# A parallel between numerical and physical worlds of dynamic systems: the true spectral properties - a challenge in current modelling and simulation methods

**Pawel Packo**

Department of Robotics and Mechatronics, AGH University of Science and Technology,
Al. A. Mickiewicza 30, 30-059 Krakow, Poland

*Presenting author: pawel.packo@agh.edu.pl

## Abstract

Numerical modelling and simulations are widely employed to facilitate the design, development, analysis and improvement of mechanical systems in various disciplines of science and industry. For the case of transient dynamic systems, both space and time domains are involved in the discretization process. The discrete nature of the resulting numerical models – approximating behaviour of the physical continuous systems – manifests itself in complex distortion of numerical responses when compared to the exact solution. A critical point in analysis of simulated results is in distinguishing between physical and non-physical contributions, where the latter relates to numerical artefacts.

The talk outlines newly developed analysis methods for true spectral characteristics, including the amplitude (excitability) and phase (dispersion) properties of wave propagation in infinite and guiding media. It is found that numerical spectral properties are substantially different than those of continuum models, and share common features with the fundamental discrete systems known from various branches of physics, e.g. optics.

The role of numerical errors is critical when analysing dynamic transient phenomena in linear media, but become even more important for nonlinear systems. In the latter, one is frequently interested in analysing small and parameter-sensitive changes in structural response. Discretisation-induced error may overlay the actual nonlinear response features in those cases. Both linear and nonlinear dynamic systems are discussed on complex wave-propagation problems examples.