The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

AERO-ACOUSTIC INSTALLATION EFFECTS IN DISRUPTIVE AIRCRAFT ARCHITECTURES

C. Schram[1], A. Zarri[1], J. Christophe[1] and H. Bériot[2,*]

[1] von Karman Institute for Fluid Dynamics, 72 chaussée de Waterloo, 1640 Rhode-St-Genèse, Belgium, christophe.schram@vki.ac.be, www.vki.ac.be

[2] Siemens Industry Software, 68 Interleuvenlaan, 3001 Leuven, Belgium, hadrien.beriot@siemens.com, www.plm.automation.siemens.com

Keywords: *aeroacoustic installation effects, distributed electric propulsion, multi-copters*

The necessary drastic reduction of aviation noise will not be achieved without the introduction of radically new aircraft architectures. The ENODISE project supports this effort, with the ambition to accelerate the maturation of aircraft concepts involving Distributed Electric Propulsion, Boundary Layer Ingestion and multi-rotor concepts.

Complex aerodynamic interactions are involved in such architectures, which affect both the aeropropulsive efficiency and noise generation: potential and viscous interactions between the airframe and the propulsion system, rotor-rotor interferences and acoustic shielding. In this work a broad simulation framework is proposed for the prediction of the aero-acoustic installation effects, ranging from semi-empirical models to scale-resolved simulations for the prediction of the aerodynamic installation effects, and combining acoustic analogies with numerical acoustic techniques (e.g. Finite Element Methods) for the purely acoustic effects.

The numerical methods are applied to a small quadcopter drone to quantify propeller-propeller and propeller-fuselage aerodynamic installation effects and the fuselage scattering effects. The methodology is validated by comparing the predicted tones with existing acoustic measurements in the literature [1, 2]. The aerodynamic simulation indicates that the dominant sound sources are due to the unsteady interactions of the blade with the other propellers and supporting struts. Sound directivity results indicate that the presence of the fuselage must be accounted for, as it has a significant effect on sound radiation, both in the acoustic near- and far-field of the drone.

REFERENCES

[1] Nanyaporn Intaratep, William N. Alexander, William J. Devenport, Sheryl M. Grace, and Amanda Dropkin. Experimental Study of Quadcopter Acoustics and Performance at Static Thrust Conditions. In *22nd AIAA/CEAS Aeroacoustics Conference*, Lyon, France, May 2016. American Institute of Aeronautics and Astronautics.

[2] Christopher S Thurman, Nikolas S Zawodny, and James D Baeder. Computational prediction of broadband noise from a representative small unmanned aerial system rotor. In *VFS International* 76^{th} *Annual Forum & Technology Display*, Virginia Beach, Virginia, USA, October 2020.