OPTIMAL SIZING OF TRAILING EDGE FLAPS FOR HELICOPTER VIBRATION REDUCTION: A RESPONSE SURFACE APPROACH

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Abstract

On-blade active trailing edge flaps are considered for helicopter vibration reduction. A Pareto optimal multi-objective optimization approach is used to obtain the spanwise and chordwise dimensions of single and dual trailing- edge flaps. The objective of this study is to simultaneously achieve minimum hub vibration levels and minimize the flap actuation power requirement. Helicopter aeroelastic analysis is used in conjunction with an optimal controller to minimize hub vibration and flap power levels. It is found that nonlinear polynomial response surfaces based on L_9 orthogonal array could adequately describe both the objectives. An intense sampling of the surrogate objective space is used to obtain optimal design points for the mutually conflicting objectives. A Pareto optimal design reduces vibration levels by about 70% and also reduces flap actuation power requirement by about 20%, in comparison to the initial design. The present study leads to an optimal design of trailing edge flaps which expend less power and can be further explored for self-powered control surfaces towards a self-powered smart blade design concept. The optimal designs are robust to uncertainty introduced by manufacturing.

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