Improvement of the aerodynamic behaviour of a blended wing body unmanned aerial vehicle: numerical and experimental investigations

Auteur : Masereel, Martin
Promoteur(s) : Andrianne, Thomas; Terrapon, Vincent
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Improvement of the aerodynamic behaviour of a blended wing body unmanned aerial vehicle : numerical and experimental investigations

Martin Masereel

University of Liège
Department of mechanical and aerospace engineering
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T. Andrianne and Prof. V. Terrapon

In this thesis, a review of the history of blended wing bodies has been done and the various advantages that blended wing bodies offer has been exposed. The increased aerodynamic performance as well as noise reduction assures blended wing bodies a bright future.

The goal of the thesis was to aerodynamically study a blended wing body UAV and propose a new enhance geometry.

To do that, two different methods of analysis were first validated through comparison with experimental results of simple geometries (NACA wings). Those two methods included a low-fidelity one, PanAir and a higher fidelity one, SU^2. PanAir results turned out to be quite accurate provided that the drag coefficient was corrected. Some limitations of PanAir have, however, been highlighted namely when it was applied to configurations comprising flaps. SU^2 showed better results but its computation time was much more important.

A detailed analysis of the baseline design of the UAV was then performed. Different aerodynamic coefficients were investigated as well as the influence of parameters of the flow. The influence of sideslip angle, control surfaces and propulsion has been studied.

Once the baseline geometry had been analysed, a parametric model of the geometry has been built. The idea was to change the geometry in order to improve the lift to drag ratio. First, the different parameters susceptible of being changed were studied separately to define the final set of varying parameters and their range of values.

A combination of the different parameters led to the study of 1024 different cases that were all compared to one another in order to find the one that maximized the lift to drag ratio while maintaining the required lift. A new geometry has thus been proposed.

The new geometry has been studied and compared to the old one to assess if it improved the aerodynamic performance. It turned out the new geometry induced an increase of 7% of the lift to drag ratio. The behaviour of the UAV when facing crosswind appeared to also be improved.

Finally, a sensitivity analysis on the Reynolds was performed to see if a future wind tunnel test campaign on a reduced size model could be possible. Trends showed that it was safe to analyse the UAV at different Reynolds number when the presence of thrust was ignored. The introduction of thrust led to some dependencies on the Reynolds pointing to the fact that a wind tunnel test should be performed cautiously.

FIGURE 1 – Picture of the GE1 in flight

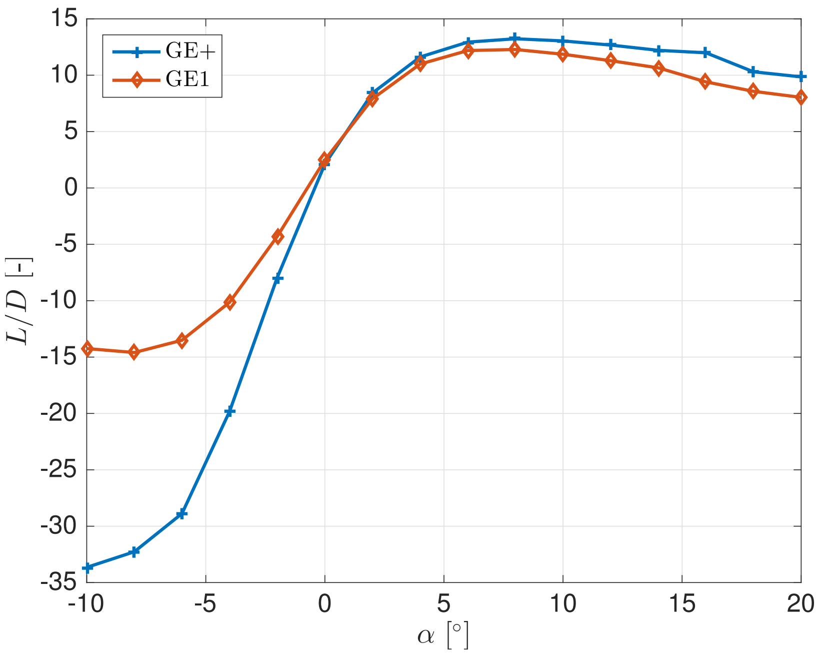

FIGURE 2 – Lift to drag ratio L/D in function of the angle of attack α for the GE1 and GE+ geometry