Dynamics of Continuous, Discrete and Impulsive Systems
Series **B:** *Applications & Algorithms* **14 (2007)** 793-809
 http://www.watam.org

CHAOTIC BEHAVIOR OF NONLINEAR CURVED-PANEL IN A SUPERSONIC FLOW

S. Ahmad Fazelzadeh

Department of Mechanical Engineering, School of Engineering,
Shiraz University, Shiraz, 71344, I.R. Iran

Email: : fazelzad@shirazu.ac.ir

Abstract. This paper investigates the effect of panel curvature on the chaotic behavior of nonlinear infinitely long panels in supersonic flow. The nonlinear governing equations are based on Von Karman's large deflection of isotropic curved panels which include the effects of constant axial edge loading and a static pressure differential. Also, the first order piston theory is utilized for aerodynamic panel loadings. The Galerkin approach is used to transform the nonlinear governing equations into a set of nonlinear ordinary differential equations. The resulting system of equations is solved through the fourth and fifth order Runge-Kutta-Fehlberg integration scheme. Divergence and Flutter bifurcation boundaries as well as panel dynamic response are determined for various design parameters. Chaotic and hyper chaotic behavior are detected using qualitative and quantitative methodologies such as time history, phase portrait, Lyapunov exponents and fractal dimension. Results indicate that many combinations of design parameters, especially panel curvature, highly influence the panel stability boundary, limit cycle amplitude, Lyapunov exponents and fractal dimension

Keywords. Chaos, Hyper chaos, Curved-panel, Flutter, Fractal dimension, Lyapunov exponents.

1 Introduction

Aircraft and spacecraft skin panel are subjected simultaneously to high levels of acoustic and aerodynamic loadings. Panel flutter has been encountered in the operation of aerospace vehicles. Libresuc [10-12] has provided a general understanding of all the factors contributing to the occurrence and increase of the flutter critical boundary. An excellent survey of nonlinear panel flutter through 1970 was given by Dowell [3].

Extending the methods developed for nonlinear mechanical systems to aeroelastic systems is a challenging topic for aeroelasticians. In nonlinear panel motion, due to large deformations and mutual interactions between the aerodynamic loadings and higher order panel modes, the panel responses becomes random-like in special regions of bifurcation boundary. In this sense, despite of the deterministic nature of the panel equation, the time response