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Preface: Recent trends in the dynamics of structures

This Special Issue of Mechanics Research Communications is devoted to the 13th International Conference on Dynamical Systems – Theory and Applications (DSTA 13) held in Łódź, Poland, December 7–10, 2015. Organized biannually by the Department of Automation, Biomechanics and Mechatronics at Łódź University of Technology since 1992, DSTA has assembled participants from the broad field of nonlinear dynamics and mathematical modelling. The 2015 conference was attended by over 200 researchers from 28 countries around the world. This conference, as does the whole series, had the overall aim of providing a common platform for the exchange of new idea and results in the field of modern dynamical systems, including both theoretical and practical applications.

DSTA 2015 embraced a wide scope of topics related to dynamical systems, including control and stability, bifurcation and chaos, asymptotic methods in nonlinear dynamics, original numerical approaches, applications in life sciences and bioengineering, engineering systems, and vibration of lumped, continuous and non-smooth systems. The Scientific Committee selected the most interesting conference presentations, and then invited corresponding authors to submit papers. This Special Issue is a result of a rigorous external review process where only the best of the submissions was accepted. A concise summary of the nine featured papers appears below.

I would like to cordially thank the Guest Co-Editor Denis Blackmore and the Editor-in-Chief Anthony Rosato for their cooperation and work in creating this special issue. I hope that the readers of the journal will find the presented works interesting, useful, and stimulating for their studies.

Summary of featured papers

Gontarz addressed the problems of mathematical, analytical and computational modelling of the failure/damage risk assessment for real-world technical objects. As demonstrated in the paper, the magnetic properties of materials and the effects of local magnetic fields may influence fatigue wear (which, for example, pose a real threat to steel-based construction). Accordingly, the author introduces a new diagnostic model for dynamic systems that capture these magneto-mechanical effects.

Gidlewski and Żardecki reported important results on control processes based on the linearization of the so-called 'bicycle model' in the global coordinate frame. For this study, the detailed multibody nonlinear system was modelled on a truck of medium load capacity.

Bulin et al. deal with absolute nodal coordinate formulation used for modelling systems composed of the cables, pulleys and other rigid bodies, and a motor with prescribed motion. Comparisons of the numerical and experimental results obtained showed that the proposed approach can be applied for dynamic analysis of such nonlinear flexible systems.

Burdzik et al. address the adaptation of linear decimation procedures (LDP) for time-frequency representation (TFR) analysis of non-stationary vibration signals of vehicle suspensions. The violent nature of vibrations resulting from the nonlinearities of the vehicle suspension elements and the random nature of dynamic interactions, make determination of frequency characteristics a very complex issue. Research is presented aimed at examining the possibility of adapting the linear decimation procedure to identify characteristic components of non-stationary vibration signals in a car.

Gałęzia et al. investigated the possibility of applying energy operators to detect failures in gears. This study was aimed at obtaining diagnostically useful information for early detection of fatigue induced tooth damage. The proposed method was based on the analysis of local and transient anomalies in vibration signals caused by the local defects during gearbox operation.

Urbaś and Augustynek provided the dynamic equations of motion for a 1-DoF spatial linkage with friction in the joints. Both the Dahl – LuGre and elasto-plastic models were applied to characterize friction interactions in revolute and prismatic joints thereby representing both the pre-sliding and sliding frictional regimes, without switching functions. These models also provided information on the Stribeck effects directly associated with stick-slip friction.

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Kuliński and Przybylski studied the effect of structural parameters and induced axial piezoelectric force on the stability of the static and dynamic responses of an Euler–Bernoulli beam with axially restrained ends, and a pair of piezo patches symmetrically bonded at a specified location. Approximate results on the influence of the electric field on the system's buckling capacity and natural vibration frequency were obtained using the Lindstedt–Poincaré method and exponential series via small amplitude parameter methods.

Dąbek and Trojnacki described results on the dynamics of a lightweight wheeled mobile robot moving longitudinally on soft ground. The robot-ground system model was obtained using the classical terramechanics models of Bekker and Janosi-Hanamoto. Experimental investigations and simulations of the robot motion enabled formulation of the dependency between the front-to-back wheel-terrain contact angle ratio and the desired velocity.

Tkacz et al. reported results of an analysis of the interactions among three systems identified in a self-acting gas bearing with a flexibly supported foil. Analytical equations were formulated for each of the three elements (rotor, gas film and flexible structure). It was found that the gas flow in the bearing could be described by the Reynolds equation, whereas a spring-damper model was selected for the structural analysis. The Alternating Direction Implicit method was used to solve the system obtained by replacing the partial derivatives in the Reynolds equation with the algebraic equations in the finite difference method.

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