Noise reduction devices for a wing tip

Satoshi Baba[1,2] & Patrick Deng[1,2] & Stéphane Moreau[2] & Philippe Lavoie[1]
1 Institute for Aerospace Studies, University of Toronto, North York, Ontario, CANADA
2 Génie Mécanique, Université de Sherbrooke, Sherbrooke, Québec, CANADA

The reduction of aircraft airframe noise has been a topic of interest in aeroacoustics for decades. This is largely due to the development of more efficient turbofan engines and the resulting reduction in aircraft propulsion noise. During the approach phase of their flight cycles, when the engine throttle is reduced, airframe noise sources, such as high-lift devices and landing gear, also become significant. This also coincides with when the aircraft is close to the ground, which makes its external noise more audible to the community in its flight path.
The current study focuses on noise reduction for a wing-tip-shaped geometry, as seen in airframe components such as the flap side edge. A representative wind-tunnel model comprising a straight, untapered wing with a blunt wing tip was used, and measurements were taken in a Kevlar-walled wind tunnel at the University of Toronto Institute for Aerospace Studies. Multiple wing-tip shape alterations were tested for the change in the far-field noise profile. It has been found from the previous study that the wing tip is a source of three independent vortices, and that the one generated on the tip surface (the primary vortex) crossing over from the tip surface to the suction surface over the sharp corner has to do with the noise generation; more specifically, it was determined that the vortex wandering in the direction grazing the corner is converted to the noise [1]. Based on this information, roughly 40 different wing-tip shape alterations and their acoustic performance were measured in the wind tunnel. The measurement included surface oil flow visualization to assess changes in flow structure shapes, and a phased microphone array to calculate far-field noise source maps.

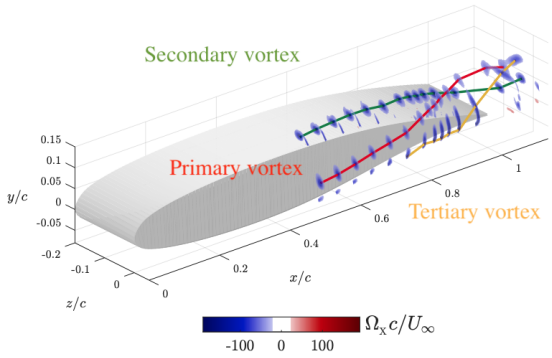

Figure 1: The ensemble-averaged vorticity field around the wing-tip model. The vorticity are normalized as $\Omega_x c/U_\infty$. The lines indicate the center of the vortices identified with Q-criterion.

References

[1] Satoshi Baba et al. "Noise-generation mechanisms of a wing-tip vortex at moderate angle of attack". In: *Journal of Fluid Mechanics* 1026 (2026), A18. DOI: 10.1017/jfm.2025.11001.

Email address for correspondence: *satoshi.baba@mail.utoronto.ca*