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Title

Smart Blade Dynamic Stall Suppression

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Abstract

Nowadays, green aircraft with zero emission is a major priority for the aerospace industry worldwide, which is more efficient, quieter, and cleaner, with low fuel consumption, pollutants emission, and operational costs. In this regard, to have low environmental impact and more sustainable flight, leading aerospace companies such as Airbus and Boeing are trying to study and design new aircrafts with new configurations and characteristics. Most of these advanced designs include more flexibility in aircraft structures. In some modern designs, in order to reduce induced drag, blades have long span and made of lighter materials to minimize overall weight, which cause more flexibility in the structure. Having more flexibility leads to sever aeroelastic behavior in the vehicle and strong coupling between aeroelastic behavior and flight dynamics [1-4].

To present a very specific problem as a 2D blade forced vibration, dynamic stall models were developed. The most validations of such model are about pitch oscillation around the quarter-chord. However, they have also been validated experimentally on linear pitch ramp and some other motions. Implementing a semi-empirical dynamic stall model needs effectively an extrapolation since the model was neither developed nor validated for motions applied. Assuming the model can be able to present well sinusoidal pitching motion around the quarter chord, it can also be able to present well all other motions. Semi-empirical dynamic stall models are usually applied to the helicopter rotor blades aeroelasticity because of similarity of the rotor blades behavior to dynamic stall models due to implementing the entire blade sinusoidal motion by the blade root cyclic pitch.

In this work, the Leishman-Beddoes model has been applied to a general pitching aeroelastic smart structure. It has been shown how by implementing smart material on the structure it is possible to remove completely dynamic stall phenomenon.

References

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