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Exploiting Rapidly Actuated Control Surfaces

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Enhancing the manoeuvrability and agility of aircraft provides advantages in situations such as air-to-air combat, shortens the transition time between manoeuvres, and improves the ability to resist against sudden external forces on the aircraft. Previous research theorises that the transient lift characteristics of unsteady aerodynamics could contribute to aircraft manoeuvrability by exploiting a prominent feature found on aircraft: control surfaces.

Several studies conducted with rapidly deflected trailing-edge control surfaces such as the works of Rennie and Jumper, and Medina and Rockwood [1, 2] have involved changing the following parameters: deflection rate ($\dot{\delta}$), deflection range (δ), and angle-of-attack (α). Despite this, there is a prevailing research gap that is the effect all three parameters together have on the amplitude and delay of the transient lift response.

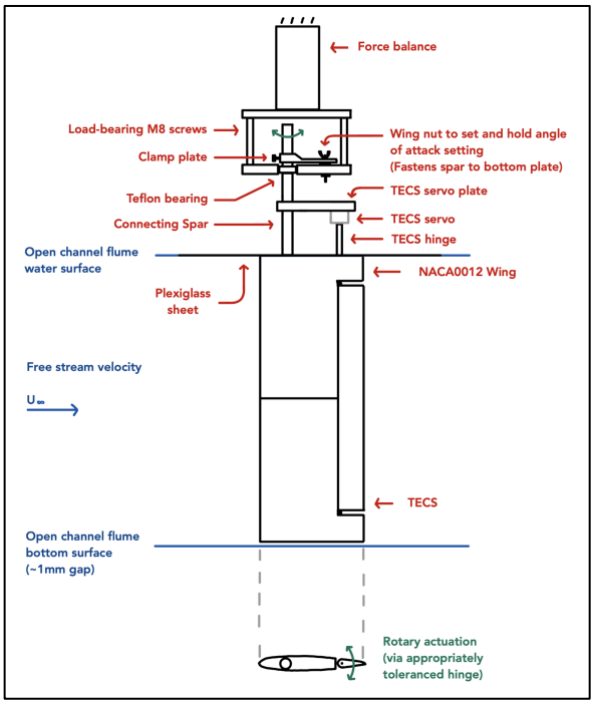

Figure 1.

This project aims to analyse the influence of the deflection rate ($\dot{\delta}$) and deflection range (δ) of a TECS, and the wing's incident angle-of-attack (α) with a more comprehensive test range on the production of transient lift peaks caused by unsteady aerodynamic effects. The results will help assess the feasibility of using rapidly deflected control surfaces in a practical application. The study will be conducted using an experimental setup containing a NACA0012 airfoil placed vertically in horizontal water tunnel (UNSW Canberra Open-Channel Flume). The wing will have a trailing-edge control surface that is actuated at different deflection rates to different ranges using a servo. The angle-of-attack of the wing relative to the upstream flow will be manually set, allowing for all three parameters to be varied accordingly.

Keywords: Unsteady aerodynamics, dynamic stall, flow separation, control surfaces, lift generation

References

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[2] Medina, A., and Rockwood, M. "On the Response of Leading-Edge Phenomena and Near-Wake Formations to Trailing-Edge Flap Actuation," Proceedings of the 10th International Micro Air Vehicle Competition and Conference, Melbourne, VIC, Australia. 2018, pp. 17-23.