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ROTOR-BEAM INTERACTION NOISE OF SMALL-SIZE DRONES

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ABSTRACT

Tonal noise is typical of small-size UAVs acoustic footprint, where interaction noise plays a major role in the emergence of harmonics of the blade passing frequency. Various aeroacoustic mechanisms can occur when a beam is in the close proximity of the rotor. The beam potential-interaction noise is one of the main contributors: the beam undergoes variations in flow speed and loading induced by the passages of the rotor blades, causing an important increase of the unsteady loading noise. A two-dimensional model based on potential flow theory, coupled with a source and vortex panel method, is developed to reproduce the unsteady loading noise radiated by the circular beam. For each blade section, the contour of the considered section is divided into a finite number of panels. A source and a vortex are then associated with each panel center. The vortex strength is constant over the whole airfoil and its value is set using the Kutta condition, while the source strength varies from panel to panel. The slip boundary condition is satisfied everywhere around the blade section using both vortex and source distributions. Once the system is solved, the source and vortex strength can be used as inputs in a two-dimensional incompressible potential flow problem around the beam to obtain the loading fluctuations, induced by the passage of the blade section. This self-contained model can consider different types of blade section with various shapes, chord lengths and thicknesses. Predictions are compared to experiments performed in the anechoic chamber of ISAE-SUPAERO, where the rotor-beam arrangement is placed at the center of the room. A simulation of the full experimental setup is planned with the Lattice-Boltzmann solver PowerFLOW to complete the comparative study and confirm the importance of the potential-interaction noise.