Acquisition of Swept Aerodynamic Data by Consecutive Change of Wing Model Configuration in Wind Tunnel Tests Using Remote and Feedback Control

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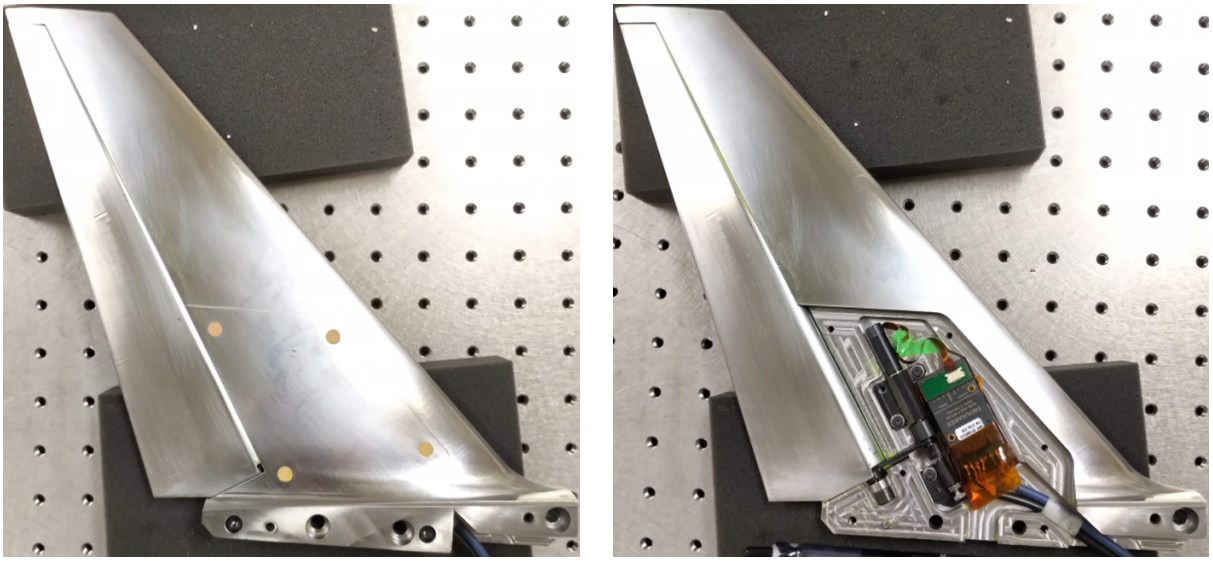
Abstract:

This study has conducted wind tunnel tests with consecutive deflection angle changes on a 3D wing with a control surface to procure aerodynamic data sweepingly.

Configuration changes of a wind tunnel test model, such as rotating the deflection angle of control surfaces, are usually performed manually with the ventilation suspended. Hence, the number of configurations that we can implement within a confined test period is restricted; the aerodynamic data gained are discrete values. We would dramatically improve wind tunnel tests' data acquisition ability by sweeping the aerodynamic data by accomplishing continuous angle modulation and enhancing it to a tool for discussing complex physical phenomena.

Thus, this study created a compact remote feedback control system using optical measurement to continuously obtain high-precision aerodynamic data without ceasing the wind tunnel, eliminating human operation. In particular, this study targets a 3D wing wind tunnel model with a control surface, which is more challenging to fabricate miniaturizing the system in a model.

We consequently attained consecutive aerodynamic data multiple times under numerous configurations, which had been impracticable to reach in the past, within a wind tunnel test period of several days, thereby dramatically raising the test's competence. We quantitatively verified the reproducibility by comparing the multiple data for the identical configurations. Furthermore, we demonstrated the reliability using discrete data obtained by conventional stepwise deflection angle adjustments. Eventually, the system was able to grasp physical phenomena involving hysteresis.



(a) external appearance (b) installed drive mechanism

Figure 1. WTT model and drive mechanism in it.

