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VIBRATION CONTROL ANALYSIS AND GENETIC ALGORITHM OPTIMIZATION OF A PIEZOELECTRIC ELEMENTS BONDED STRUCTURE SUBJECT TO IMPACT

Abstract

As a baseline for treating flexible beam attached to central-body space structure, the generic problem of a cantilevered Euler-Bernoulli beam with piezoelectric actuator attached as appropriate along the beam and its control is solved in great detail. For comparative study, three generic configurations of the vibration of the combined beam and piezoelectric elements are solved, utilizing Euler-Bernoulli theory by both analytical and numerical methods. Selected configurations of the beam and piezoelectric elements are investigated, and three different control systems are investigated, PPF, PID and LQR, and assessed. Some preliminary results are illustrated in Table 1 for PID and LQR controllers and Figure 1. Based on theadvantage of the Linear-Quadratic-Regulator, a generic control system have been designed using piezoelectric actuator to control the vibration of an elastic cantilevered beam subject to impulsive disturbance. The equation of motion for the system is elaborated using energy principle and full-state observer Linear-Quadratic-Regulator controller has been selected as the vibration control tool. To avoid iterative choice of Q and R in the LQR, Genetic Algorithm optimization scheme has been incorporated. Preliminary results shown in Figure 2 was considered to be satisfactory, and further development will be developed for more complex systems. Next, impact resilient structures are of great interest in many Engineering Applications varying from civil, land vehicle, aircraft and space structures, to mention a few examples. For this purpose the impacted panel structure is modeled as a set of Mindlin plates bonded together which is considered to represent a generic engineering structure. Utilizing analytical and computational approaches as well as in material science and technology, this work looks at a generic composite beam and plate structure subject to impact loading and carry out analysis and numerical simulation. The first objective of the work is to develop a computational algorithm to analyze flat plate as a generic structure subjected to impact loading for numerical simulation and parametric study. The analysis will be based on dynamic response analysis. The second objective is to utilize the computational algorithm for direct numerical simulation, and as a parallel scheme, commercial off-the shelf numerical code is utilized for parametric study, optimization and synthesis. Through such analysis and numerical simulation, effort is devoted to arrive at an optimum configuration in terms of loading, structural dimensions, material properties and composite lay-up, among others. Preliminary results for impact of GLARE composite plate is exemplified.