MATHEMATICAL MODELING AND PARAMETRIC STUDY OF SHIMMY EFFECT FOR AN AIRCRAFT NOSE LANDING GEAR SYSTEM

By

DANUT SHEWTANASOONTORN

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ABSTRACT

Landing gear system is a major component of every airplane. It is the mechanical system that absorbs landing and taxi loads as well as transmits part of these loads to the airframe so that a majority of impact energy as a result of a crash is dissipated. One of the problems that most frequently occur in the airplane during take-off, landing and taxiing comes from shimmy effect. It is the self-excited oscillation about the gear swivel axis. Analysis and development in theory of shimmy has been a subject of intense research for a long time. In this thesis, a set of nonlinear differential equations were used to describe the dynamic behavior of the system. Assumptions were made to simplify the system and a derivation of the equation of motion of a co-rotating nose gear having four degrees-of-freedom was presented. These equations were obtained by using a special form of the Lagragian formalism. This mathematical model was compared to an existing model from the literature. Numerical methods were developed using the programming language FORTRAN, and the fourth-order Runge-Kutta algorithms. Dynamic analyses including angular positions, angular velocities and angular accelerations were conducted on the simplified linkage mechanism. Finally, a parametric study, by varying some system parameters including dimensions, mass of the wheel, velocity, and damping coefficient were also conducted to quantity the design effects.

It was concluded that the most important factor for reducing the shimmy effect was the trail length. By reducing the trail length, the amplitude of oscillation can be reduced most effectively and obviously as compared with other methods. The results of the study also indicated that landing gear stability can be improved by longer wheel axle, stiffer damping mechanism, smaller wheel mass and lower aircraft velocity. Many more options could be decided to functionally and operationally improve the design using various computer programs. Detailed results from further study and experimental data would be needed to justify any redesign in the future.