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Editorial

A Study on the Stability of Aircraft's Nonlinear Dynamics

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EDITORIAL

Engineers, biologists, physicists, mathematicians, and many other scientists are interested in nonlinear problems since most systems are intrinsically nonlinear. In contrast to considerably simpler linear systems, nonlinear dynamical systems, which describe changes in variables over time, may appear chaotic, unpredictable, or paradoxical. In mathematics, the behaviour of a nonlinear system is typically described by a nonlinear system of equations, which is a set of simultaneous equations in which the unknowns (or unknown functions in the case of differential equations) appear as variables of a polynomial with a degree greater than one or in the argument of a function that is not a polynomial with a degree greater than one. In other words, the equation (s) to be solved in a nonlinear system of equations cannot be expressed as a linear combination of the unknown variables or functions that appear in them.

Nonlinear systems can be defined regardless of whether known linear functions appear in the equations. A differential equation is linear if and only if it is linear in terms of the unknown function and its derivatives, even if it is nonlinear in terms of the other variables in it. The nonlinear dynamics of solids covers a wide spectrum of effects and circumstances. When combined with the additional issues of field diffraction, energy dissipation, temperature dependent wave propagation, and even fluid dynamics, which may also be included as part of the subject matter, they present an overwhelming quantity of information for consideration. Whirl flutter, an aeroelastic instability, is an essential factor in aircraft design. Whirl flutter can occur when a propeller or rotor is positioned in a wing nacelle. The phenomenon is most commonly linked with tiltrotors and some fixed-wing aircraft, and it is manifested by the hub rotating around its original location. Aerodynamic forces operating on the blades and gyroscopic effects acting on the rotor as a whole combine to produce this unstable motion, which can damage or destroy the aircraft structure. There are two whirl flutter modes: Forward Whirl (FW) and Backward Whirl (BW).

Nonlinearity between load and displacement in the stiffness of a structure can be induced by non-uniformity in geometry or material properties. Both types of non-uniformity are expected to exist in any aeronautical construction, which means that linear stiffness approximations are only acceptable when deflections are very modest. Realistic spring characteristics may include both softening and hardening occurrences at various locations in the stiffness profile, which are apparent as drops and rises in the stress gradient, respectively. When dealing with dynamic, nonlinear, large-scale process models, several computing challenges arise. One solution to this challenge is to replace these large-scale models with more accurate surrogate models. Model Order Reduction (MOR) produces significantly less complex models with a fewer number of states, resulting in speedier model evaluations. Because of their versatility and general applicability, snapshot-based MOR techniques are regarded as one of the most promising methodologies for nonlinear systems. Nonlinear dynamics models can be used to investigate spatially extended systems such as acoustic waves, electrical transmission issues, and plasma waves, among others. A linear chain of discrete oscillators with nearest neighbour coupling was used to model these challenges. A phenomenon called as soliton wave dynamics can arise when the coupling between the oscillators is nonlinear.

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