Institut für Strömungsmechanik und Technische Akustik
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BACHELOR THESIS

Literature research on unsteady effects at pitching, plunging, and surging airfoils

The aerodynamics of steady flows around airfoils is, for the most part, properly understood and the theoretical framework has been validated by numerous experiments. However, many technical applications operate in highly unsteady flows. The added time dependency alters the steady state solution and has far-reaching effects on theory and practical purposes. Some examples are airplanes, Horizontal- and Vertical Axis Wind Turbines (HAWT's & VAWT's), helicopters, underwater vehicle's, and Micro Air Vehicles (MAV's). Variations in freestream velocity and in angle of incidence cause significant deviations from steady flow conditions depending on amplitude and frequency of the unsteady motion. Despite extensive efforts in understanding the nature of unsteady flow effects experimentally and numerically, the accurate prediction of the unsteady aerodynamic forces remains challenging.
Three types of motion can be defined: surge, pitch, and plunge, which significantly influence the flow physics and cause unsteady loads. For pitch and plunge the unsteady loads are caused by a change of incidence, whereas it is the change in freestream velocity for the surging motion, thus imposing differences in dynamic pressure and REYNOLDS number.

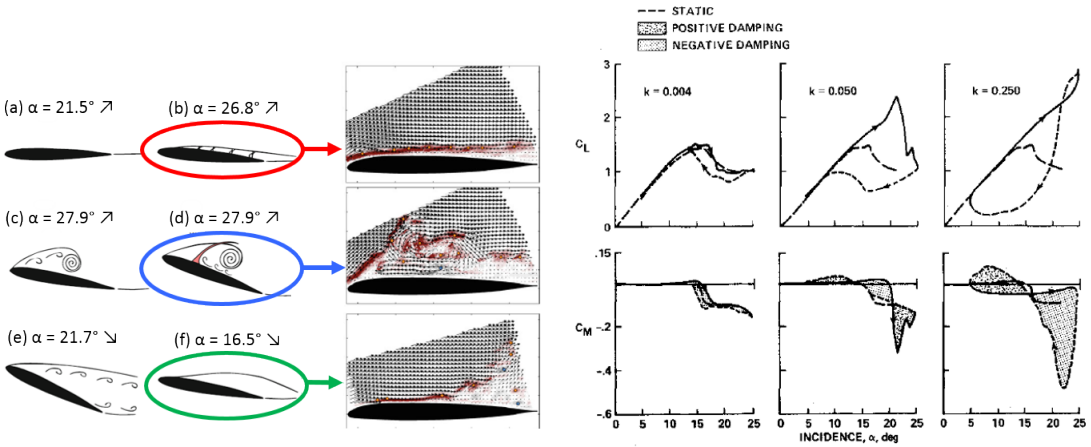

Figure 1: Left: Dynamic stall process: sketch and PIV [1] and Right: Effect of reduced frequency on the dynamic stall of an oscillating airfoil [2]

The scope of the proposed bachelor thesis is the elaboration of detailed literature review. The thesis shall provide a well-structured overview on the research field of unsteady profile aerodynamics for finite and infinite wings. Numerical and experimental studies on the individual types of motion as well as their superposition shall be sorted, summarized, and discussed. The thesis has to be written in English.

Begin of work: asap

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[1] Mulleners, K., and Raffel, M., "Dynamic stall development", Experiments in Fluids; Vol. 54, No. 2, 2013. doi:10.1007/s00348-013-1469-7

[2] McCroskey, W. J., "Unsteady Airfoils" Annual Review of Fluid Mechanics; Vol. 14, No. 1, 1982, pp. 285–311. doi:10.1146/annurev.fl.14.010182.001441