The effect of Gurney flap height on vortex shedding modes behind symmetric airfoils

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The Gurney flap is a small device (1% to 4% of airfoil chord length) used to increase the lift on an aerodynamic surface. Wadcock (1987) performed wind tunnel tests at a Reynolds Number of 1.64×10^6 on a baseline NACA 4412 airfoil that showed a significant increase in the lift coefficient, shifting the lift curve up by 0.3 for a Gurney flap of 1.25% of the chord length. In previous studies (Troolin et al., 2006), two shedding modes that interacted in the flap wake were shown to have a significant impact on the lift generated by the airfoil. In this study, time-resolved particle image velocimetry (TRPIV) and hot-film anemometry are used to characterize the nature of the trailing wake behind a NACA 0015 airfoil with Gurney flaps of different heights.

1. Experimental Setup

Wind tunnel experiments were performed at $Re = 2.0 \times 10^5$ on airfoil test sections with an aspect ratio of 1.6. A pair of high-frequency Nd:YLF lasers were used in combination with a high frame rate CMOS camera. For the TRPIV measurements, the laser light sheets entered the tunnel from above, with the camera mounted on the side of the tunnel. The data from this configuration was inverted in the plots for purposes of comparison.

2. Results and Conclusions

Figure 1 presents two sequences of velocity normal to the freestream for the 4% flap case, shown in intervals of $tU_\infty/h = 0.915$. In the column on the left, a burst of downward normal velocity (seen in blue) emerges from the upstream cavity of the flap and coincides with a local downflow caused by the primary shedding. In the column on the right, a downward burst interacts first with a local upflow. Longer sequences showed that both types of behavior occurred for both the 2% and 4% flaps. In the full paper, this behavior is contrasted with the flow structure behind 'closed' flap configurations where the area upstream of the flaps was filled in. Examination of the flow sequences as well as spectra from hot film measurements indicated that the coherence of upstream shedding increased with angle of attack, and that the frequency ratio of upstream to downstream shedding modes fell within a range centered at approximately 0.8 for both the 4% and 2% flaps. TRPIV sequences downstream of 1% flaps revealed smaller scale structures and inconclusive results.

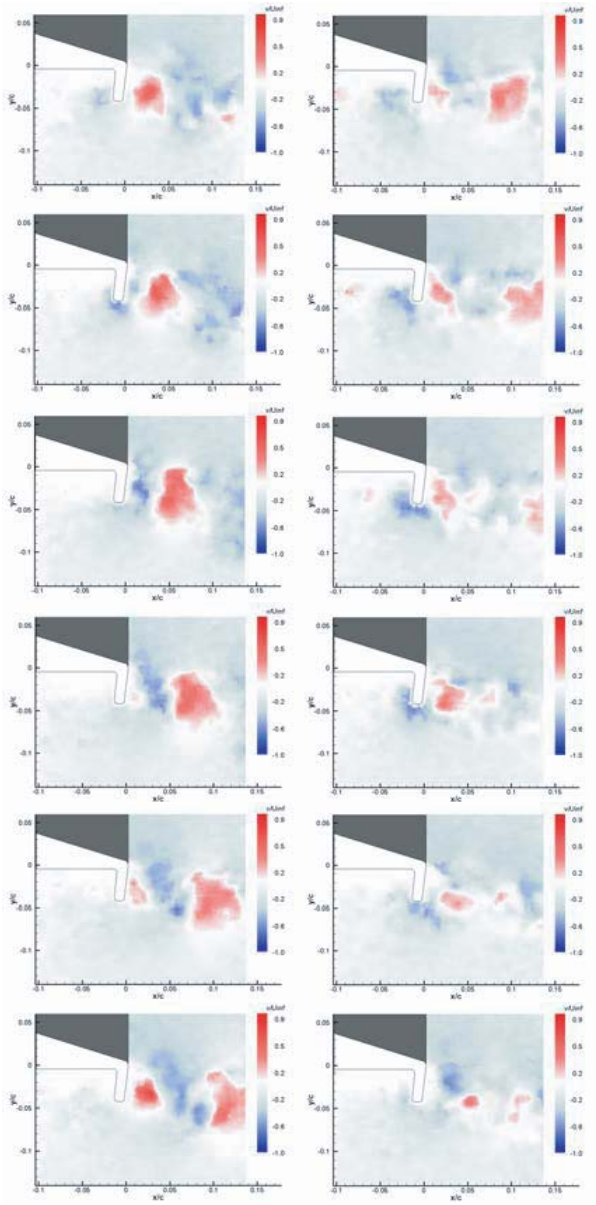

Fig. 1 Normal velocity at intervals of $tU_\infty/h = 0.915$ for the 4% Gurney flap, $\alpha = 8°$.

3. References

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