

# ABSTRACTS

#### Yurii Streliaiev, Rostyslav Martynyak, Kostyantyn Chumak

Thermomechanical Slip in Elastic Contact between Identical Materials

The contact problem for interaction between an elastic sphere and an elastic half-space is considered taking into account partial thermomechanical frictional slip induced by thermal expansion of the half-space. The elastic constants of the bodies are assumed to be identical. The Amontons–Coulomb law is used to account for friction. The problem is reduced to non-linear boundary integral equations that correspond to the initial stage of mechanical loading and the subsequent stage of thermal loading. The dependences of the contact stress distribution, relative displacements of the contacting surfaces, dimensions of the stick and slip zones on temperature of the half-space are studied numerically. It was revealed that an increase in temperature causes increases in the shear contact stress reach their maximum at the boundaries of the stick zones. The greatest value of the moduli of the relative shear displacements are reached at the boundary of the contact region. The stick zone radius decreases monotonically according to a nonlinear law with increasing temperature.

#### Vladimir Morkun, Natalia Morkun, Vitaliy Tron, Olga Porkuian, Oleksandra Serdiuk, Tetiana Sulyma

Application of Magnetic and Ultrasonic Methods for Determining Parameters of Ferromagnetic Component in Iron Ore Slurry Flows

The article considers the method for controlling the ferromagnetic component content in slurry flow by ultrasonic and magnetic measurements. One of the basic factors determining the efficiency of magnetic separators at iron ore concentration plants is the quality of distribution of the ground ore into the product containing the ferromagnetic component and the waste rock. Due to the fact that in most cases, magnetic separators extract minerals with strongly magnetic properties, it is essential to find the magnetic component content in the input ore and products of its distribution in order to improve control over the technological process. Currently, low accuracy and reliability make existing means of operative control over the ferromagnetic component content in the slurry flow inefficient. Density of slurry is one of the primary disturbing factors affecting the accuracy of measurements, and this fact determines the necessity of measuring this parameter while controlling the ferromagnetic component content in the slurry flow. The article describes the method for controlling the ferromagnetic component content in slurry flow by ultrasonic and magnetic measurements.

## **Ould Mohamed Mohamed Vall**

Design of Decoupled PI Controllers for Two-Input Two-Output Networked Control Systems with Intrinsic and Network-Induced Time Delays

Proportional integral controller design for two-input two-output (TITO) networked control systems (NCSs) with intrinsic and network-induced time delays is studied in this paper. The TITO NCS consists of two delayed sub-systems coupled in a 1-1/2-2 pairing mode. In order to simplify the controller design, a decoupling method is first applied to obtain a decoupled system. Then, the controllers are designed based on the transfer function matrix of the obtained decoupled system and using the boundary locus method for determining the stability region and the well-known Mikhailov criterion for the stability test. A comparative analysis of the designed controllers and other controllers proposed in previous literature works is thereafter carried out. To demonstrate the validity and efficacy of the proposed method and to show that it achieves better results than other methods proposed in earlier literature works, the implementation in simulation of Wood–Berry distillation column model (methanol–water separation), a well-known benchmark for TITO systems, is carried out.

#### Vikas Singh Panwar, Anish Pandey, Muhammad Ehtesham Hasan

Generalized Regression Neural Network (GRNN) Architecture-Based Motion Planning and Control of an E-Puck Robot in V-Rep Software Platform

This article focuses on the motion planning and control of an automated differential-driven two-wheeled E-puck robot using Generalized Regression Neural Network (GRNN) architecture in the Virtual Robot Experimentation Platform (V-REP) software platform among scattered obstacles. The main advantage of this GRNN over the feedforward neural network is that it provides accurate results in a short period with minimal error. First, the designed GRNN architecture receives real-time obstacle information from the Infra-Red (IR) sensors of an E-puck robot. According to IR sensor data interpretation, this architecture sends the left and right wheel velocities command to the E-puck robot in the V-REP software platform. In the present study, the GRNN architecture includes the MIMO system, i.e., multiple inputs (IR sensors data) and multiple outputs (left and right wheel velocities). The three-dimensional (3D) motion and orientation results of the GRNN architecture-controlled E-puck robot are carried out in the V-REP software platform among scattered and wall-type obstacles. Further on, compared with the feedforward neural network, the proposed GRNN architecture obtains better navigation path length with minimum error results.



