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Preface

Preface to the special issue of selected papers from the 15th International Conference Dynamical Systems – Theory and Applications (DSTA 2019)☆

This Special Issue of Applied Mathematical Modelling journal consists of selected quality papers originally presented at 15th International Conference "Dynamical Systems – Theory and Applications" (DSTA) which took place on December 2–5, 2019 in Lodz, Poland. The conference is a biennial event organised by the Department of Automation, Biomechanics and Mechatronics of the Lodz University of Technology under the patronage of the Committee of Mechanics of the Polish Academy of Sciences. since 1992. The DSTA conference provides a platform for researchers to exchange new ideas and results of recent developments in the field of mathematical modelling, simulation and control of the dynamical systems.

The 2019 edition of the conference was successfully attended by over 200 participants from 40 countries, who discussed new ideas and results in the field of theoretical and technological advances in modern dynamical systems. This special issue is a collection of the best papers devoted to mathematical modelling of non-classical problems of mechanics as well as a mathematical description of novel engineering constructions and its control strategies. The papers for prospective incorporation in the Special Issue were selected by the Conference Organizing Committee Chairmen based on its quality and journal scope relevance. The corresponding authors of the selected papers were invited to prepare the extended versions of their papers for submission to this Special Issue. The papers underwent blind peer review process according to the best journal's standards. Out of all recommended papers the following 12 papers have been accepted. They are summarised briefly as follows:

Amer et al. outlined the three-dimensional motion of a rigid body about a fixed point under the action of a gyrostatic moment and a Newtonian force field. Four first order differential equations are solved using the Poincare method of small parameter and the solutions are verified numerically. The attained results can find applications in celestial mechanics, physics or gyroscopic applications.

Zimmermann et al. derived the mathematical model of the biologically inspired drive concept, that uses the controllable mechanical properties of a magnetorheological fluid to provide an asymmetry of the viscous friction what enables vibration-based translational motion. Using asymptotic methods of non-linear mechanics, an expression for the average velocity of the slider is obtained in an analytical form. The results are verified experimentally on a prototype drive.

Dosaev et al. constructed the mathematical model of a plane-parallel motion of the inertial robot containing one unbalanced rotor and one flywheel, supported by two points on a supporting rough plane. A technique for evaluating the friction coefficient between the robot and the supporting plane is proposed as well as an algorithm for controlling the motion of the robot in the desired direction. It is shown that an increase in friction enhance the robot's acceleration efficiency.

Dzyubak et al. analysed a non-linear multi-scale diffusion cancer invasion model that describes the interactions of the tumour cells, matrix-metalloproteinases, matrix-degradative enzymes and oxygen. Chaotic cancer attractors are quantified and multi-parametric evolution of conditions leading to cancer invasion is defined.

Lopes and Machado adopted concepts of systems' theory and multidimensional scaling to study the competitiveness in national soccer leagues. A season of a league is interpreted as a dynamical system with states measured at discrete time samples (league rounds). The teams relative evolution is represented as loci in the complex plane. The entropy and the fractal dimension of the loci are used for competitiveness quantification.

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Żardecki and Dębowski derived and analysed mathematical model of a vehicle suspension system. Strong nonlinearities connected with backlashes and dry friction in the system are modelled with authorial piecewise-linear projections, which enables analytical operations for differential and algebraic equations and simplifies numerical operations.

Smirnova and Cherkasov studied the brachistochrone problems for a mass moving in a vertical plane in a uniform gravity field with various penalties for fuel expense. Considering the lift force and thrust as control variables the extremal trajectories are obtained. The structure of the extremal thrust control program is defined, and the sequence of the arcs is found analytically.

Selyutskiy analysed the influence of potential forces upon stability of trivial equilibrium in two degrees-of-freedom, non-conservative system. Certain conditions are found, for which the stability character changes several times when the stiffness in one of generalised coordinates changes. Stability alternation is illustrated by an aeroelastic system with two translational degrees of freedom. The observed effect can be found useful in engineering practice.

Awrejcewicz et al. dealt with obtaining estimates of the domains of attraction and stability in nonlinear dynamical systems. Special recursive procedures for constructing polynomial Lyapunov function is proposed. Effectiveness of the proposed method is shown using various examples of single degree-of-freedom mechanical systems with uncertain parameters.

Uzny et al. studied the boundry problem of non-linear vibration of a column that is loaded with a mass element. Mathematical model's non-linear components are expanded into a power series of a small parameter. It was found that the vibration amplitude increase reduces the natural frequency of the system. Derived numerical model is in a good agreement with the real system experimental data.

Dosaev solved the problem of the contact of a brake shoe with a spinning wheel by methods of theoretical mechanics showing new insight into this classical problem. The compliance of the area of contact is modelled by the element with elastic and viscous properties. The solutions of the linearized and complete systems are discussed. It is shown that the wheel braking process can be nonmonotonic.

Lacerda et al. modelled power grid (energy transmission network) as a complex network of second order Kuramoto oscillators. The methodology for building power grid that has relatively low number of edges and favours synchronization is described. The presented methodology would be interesting for designers of power grids due to possible reduction of building and operating costs.

We would like to gratefully thank the Editor-in-Chief Professor Johann Sienz for cooperation and work in creating this Special Issue. It would not have been possible without the great support the office of Applied Mathematical Modelling journal, especially that of Mrs Jennifer Crossley and Ms Barbara Bostock, as well as Ms Priyadharsini Muthukumar from Elsevier.

We do hope that the readers of the journal will be attracted by the topics covered in this Special Issue and find them stimulating for their studies.

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