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Propeller Performance Modeling through a Computational Fluid Dynamics Analysis Method

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Abstract : The evolution of aircraft is closely linked to the study and improvement of propulsion systems. Determining the propulsion performance is a real challenge in aircraft modeling and design. In addition to theoretical methodologies, experimental procedures are used to obtain a good estimation of the propulsion performances. For piston-propeller propulsion, the propeller needs several experimental tests which could be extremely demanding in terms of time and money. This paper presents a new procedure to estimate the performance of a propeller from a numerical approach using computational fluid dynamic analysis. The propeller was initially scanned, and then, its 3D model was represented using CATIA. A structured meshing and Shear Stress Transition k-ω turbulence model were applied to describe accurately the flow pattern around the propeller. Thus, the Partial Differential Equations were solved using ANSYS FLUENT software. The method was applied on the UAS-S45's propeller designed and manufactured by Hydra Technologies in Mexico. An extensive investigation was performed for several flight conditions in terms of altitudes and airspeeds with the aim to determine thrust coefficients, power coefficients and efficiency of the propeller. The Computational Fluid Dynamics results were compared with experimental data acquired from wind tunnel tests performed at the LARCASE Price-Paidoussis wind tunnel. The results of this comparison have demonstrated that our approach was highly accurate.

Keywords : CFD analysis, propeller performance, unmanned aerial system propeller, UAS-S45
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