Preface to the Special Issue on “Modelling and Simulation in Engineering”

Camelia Petrescu 1,* and Valeriu David 2

1. Introduction

The continuing achievements in Information Technology and Computer science in recent decades provide new tools for engineers in the design of devices and systems, with significant advances both in numerical and in analytical methods of analysis. Thus, modelling and simulation of processes have become mandatory stages prior to the experimental setup and are now part of the engineering culture.

The purpose of this Special Issue is to offer a platform for ongoing valuable research involving modelling and simulation methods in mathematical physics, to present new simulation software applications in engineering, and to also present recent advances in decision support systems or in the design of experiments.

The response of the scientific community was significant, with a total of 28 papers being submitted for consideration, of which 14 were accepted for publication after attentive peer-review by respected reviewers in the fields of the papers.

2. Description of Published Papers

In the following, a brief overview of the published papers is presented.

The paper by R.A. Hamid et al. [1] analyses a ferrofluid transport problem in a magnetic field, solved using the MATLAB bvp4c routine. The influence of the magnetic field and of the Stefan blowing parameters was investigated, leading to conclusions regarding the availability and stability of solutions.

The paper authored by Y. Li et al. [2] proposes a new estimation of the Hurst exponent used in long-term memory of time series and, in the context of this paper, in volatility modelling. In order to validate the new Hurst estimator tests are conducted for data taken from Chinese financial markets, with emphasis on truncated and non-truncated spot volatility.

The paper by F. Feng et al. [3] proposes an improved version of a RSE algorithm, previously developed by the same authors, used to recognize the complexity of non-fractals common in signals (roughness scaling extraction algorithm with first-order flattening (RSE-f1)). The speed of the newly proposed algorithm increases significantly (by 13 times), making it also faster than other typical algorithms. The new algorithm is then used to analyse the vibration signal from a mill in order to distinguish between the machine states (idle, stable, and chatter).

The paper by V. Saenko et al. [4] performs a study of the anomalous diffusion equation with a fractional derivative with respect to both time and coordinates, proposing a solution based on the Monte Carlo method. The numerical method for solving the anomalous diffusion equation, in which both the time derivative and the coordinate derivative can be of non-integer order, using a model of random realizations of particle trajectories, is proposed and applied in the analysis of the combustion process.
The paper by A. Alahmer et al. [5] investigates the effect of using various biodiesel mixtures on the performance of a CI engine under full load and at different engine speeds. Specific parameters such as brake torque, brake power, fuel consumption and brake thermal efficiency are monitored, and an optimisation procedure based on fuzzy logic and particle swarm optimisation is carried out in order to determine the optimal engine speed and best fuel type. The results obtained show that the overall performance is fairly increased as compared to the experimental results.

The paper by K. Zhang et al. [6] studies calcium leaching in hydraulics applications, formulated as an inverse problem, which is studied using genetic algorithms and the finite element method. The objective function is constructed using the hydraulic head and leakage quantity time-series measurements. The proposed inverse analysis method is applied to predict the grout curtain hydraulic conductivity of a concrete dam in the leaching process, the simulation results being consistent with the monitored data.

The paper by N.F.H.M. Sohut et al. [7] analyses the unsteady 3D rotating hybrid nanofluid flow on a stretching sheet, by considering and representing the effects of some parameters. Thus, the specific system of partial differential equations was transformed to a system of ordinary differential equations, which were solved numerically using the MATLAB software.

The paper by G. Gordillo et al. [8] addresses the control of contaminant spill in water and, more generally, the problem of water quality control by using the gradient-descent method supplied with a first-order iterative process. The authors consider both the validation of the numerical technique and the possibilities and limitations of the applied method.

The paper by N.A. Yacob et al. [9] studies rotating flow in nanofluids over a permeable stretching/shrinking surface. The authors present the numerical results obtained with MATLAB software, starting from a mathematical model with carbon nanotubes (single and multi-walled), and analyse the heat and mass transfer characteristics, and also the stability of the considered solutions.

The paper by M.I. Dieste-Velasco [10] proposes an artificial neural network for fault diagnosis in analogue electronic circuits. This method is based on a small number of measurements and has been successfully tested to predict the hard faults in two electronic amplifiers.

The paper by V. Saenko et al. [11] analyses the possibility to obtain numerical solutions for fractional differential equations of anomalous diffusion. The kinetic equations that describe the process of walks are considered and their numerical solutions based on a local estimate of the Monte Carlo method are established, highlighting the advantages and limitations.

The paper authored by C. García-Hernández et al. [12] performs a study of the trochoidal milling path with variable feed. A process optimization is considered and a trochoidal milling test with the presentation and analysis of the obtained results is presented.

The paper by Y. Li et al. [13] proposes a surrogate for the original Kriging modelling method, which is tested in an air traffic control radar design simulation system. The proposed high-dimensional Kriging modelling method is characterised by a faster modelling efficiency and large possibilities for new applications.

D. Legatiuk proposes in [14] a new development of the category theory-based modelling methodology introduced in a previous paper that he co-authored. This methodology is based on representation of mathematical models by the help of categorical constructions. Two practical examples are used as illustrations for this method, namely the beam models and the aerodynamic models used in bridge engineering. The author points out that the category theory-based modelling methodology presented in the paper can be used in the model selection process after constructing a set of mathematical models and formulating criteria imposed on a model for a given practical problem.
3. Conclusions

As guest editors of the Special Issue Modelling and Simulation in Engineering, we would like to express our gratitude to all the authors who sent their articles for publication in this issue. We also express our gratitude and appreciation to the reviewers for their valuable observations, which helped improve the submitted papers.

We hope that the papers selected for this Issue will attract a significant audience in the scientific community and will further stimulate research involving modelling and simulation in mathematical physics and engineering.

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