Global first harmonic bifurcation diagram for odd piecewise linear control systems

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(Received October 1994; final version September 1995)

Abstract. *The describing function method (used normally as a first approximation to study the existence and the stability of periodic orbits) is used here to analyze the dependence of periodic orbits on the parameters of autonomous systems. The method can be applied to a large class of nonlinear systems but, for simplicity, attention here is paid to a class of single-input, single-output control systems with a piecewise linear characteristic function. A first approach to the bifurcation diagram associated with the periodic orbits of such systems, called a 'first harmonic bifurcation diagram' is obtained for two and three dimensions. This diagram in two dimensions describes all the qualitative behaviour of such systems. Although this is not the case in three dimensions, the information contained in the corresponding first harmonic bifurcation diagram is of great value. It shows much of the complexity of the periodic structure that can be found in such three-dimensional systems; in fact, part of the first harmonic bifurcation diagram coincides with the actual bifurcation diagram.*

1 Introduction

After equilibrium points, the next simplest orbits of an ordinary differential system are the periodic orbits. In most cases, it is not possible to obtain explicitly the solutions of the ordinary differential equation involved, so the analysis of the existence of periodic orbits and their stability is generally a complicated problem.

The 'harmonic balance method' is a tool for studying approximate periodic orbits and their stability by trying to fit a truncated Fourier series and choosing the

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0268-1110/96/01049-40