

Abstract:

Smart structure is an emerging technology, which offers potential benefits to many engineering industries in general but specially to aerospace, automotive, civil and wind power in particular. Smart structure is built by integrating sensors, actuators, and controls, which behaves as a multi-functional system. This structural system displays a high functional ability with adaptability features to environmental changes to carry out desired tasks such as Active Vibration Control (AVC), Active Flutter Control (AFC), Position Control (PC) and even contribute significantly to Structural Health Monitoring (SHM) of aerospace, automobile, civil and wind power structural systems. Modeling and simulation techniques are developed for smart structures using electro-mechanically coupled finite elements (beams, plates/shells). Variational approaches of continuum mechanics are extended to adopt piezo-hygro-thermo-elastic material system, so that environmental influence on smart sensing and actuation could be better addressed with active control. Numerical simulations are made to obtain the structural responses to mechanical and aerodynamic disturbances through sensing and corrections are applied through induced actuation for improved vibration and aero elastic control performances. Some of the key findings are active damping through shear actuation, directional actuation using monolithic PZT crystal and hybrid actuation through extension and shear piezoelectric crystals. A dynamic model order reduction technique through sub-structuring process has been developed for coupled field problems to analyze large smart structures like adaptive wing, T-Tail etc. The active and passive sub-structure concept helps to facilitate optimal placement of actuators/sensors in aircraft structure. Piezoelectric materials are basically energy transformers; at NAL a simple energy harvesting system (EHS) is developed and demonstrated to be used for predicting damage occurrence and load monitoring. Numerical simulation of large smart structural system and active vibration control implementation related issues are discussed.

Bio:

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