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Preface

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The present Special Issue follows the 15th conference "Dynamical Systems – Theory and Applications" (DSTA) held in Łódź, Poland, December 2–5, 2019. This international event is organized by the Department of Automation, Biomechanics and Mechatronics (Lodz University of Technology) every two years since 1992.

A special group of works of the most interesting topics presented during the DSTA conference and related to modelling and analysis of mechanical systems dynamics were selected. Their authors were invited to prepare the extended versions of their papers for publication in this Special Issue. The works underwent a rigorous reviewing process before publication. They fall in the scope of the following topics: bifurcation and chaos in mechanical systems; asymptotic methods in nonlinear dynamics of mechanical systems; modelling and dynamics in life science and bioengineering; original numerical methods of vibration analysis; stability of mechanical systems; nonsmooth mathematical models of mechanical systems and mechatronics.

Al-Shudeifat and Saeed aim to further improve the single-sided vibro-impact (SSVI) nonlinear energy sinks (NES), including the coefficient of restitution in the performance optimization. Accordingly, a significant improvement in the performance of the SSVI NES is obtained for specific coefficients of restitution. In addition, a performance comparison is performed between the enhanced SSVIe NES and several existing types of NESs.

Awrejcewicz et al. deal with the dynamics of a lumped mass mechanical system containing two nonlinear springs connected in series. The external harmonic excitation, linear and nonlinear damping are included into considerations. The steady and non-steady resonant vibrations are analyzed by employing the modulation equations of the amplitudes and phases which are yielded by the multiple scales method.

Burlon et al. investigate viscoelastic constitutive models involving variable-order fractional operators. A novel formulation of fractional model is proposed to effectively compute the strain response of a viscoelastic material with time-dependent mechanical properties due to any stress input. The main achievement of the paper is proof that the proposed formulation is strictly related to the meaningful fractional model existing in the literature to which, therefore, a reliable mechanical meaning can be given.

Cekus et al. present in their paper the analysis of the load motion during the interaction of wind pressure. The mathematical model of load motion is presented, which may be an universal approach for transporting machines equipped with a rope-lifting system. The numerical results are compared with the experiments obtained in the wind tunnel.

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Di Matteo et al. introduce an innovative ambient identification method based on applying the Hilbert Transform. The analytical signal is a complex representation of a time domain signal: the real part is the time domain signal itself, while the imaginary part is its Hilbert transform. A 3DOF numerical example is presented to show the accuracy of the proposed procedure. The method is also extended to the real case study of the Chiaramonte Palace, a historic building located in Palermo.

Herisanu and Marinca based on Hamiltonian principle and a modified couple stress theory, present a nonlinear differential equation of motion of electrostatically actuated microbeams. The proposed procedure is effective, convenient and does not require linearization or small parameters assumption. The main advantage of this technique consists in that it provides a convenient way to control the convergence of the approximate solution in a very rigorous way.

Kaliński et al. present an original method concerning vibration suppression problem during milling with the use of novel way of selecting the spindle speed of cutting tool. It consists in repetitive simulations of the cutting process for subsequent values of the spindle speed, until the best vibration state of the workpiece is reached. The efficiency of the proposed approach is evidenced by chosen technique of mechatronic design, called Experiment Aided Virtual Prototyping (EAVP).

Martowicz et al. present the numerical aspects of the modeling tool elaborated to simulate the phenomenon of solid phase transformation in shape memory alloys. Particularly, a nonlocal approach, namely the bond based variant of peridynamics, is of concern to handle material model nonlinearities conveniently.

Możaryn et al. develop the step-by-step design procedure, parameter tuning, and experimental evaluation of the Fractional Order Proportional-Integral-Derivative (FOPID) controller. The control algorithm is based on the Continued Fraction Expansion approximation of the fractional-order operators. The proposed solution shows increased efficiency in terms of robustness compared to the standard PID closed-loop control.

Nabarrete and de Freitas Fonseca include the nonlinear formulation of a magnetorheological fluid journal bearing in the finite element model that evaluates the nonlinear responses of a complete rotor system subject to rigid coupling misalignment. Bifurcation analysis demonstrates the influence of misalignment to obtain periodic and period-doubling orbit for the center position of the rotor. Results are demonstrated through displacements versus time and frequency responses.

Patkó and Zelei study the stability properties and the feasibility of a tracking error feedback and a direct tracking error elimination approach of the numerical implementation of the inverse kinematics (IK) calculation both on velocity and acceleration level. The closed form results and numerical case study examples show the stability properties, benefits and disadvantages of the assessed IK implementations.

Prochowski et al. analyze the kinematics of the process of deformation of the motorcar body side in the culminating phase of a front-to-side vehicle collision as a possible basis for analyzing and modeling the process of emergence of a hazard to car occupants during a road accident. The results of calculation of the deformation rate and range in various car body zones, velocity of the test dummy placed on driver's seat, and velocity of possible dummy's impact against the car body side being deformed may be taken as a basis for designing effective occupant protection systems.

Santoro and Failla prepared an interval framework for uncertain frequency response of multi-cracked beams is addressed by the paper. On adopting the standard Euler–Bernoulli beam theory, every crack is modeled as a linearly-elastic rotational spring whose stiffness and position are treated as uncertain-but-bounded parameters. The sensitivity functions of the response are calculated as every uncertain parameter varies within the respective interval and the bounds of the response are computed by either a sensitivity-based method or a global optimization technique.

Schorr et al. apply a tensegrity structure with spatially curved members as rolling locomotion system. The kinematics of the system considering the nonholonomic constraints are derived in order to control the locomotion system. To verify this approach kinematic analyses are evaluated numerically.

Sypniewska-Kamińska et al. analyze resonances in a spring pendulum applying the polynomial approximation in quadratic means. In contrast to the approximation by Taylor series, the proposed manner approximates the trigonometric functions not around a given point but on the given interval. Quality and accuracy of the solutions obtained using the multiple

scales method based on such approach have been tested.

Trentin et al. present an experimental study on a strategy that combines on–off and sliding mode control to swing up and control a pendulum with two reaction wheels in the inverted position. The control scheme uses only one reaction wheel at a time, adapting the control law to turn off one of the control actions. The mechanical differences between the standard reaction wheel pendulum configuration and the one studied in this paper are pointed out to explain the use and the operation of the controller.

At the end, we would like to cordially thank to the authors for their effort in preparation of high-quality works, reviewers for work done during the peer-review process and the Editor-in-Chief, Professor Luigi Gambarotta, for his acceptance and cooperation during the realization of this special issue.

We believe that the content of this Special Issue will be interesting and motivating for the readers of Meccanica in their own researches in the field of modelling and analysis of mechanical systems dynamics.