ROLE OF MODAL APPROACH FOR SOUND SYNTHESIS OF NONLINEAR SYSTEMS: THE CASE OF PLATES

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ABSTRACT

Time-domain simulation of musical instruments has shown promising results in recent years. Particularly attractive from a sound synthesis perspective is the resolution of system displaying some degree of nonlinearity, because of the richness of the perceptual information that nonlinearities produce.

In this work, the focus is on one such system, namely a flat (circular or rectangular) plate which, to a first approximation, can efficiently simulate the sound of a gong [1, 2]. From a dynamical perspective, in spite of very different geometries, plates and gongs behave similarly, meaning that the degree of nonlinearity is set by how large the amplitude of vibrations of the flexural waves is. In particular, plates and gongs may attain linear, weakly nonlinear and strongly nonlinear regimes when the amplitude of vibrations is, respectively, much smaller, of the same order of and larger than some defining thickness parameter [3, 4].

The dynamics of plates is well described by a set of two coupled Partial Differential Equations (PDEs) known as the von Kármán equations. For rectangular plates, a family of conservative Finite Difference schemes was developed by Bilbao [5]. An alternative approach is offered in this work, where the von Kármán equations are discretised along the modes of the system in order to reduce the original PDEs to a set of coupled Ordinary Differential Equations (ODEs). This is approach is referred to as *modal approach*, and it used for here in the context of sound synthesis of nonlinear systems [6]. Salient features of this approach include

- implementation of complex decay ratios with no extra effort using modal damping;
- simulation of circular plates without bothering with the problems related to particular spatial grids (a frustrating aspect for Finite Difference schemes);
- fast computational times for linear and weakly nonlinear regimes.

This work intends to show that the modal approach could be applied to a large class of nonlinear problems, against the common misconception that modes are only useful in treating linear problems. Sound examples and videos are shown in order to complete the presentation.

1. REFERENCES

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