## Michal Korbut, Dariusz Szpica

A Review of Compressed Air Engine in The Vehicle Propulsion System

Engines powered by compressed air as a source of propulsion are known for many years. Nevertheless, this type of drive is not commonly used. The main reason for not using commonly is the problem with the low energy density of the compressed air. They offer a number of advantages, primarily focusing on the possibility of significantly lowering the emissions of the engine. Their emissivity mainly depends on the method of obtaining compressed air. This also has an impact on the economic aspects of the drive. Currently there are only a few, ready to implement, compressed air powered engine solutions available on the market. A major advantage is the ability to convert internal combustion engines to run with compressed air. The study provides a literature review of solutions, focusing on a multifaceted analysis of pneumatic drives. Increasing vehicle approval requirements relating to their emissions performance are encouraging for the search of alternative power sources. This creates an opportunity for the development of unpopular propulsion systems, including pneumatic engines. Analysing the works of some researchers, it is possible to notice a significant increase in the efficiency of the drive, which may contribute to its popularisation.

#### Youssef Benfatah, Amine El Bhih, Mostafa Rachik, Marouane Lafif

An Output Sensitivity Problem for a Class of Fractional Order Discrete-Time Linear Systems

 $\begin{array}{l} \text{Consider the linear discrete-time fractional order systems with uncertainty on the initial state} \begin{cases} \Delta^{\alpha} x_{i+1} = A x_i + B u_i, & i \geq 0 \\ x_0 = \tau_0 + \hat{\tau}_0 \in \mathbb{R}^n, & \hat{\tau}_0 \in \Omega, \\ y_i = C x_i, & i \geq 0 \end{cases} \\ \text{where } A, B \text{ and } C \text{ are appropriate matrices, } x_0 \text{ is the initial state, } y_i \text{ is the signal output, } \alpha \text{ the order of the derivative, } \tau_0 \text{ and } \hat{\tau}_0 \\ \text{are the known and unknown part of } x_0, \text{ respectively, } u_i = K x_i \text{ is feedback control and } \\ \Omega \subset \mathbb{R}^n \\ \text{ is a polytope convex of vertices } \end{cases}$ 

 $w_1, w_2, \dots, w_p$ . According to the Krein-Milman theorem, we suppose that  $\hat{\tau}_0 = \sum_{i=1}^p \alpha_i w_i$  for some unknown coefficients

 $\alpha_1 \ge 0, \dots, \alpha_p \ge 0$  such that  $\sum_{j=1}^{p} \alpha_j = 1$ . In this paper, the fractional derivative is defined in the Grünwald–Letnikov sense. We investigate the characterisation of the set  $\chi(\hat{\tau}_0, \epsilon)$  of all possible gain matrix K that makes the system insensitive to the unknown part  $\hat{\tau}_0$ , which means  $\chi(\hat{\tau}_0, \epsilon) = \{K \in \mathbb{R}^{m \times n} / \| \frac{\partial y_i}{\partial \alpha_j} \| \le \epsilon, \forall j = 1, ..., p, \forall i \ge 0\}$ , where the inequality  $\| \frac{\partial y_i}{\partial \alpha_j} \| \le \epsilon$ showing the sensitivity of  $y_i$  relatively to uncertainties  $\{\alpha_i\}_{i=1}^p$  will not achieve the specified threshold  $\epsilon > 0$ . We establish, under certain hypothesis, the finite determination of  $\chi(\hat{\tau}_0, \epsilon)$  and we propose an algorithmic approach to made explicit characterisation of such set.

