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NUMERICAL SIMULATION OF INCOMPRESSIBLE FLOW AROUND AEROFOIL VIBRATING WITH TWO DEGREES OF FREEDOM

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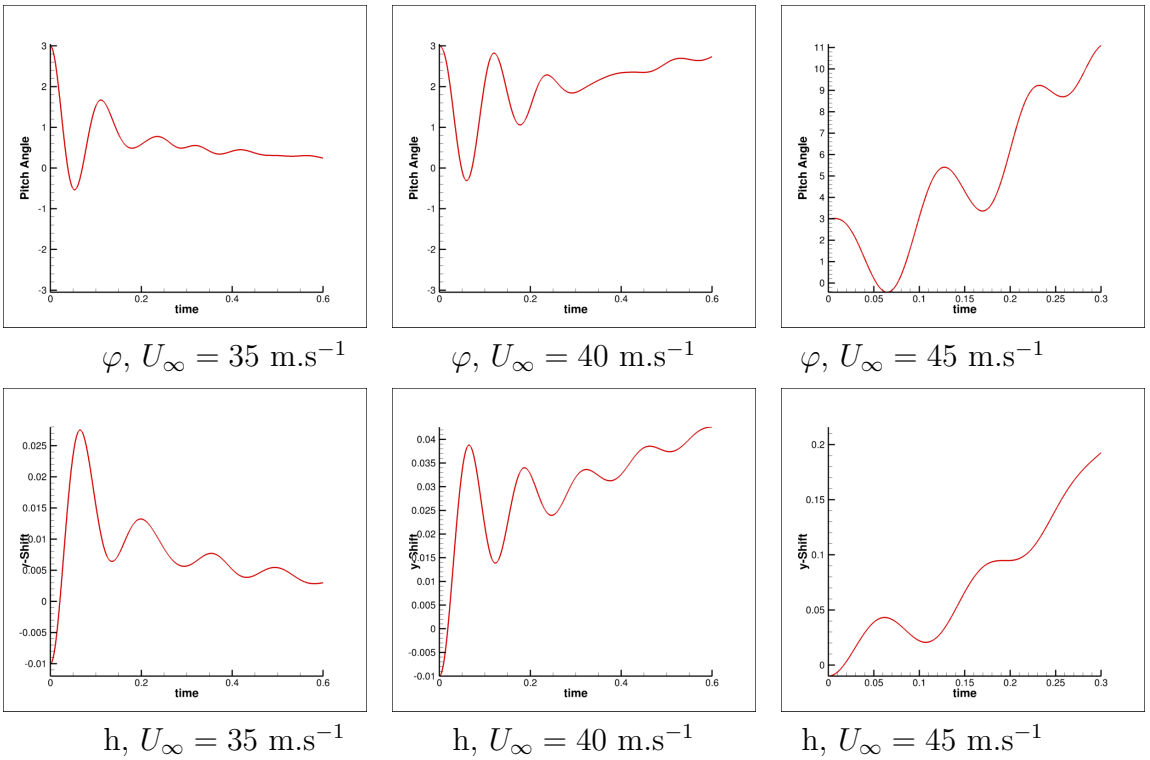
Aeroelastic effects (e.g. buffeting of flutter) which are present in flows around aerofoils and wings have usually a significant influence on the flowfield. Possibilities how to simulate them numerically with the use of commercial CFD codes are still very limited and such problems are often solved by a problem-tailored software solvers. The aim of this work is to research one of such approaches. The so called Modified Causon's scheme (derived from TVD form of the classical MacCormack scheme) is extended in order to simulate unsteady flows with the use of the ALE method. A flow over NACA 0012 profile is simulated, while the profile itself is moving with two degrees of freedom (oscillations around an elastic axis and motion in direction of vertical axis). The motion itself is induced by the flowing air and described by system of two ordinary 2^{nd} order differential equations. More inlet velocities, initial deviation angles and shifts in vertical direction are considered. Stiffness is modeled both as linear and non-linear. Obtained results are compared with NASTRAN analysis and results of in-house code by Radek Honztko from Department of technical mathematics (Faculty of Mechanical Engineering, CTU in Prague). Critical velocities for unstable oscillations are the same interval in all simulated cases.



φ, $U_\infty = 35$ m.s^{-1} φ, $U_\infty = 40$ m.s^{-1} φ, $U_\infty = 45$ m.s^{-1}

h, $U_\infty = 35$ m.s^{-1} h, $U_\infty = 40$ m.s^{-1} h, $U_\infty = 45$ m.s^{-1}

Figure 1: Behaviour of the pitch angle φ and shift h for inlet velocities $U_\infty \in [35, 40, 45]$ m.s^{-1} during the first 0.6 seconds of flow. Linear system, initial conditions: $\varphi_1 = 3, h_1 = -0.01$ [m].

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