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Editorial

Review of Advanced Digital Technologies, Modeling and Control Applied in Various Processes

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This special issue reviews advanced digital technologies in modeling and control of technological processes. Methods of numerical modeling, artificial intelligence, machine learning, automatic control and optimization theory were considered in the published manuscripts of the special issue. It is especially noteworthy that this special issue is devoted to solving specific applied problems based on international standards, which has recently become of paramount importance for the scientific and professional community [1].

Conducting applied research by international scientific teams is of great importance for the development of science and the unification of scientific teams, especially given the current tensions in the world. The presented special issue includes a number of studies carried out by international teams. Collaboration between scientists from different countries allows the sharing of knowledge, experience and resources, which contributes to a better understanding of complex problems and the development of innovative solutions. Such research leads to new discoveries and technological breakthroughs that can have important implications for critical areas of science and technology.

Considering the impact of advanced digital technologies in artificial intelligence and big data, the authors presented their research manuscripts in various fields such as mining and mineral processing, mineral processing, vision and image processing systems. Invited editors and reviewers conducted a comprehensive review process for each manuscript in accordance with the journal's policies and guidelines. Twenty-seven papers were submitted to this special issue, and after comprehensive review, 12 high-quality papers were accepted for publication. It should be noted that this special issue is one of the most viewed (Viewed by 32,481), over the past 2 years, the total number of citations, at the time of writing this review is 231, and the average citation per article is more than 19. The contributions are listed in List of Contributions.

The challenge of energy efficiency in medium and high voltage networks is of great importance to reduce energy losses and improve overall energy efficiency. Some of the key aspects of this challenge include the development of more efficient transmission and distribution methods, the use of intelligent control and monitoring systems, and improved power transformation and switching technologies. In addition, introducing renewable energy sources into the grid can also help increase energy efficiency. Overall, these measures can significantly reduce energy losses and improve the sustainability and reliability of energy supply. Thus, contribution 1 focuses on developing the structure of a fast and flexible data acquisition system based on the proposed approach for measuring power quality indicators in three-phase distribution networks. contribution 2 presents a computational tool for evaluating the energy produced by low-power photovoltaic systems based on the specific conditions of the region under study. The approach presented in this work will allow to determine the relationship between climatic factors affecting energy production in PV systems operating in any region, as well as to evaluate the most favorable geographical location of PV panels, which contributes to improving the efficiency of solar-to-electric energy conversion.

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Another relevant challenge is the use of predictive models for fault detection. This is of great importance in various fields including mineral processing, equipment maintenance, aviation and many others. Predictive models based on data analytics and machine learning can help predict possible malfunctions and failures of equipment based on historical performance data. In contribution 3, the authors review an approach to study metallurgical processes using analysis of a large array of operational control data. Using steel rolling production as an example, they consider the development of a predictive model based on the processing of a large array of operational control data. The purpose of the work is to implement a predictive model of roll wear of rolling mill rolls based on a large array of operational control data. The predictive model of mill roll wear will allow rational use of rolls in terms of minimizing the total roll wear.

Another example of control of process parameters is the approach to create a virtual soft sensor, which allows to establish a correct relationship between the fractional composition and individual composition of hydrocarbons (contribution 4). The virtual soft sensor is based on chemical and mathematical principles. The paper shows the application of this technique on data from a real refinery. Obtaining accurate data on the individual composition of the feedstock using the virtual soft sensor will optimize the catalytic reforming process and thus indirectly improve its environmental friendliness and enrichment efficiency.

An important direction is the development of autonomous transportation control systems, where artificial intelligence, machine learning, sensor and automation technologies play a key role. These systems can be applied to various modes of transportation, including cars, buses, trains, unmanned aerial vehicles (drones), and even marine vessels. In this regard, the authors of contribution 5 propose the use of a self-optimizing controller structure with trajectory tracking based on reinforcement learning. For lateral vehicle control, a steering method based on combining reinforcement learning methods and traditional PID controllers is developed to adapt to different tracking scenarios. The interactive learning mechanism based on advanced control structures can realize online optimization of PID controller parameters to better handle tracking error under complex trajectories and dynamic changes of vehicle model parameters.

A similarly excellent example is the manuscript: contribution 6 on machine learning for the oil and gas industry. This work is devoted to the most relevant issues of machine learning and artificial intelligence. One of the goals of this research was to build a model for predicting possible risks arising in the process of well drilling. Drilling wells for oil and gas production is a very complex and expensive part of reservoir development. Therefore, along with preventing injuries, the task of saving the cost of downtime and repair of drilling equipment is worthwhile. Nowadays, companies have started looking for ways to improve drilling efficiency and minimize downtime using digital technologies.

The author of contribution 7 devotes a large dissertation research to solving the problem of improving the accuracy of determining the main shape-forming dimensions of axisymmetric parts using an inspection system that implements the optical method of spatial resolution. This work shows the influence of the projection error of a passive optical system for controlling the geometric parameters of bodies of rotation by the image of its sections obtained by a digital camera with non-telecentric optics on the accuracy of measurements. In the field of image processing, the authors of contribution 8 proposed an algorithm for symmetric encryption using multi-parameter fractional Fourier transform. The presented algorithm with two vector parameters has enhanced security, which becomes the main technical means to protect information security.

In the field of molecular dynamics modeling, the authors of contribution 9 proposed a cross-scale critical velocity prediction model for superhydrophobic surfaces with symmetric structure based on mechanical equilibrium system. The study of the critical velocity of a droplet at transition is very important for many applications such as windshield glass fogging protection, medical cooling spray, anti-icing of aircraft surfaces and circuits, and fouling protection of photovoltaic panels. Another example of the use of numerical

modeling methods is the work contribution 10 where the authors determined stable zones in the gas duct of an ore-heat furnace on the basis of computational fluid dynamics methods. This approach is necessary to improve the efficiency of control of the composition of waste gases in the production of metallurgical silicon. This work allowed solving the practical problem of determining the place for installation of measuring equipment.

Another important direction of the presented special issue was a series of scientific papers by Boykov et al. devoted to modeling of various processes. The contribution 11 describes the development of a universal calibration approach for modeling using the discrete element method (DEM). The discrete element method is the most popular approach for computer simulation of the behavior of bulk materials. The corresponding software implementing DEM in a graphical user interface is a highly efficient tool for mining equipment optimization. Recently, DEM is often used in combination with CFD and other methods, which opens up the possibility of calculating complex multiphase processes. contribution 12, which deserves special attention, presents a methodology for training neural networks for vision tasks on synthesized data using the example of steel defect recognition in automated production control systems. The process of procedural generation of a dataset of steel slab defects with symmetric distribution is described. The results of training two neural networks Unet and Xception on the generated data grid and their testing on real data are presented.

Acknowledgments: I dedicate this manuscript to the memory of a remarkable scientist, friend and colleague of Boikov Alexey, author of two relevant scientific articles in this special issue, who left a great scientific contribution to the development of modern digital technologies. His ideas and approaches have already been further developed and are a reminder of his good deeds for us.

Conflicts of Interest: The author declares no conflict of interest.

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