## Per Lindh. Polina Lemenkova

Evaluation of Different Binder Combinations of Cement, Slag and CKD for S/S Treatment of TBT Contaminated Sediments

The seabed in the ports needs to be regularly cleaned from the marine sediments for safe navigation. Sediments contaminated by tributyltin (TBT) are environmentally harmful and require treatment before recycling. Treatment methods include leaching, stabilisation and solidification to remove toxic chemicals from the sediments and improve their strength for reuse in the construction works. This study evaluated the effects of adding three different binder components (cement, cement kiln dust (CKD) and slag) to treat sediment samples collected in the port of Gothenburg. The goal of this study is to assess the leaching of TBT from the dredged marine sediments contaminated by TBT. The various methods employed for the treatment of sediments include the application of varied ratios of binders. The project has been performed by the Swedish Geotechnical Institute (SGI) on behalf of the Cementa (Hei-delbergCement Group) and Cowi Consulting Group, within the framework of the Arendal project. An ex-periment has been designed to evaluate the effects of adding CKD while reducing cement and slag for sediment treatment. Methods that have been adopted include laboratory processing of samples for leaching using different binder combinations, followed by statistical data processing and graphical plot-ting. The results of the experiment on leaching of TBT for all samples are tested with a varied ratio of cement, slag, CKD and water. Specimens with added binders 'cement/CKD' have demonstrated higher leaching compared to the ratio 'cement/slag/CKD' and 'cement/slag'. The 'CKD/slag' ratio has presented the best results followed by the 'cement/slag/CKD', and can be used as an effective method of s/s treatment of the sediments. The results have shown that the replacement of cement and slag by CKD is effective at TBT leaching for the treatment of toxic marine sediments contaminated by TBT.



## Anna Kasperczuk

Selected Morphotic Parameters Differentiating Ulcerative Colitis from Crohn's Disease

This paper presents a method that binds statistical and data mining techniques, which aims to support the decision-making process in selected diseases of the digestive system. Currently, there is no precise diagnosis for ulcerative colitis (UC) and Crohn's disease (CD). Specialist physicians must exclude many other diseases occurring in the colon. The first goal of this study is a retrospective analysis of medical data of patients hospitalised in the Department of Gastroenterology and Internal Diseases, Bialystok, and finding the symptoms differentiating the two analysed diseases. The second goal is to build a system that clearly points to one of the two diseases UC or CD, which shortens the time of diagnosis and facilitates the future treatment of patients. The work focuses on building a model that can be the basis for the construction of action rules, which are one of the basic elements in the medical recommendation system. Generated action rules indicated differentiating factors, such as mean corpuscular volume, platelets (PLTs), neutrophils, monocytes, eosinophils, basophils, alanine aminotransferase (ALAT), creatinine, sodium and potassium. Other important parameters were smoking and blood in stool.

## **Paweł Dzienis**

Perturbations of the Depth of Liquid Penetration into the Capillary During the Bubble Departures

In the present paper, the influence of bubble size on liquid penetration into the capillary was experimentally and numerically studied. In the experiment, bubbles were generated from a glass capillary (with an inner diameter equal to 1 mm) in a glass tank containing distilled water, tap water or an aqueous solution of calcium carbonate. These liquids differ in the value of their surface tension, which influences the bubble size. During experimental investigations, air pressure fluctuations in the gas supply system were measured. Simultaneously, the videos showing the liquids' penetration into the capillary were recorded. Based on the videos, the time series of liquid movements inside the capillary were recovered. The numerical models were used to study the influence of bubble size on the velocity of liquid flow above the capillary and the depth of liquid penetration into the capillary. It was shown that the air volume flow rate and the surface tension have the greatest impact on the changes of pressure during a single cycle of bubble departure ( $\Delta p$ ). The changes in pressure during a single cycle of bubble departure determine the depth of liquid penetration into the capillary. Moreover, the values of  $\Delta p$  and, consequently, the depth of liquid penetration can be modified by perturbations in the liquid velocity above the capillary outlet.