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【論文の内容の要旨】

The purpose of this thesis is to investigate the proposed framework of time-series trajectory optimization by global optimization method. Aerodynamics of a civil aircraft was acquired by computational fluid dynamics (CFD) and databases were constructed to solve the equation of motion. Then, efficient global optimization calledEGO, which was based on the surrogate model evolutionary algorithm for arbitrary aircraft motion was applied. The developed methodology was demonstrated to find the optimum trajectory of aircraft landing under hazardous condition.

Chapter 1 presented the introduction and overview of the thesis. The current situation Of aircraft designs and developments were discussed. The realistic usage of CFD and its limitations were also explained. The importance of the aircraft evaluation in consideration of the hazard effect were also explained.

Chapter 2 discussed the definitions and formulations of estimating the aerodynamic derivatives for longitudinal motion. The low- and high-fidelity aerodynamic models

were applied to estimate the aerodynamic derivatives for the standard dynamic model, the experimental data of which was widely acquired. Low-fidelity aerodynamics was empirically evaluated while high-fidelity aerodynamics was evaluated by a compressible Favre averaged Navier-Stokes solver using an unstructured mesh.
The aerodynamic databases constructed by these flow solvers were compared with wind tunnel experimental data. To improve the accuracies of time-series aerodynamic predictions, maximum likelihood estimation (MLE) was applied and additional samples are acquired by maximizing expected improvements. In order to investigate the usage ofthe aerodynamic databases, mode analysis was carried out first using the low-fidelityaerodynamic evaluations. Improved databases showed close agreement with thetheoretical and the exact results compared to the initial databases. The investigation was also carried out by high-fidelity evaluation and similar results were obtained. Thus,the method of producing aerodynamic derivatives was applicable on this research.

Chapter 3 presented an extension of the methodology to evaluate the lateral motion. In this chapter, MLE was also applied. As a result, the successful analysis of the two-mode motions for the longitudinal axis and three-mode motions for the lateral axis were explained. Further, their major effects on motion variables such as angle of attack, pitch rate and sideslip angle were explained in details.

Chapter 4 discussed trajectory optimization using the optimal aerodynamic database NASA’s common research model (CRM), which had a similar size as Boeing777was used as an experimental model and the low-fidelity evaluation was employed
as a first check. In this chapter, the single objective, which was minimization of cost function, the minimum value of which was equivalent to the continuous-descent

approach (CDA) for a trajectory was considered first. Second, the optimization problem deals with two objective functions: minimization of the cost function and minimization of maximum acceleration. In the optimization process, the initial angle of attack, initial Mach number, initial pitch rate and initial deflection angle of the results were considered as design variables. The microburst model was included in the evaluationof the trajectory. Based on the results obtained for both cases, the MLE-based prediction with improved database showed reasonable results which showed better agreement with the exact solution obtained by observing the time histories of variations of the altitude,angle of attack and deflection angle of the control surface. By comparing results with/without the microburst effect, it was found that the similar trajectory could be acquired.

Chapter 5 discussed the aerodynamics acquired by the high-fidelity aerodynamic evaluation for NASA’s CRM. Then, the database was used for the flight trajectory optimization for two cases: with and without hazardous situation. The grid dependency for the high-fidelity aerodynamic evaluation is also investigated and the optimum grid size for the trajectory evaluation is obtained. According to the optimization results, the optimum trajectory with the microburst was determined and it shows similarhistory as the optimization results without the microburst. However, their trajectories are not close to the CDA.

Chapter 6 concludes the thesis.