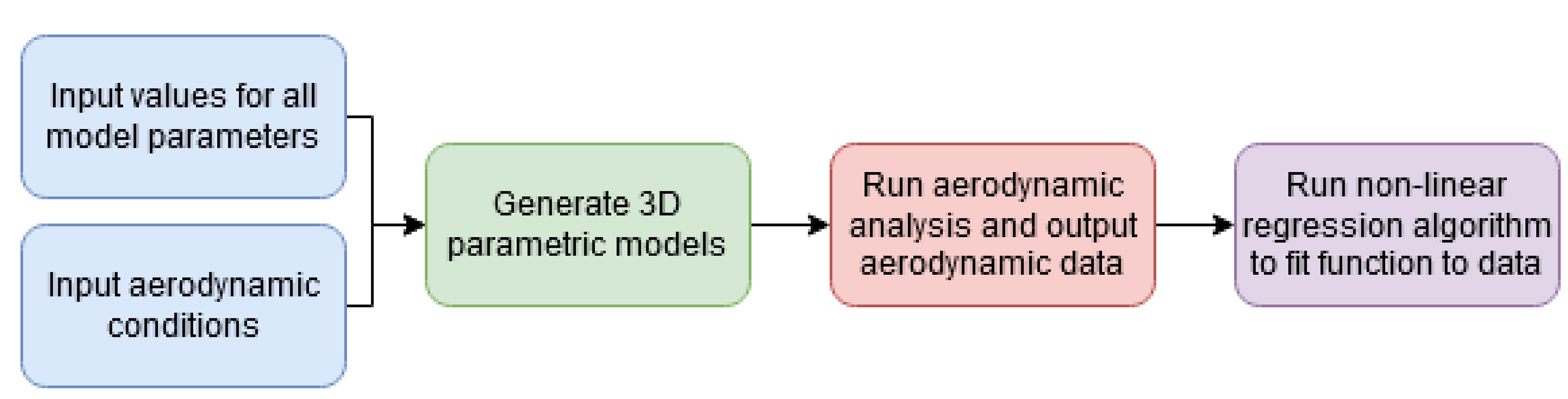

Fig. 3 — Flow diagram for the developed algorithm.

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