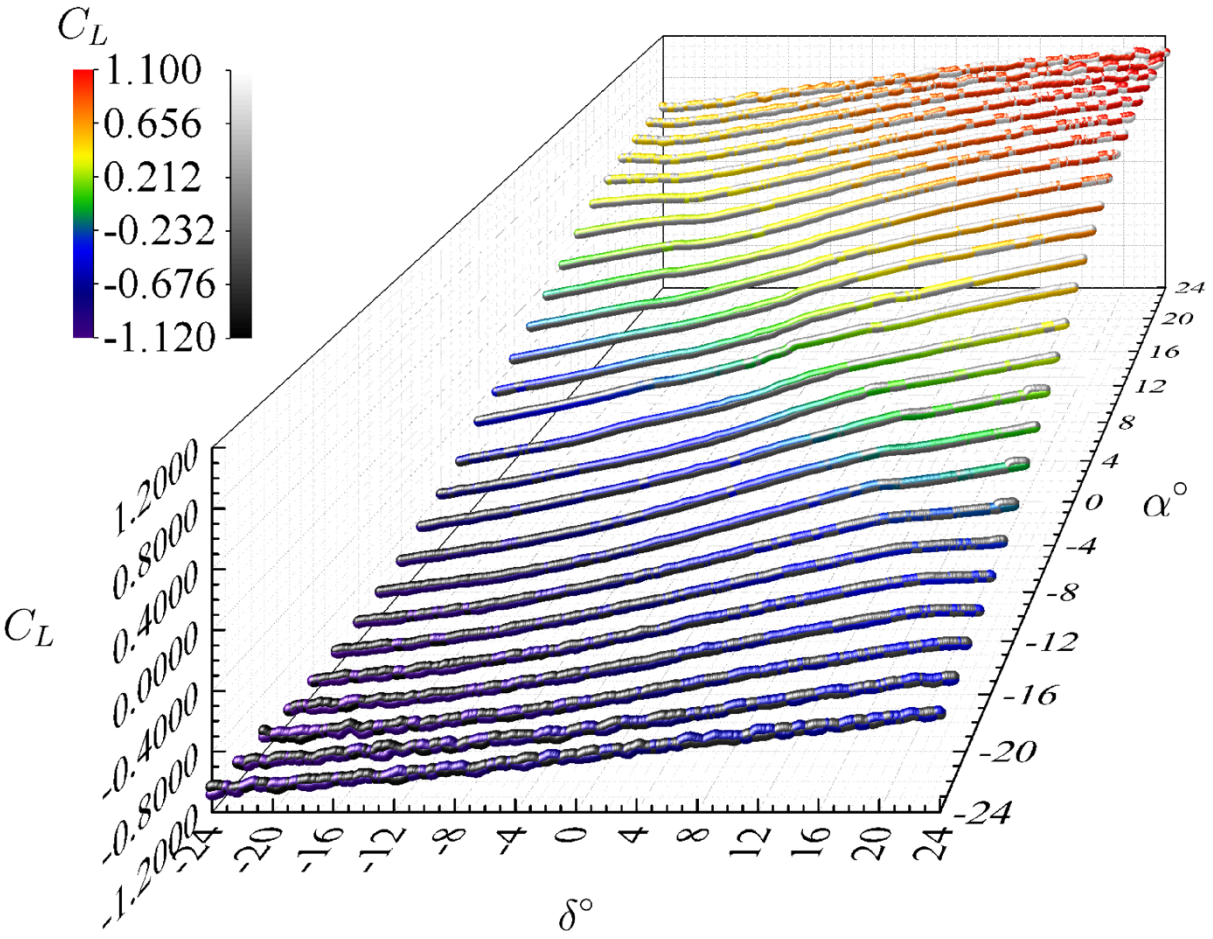


Figure 2. Aerodynamic data acquired by changing the angle of attack alpha and the flap angle delta. We switched alpha in the stepwise mode and shifted delta in the sweeping mode. The figure depicts data gained by down-wise route in color and those procured by up-wise route in monochrome.