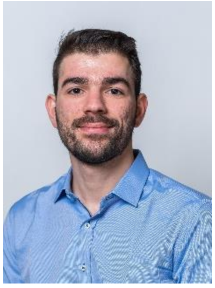
Distributed Propellers Configuration in Forward Flight

A Computational Aerodynamic and Aeroacoustic Investigation



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The investigation and development of distributed propellers systems follow the need for sustainability towards low noise and pollutant emissions. Distributed propellers systems are propulsive configurations with multiple propellers used to produce thrust, applied to air vehicles and UAVs to broaden the design space and reach new performance goals. The current computational study investigates the aerodynamic interactions and aeroacoustic behaviour of distributed-propellers configuration in forward flight, including phase angle effects.

The performance of the distributed propellers when operating at a close distance show a change combined with thrust oscillations. The induced effects originated by the adjacent propellers alter the behaviour of the flow upstream and downstream of the propellers, affecting their performance. Thrust reduction occurs during a propeller's revolution when the blades approach the adjacent rotors, and a thrust increase during the retreat. The unsteady character of the loading alters the noise emission of the system. The noise increase is observed in front of the propellers, reaching 13.2dB compared to the isolated propeller. On the contrary, there is not a remarkable change parallel to the propellers plane. This directivity pattern combined with the enhanced tonal components shows that unsteady loading is the primary noise source. The effects of the relative phase angle are also examined in the present study. Its effects are primarily on unsteady loading, as the time-averaged performance remains unaffected and the unsteady component is reduced. The phase difference between blades passing through the region of interference results in reduced induced effects compared to a model without a relative phase angle. This results in noise emission reduction, as proved by the 5dB decrease of the distributed propellers system in the upstream direction. Thus, the impact of relative phase angle on noise emission is beneficial.