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EFFICIENT AERODYNAMIC OPTIMIZATION OF AIRCRAFT WINGS

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Abstract: One of the most important keys to the successful design of complex systems is disciplinary inte- gration. Multidisciplinary Design and Optimization is now a promising methodology for the efficient design of such systems, since it combines multidisciplinary analysis with gradient-based optimization techniques. Therefore, this methodology requires the derivatives evaluation of the functions of interest with respect to the design variables, which is the most demanding computational task in the optimization process. Traditionally, those derivatives are calculated inefficiently and inaccurately using approximate methods. Therefore, the objective of this work is to develop an efficient optimization framework to solve aerodynamic design problems using exact gradient information. Firstly, a survey on sensitivity analysis methods is conducted to identify which tools are available and understand their respective merits. Secondly, an aerodynamic model based on the panel method is reformulated into five smaller modules, in which the respective sensitivity analysis blocks are constructed using exact gradient estimation methods: automatic differentiation, symbolic differentiation and the adjoint method. Both the aerodynamic tool and respective sensitivity analysis are validated using a wing design tool and the finite-differences method, respectively. Finally, aerodynamic optimization problems are solved using the new tool with remarkable success since, when compared to the finite-differences method, the optimization time can be reduced by 90%.