Optimization design of a fly wing UAV based on CFD simulation

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Abstract

Although they were firstly invented and applied in military fields, unmaned aerial vehicle (UAV), have become more and more popular in many civil fields, such as disaster relief and express deliberies. There were many mechanical problems that should be solved during the process of designing an UAV. Aerodynamic performances were critical ones among these problems. Massive number of times of computational fluid analyis should be done to study aerodynamic performances of a plan, which were impotant for improvement of design. If these repeated analysis behavior could not be finished automatically, the researcher would spend tremendous time. In this paper, an automatic analysis precedure for optimizing design of a type of UAV based on a commerical software, i.e., Hyperworks, was discussed.

The automatic analysis procedure was developed in a module of Hyperworks called Process Studio through combined using of Tcl/Tk language and builted in functions in Hyperworks. The technological process contained four steps: firstly, import a initial version of the designed fly wing UAV, create boundaries of flow zone, generate meshes in the flow zone, set boundary conditions, carry out low Ma aerodynamic analysis using fluid dynamic module of Hyperworks, i.e., AcuSolve, obtain critical results and write them to files; secondly, obtain command stream of the first step from the file called “command.cmf”; thirdly, use the module Process Studio to develop a standard procedure based on the command stream, test this standard procedure and modify it; finally, set value ranges for selected geometrical parameters and define optimization goal, use linear search method to find the best paramter values.

Based on a formerly designed simple fly wing UAV, aerodynamic numerical optimization using procedue metioned above was carried out. Geometrical parameters that were used for optimization contained sweep angle and dihedral angle of the wings, while lift-drag ratio was selected as the optimization goal. These geometrical parameters and the optimization goal might be not enough for optimizing design of an UAV in practices, but they were good choices for explaining the automatical aerodynamic analysis procedue. Inital values for sweep angle and dihedral angle were set to be 30° and 0°, while value ranges were set to be 10°~60° and -10°~10° respectively. A series of computational fluid dynamic analysis were carried out using optimization design procedure in this paper, and the results showed that: (1) the automatic procedure worked well throughout the whole analysis process, and no man needed on duty until the whole process finished; (2) aerodynamic results could be automatically analyzed and written to files for further study; (3) optimized designing parameters could be generated automatically. The procedue discussed in this paper could obviously improve efficiency of UAV’s design works.

Keywords: CFD, optimization design, fly wing, UAV, automatic analysis module.