Investigating Incipient Separation for an Aerofoil at an Arbitrary Orientation Subjected to an Oncoming Gust

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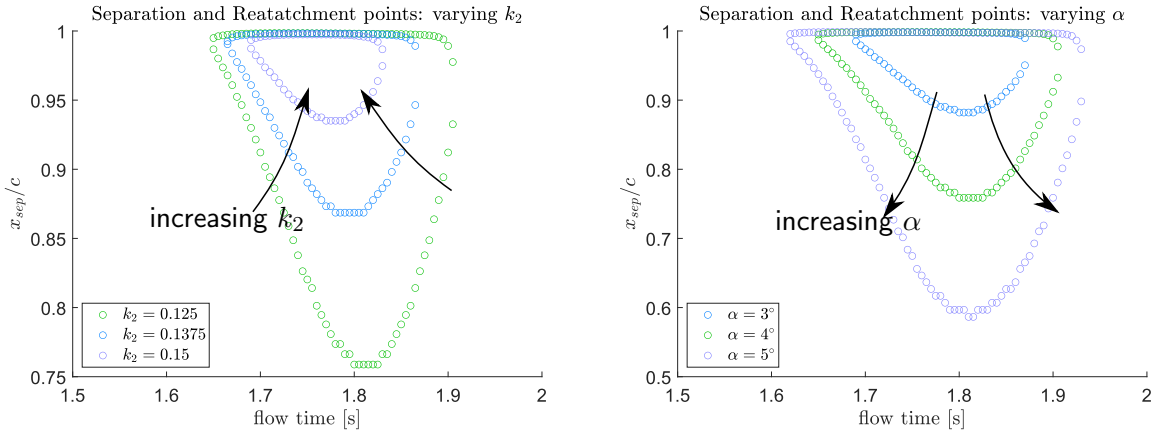
Abstract

The purpose of this paper is to develop an efficient method for analysing the gust response of an aerofoil using CFD. The new method was then applied to investigate how varying the characteristics of a sinusoidal gust affects flow separation over a NACA0012 aerofoil. A two-dimensional periodic gust was implemented in ANSYS FLUENT using the User Defined Function tool. A specialised mesh was designed to allow for accurate modelling of a gust past a NACA0012 aerofoil. The features a rounded trailing edge and an O-grid structure with 164,000 cells. An incompressible SIMPLE pressure-based solver was used in ANSYS FLUENT. The k-ω SST turbulence with low Reynold's corrections was chosen due to its effectiveness in modelling pressure induced flow separation. The velocity-inlet boundary was defined by the user defined function velocity components with an angle of attack α.



Eight simulation cases were run, all with a Reynolds number of $3mil$ and with varying values for the angle of attack and varying gust parameters. The gradient of the horizontal velocity profile ($\partial u_x/\partial y$) was exported for every node on the aerofoil surface after every ten time-steps. A MATLAB program was written to find the separation and reattachment points on the aerofoil by analysing the solution data for $\partial u_x/\partial y$ at every exported time-step. In the paper, we show how the location of separation and reattachment points along the chord vary with the gust parameters and mean angle of attack against time as seen on the two graphs above where the effect of varying k_2 (the gust wavelength in the transverse direction) and α (the mean angle of attack) is shown.