ACTIVE SUPPRESSION OF AEROELASTIC VIBRATIONS BY ROBUST CONTROL METHODS WITH INCOMPLETE MEASUREMENTS

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Abstract. A majority of aircraft, including most famous ones, had greater or lesser problems with aeroelastic vibrations. Such vibrations of lifting surfaces and controls are very dangerous because flutter usually causes disaster of aircraft, whereas vibrations of ailerons, although less dangerous, are highly undesirable because of their destructive influence on the control devices.

Aeroelastic vibrations can be suppressed actively by using the Flight Control Systems (FCS). Although the concept of flutter suppression has been abandoned because of its impracticality (regulations require the flutter speed be high enough), the active suppression of other aeroelastic vibrations, such as nonlinear vibrations of ailerons, are very attractive because they occur at the speed much lower than that of flutter (as it was in a disaster of F-117 stealth aircraft) and the FCS systems mounted on the aircraft can be used for suppressing of such vibrations without essential modifications.

In this paper it will be shown that using the AFCS systems the aeroelastic vibrations, especially the nonlinear vibrations of ailerons caused by freeplays or hysteresis nonlinearities, can be suppressed very effectively by robust H∞ method of control. It will be shown that the ability of H∞ controller to suppress such vibrations depends essentially on the completeness of state measurements: if the full state is available the H∞ method is very effective, whereas in case of incomplete measurements the number and type of measurements are essential for efficiency of suppression. It will be also shown that although hysteresis vibrations are very hard to suppress, the H∞ controller is still able to prevent ailerons flutter by reducing the amplitudes of vibrations to acceptable, safe level. Some comparisons of the H∞ method and the LQG method will also be presented.

Keywords. Aeroelasticity, Flight Control System