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ITERATIVE LEARNING CONTROL: A STATUS REPORT AND LOOK AHEAD ON ALGORITHM DEVELOPMENT, EXPERIMENTAL VERIFICATION AND APPLICATIONS

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SYSTEMS AND CONTROL IN THE ERA TOWARDS AUTONOMY, EXPERIENCES AND WHAT THE FUTURE MAY HOLD

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TWO DIMENSIONAL MATERIALS: AN EMPOWERING CONTESTANT FOR ENVIRONMENT SENSITIVE ENERGY HARVESTING

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MODELLING AND OBSERVER-BASED CONTROL OF DISTRIBUTED PARAMETER SYSTEMS

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FLEXIBLE MAGNETIC FIELD SENSORS

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SESSION 1
CONTROL OF MECHATRONIC SYSTEMS I

IMPLEMENTATION OF PI CONTROLLER IN RECONFIGURABLE PSOC MICROCONTROLLER TO CONTROL THE SPEED OF MOBILE ROBOT DRIVES

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The paper presents the realization of analogue Proportional - Integral (PI) controller in reconfigurable microcontroller CY8C27643 from PSoC1 family. The DC motor as a mobile robot drive is used as the controlled system. The controlled variable is the speed of the rotor.

RESEARCH ON THE MECHATRONIC GAIT MONITORING SYSTEM WITH NORDIC WALKING POLES

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Gait with Nordic Walking poles (NW) is used in the rehabilitation process of patients with different diseases and disfunctions. In a typical rehabilitation process, the patient during gait is supervised by a trainer or physiotherapist who assesses the correctness of the patient's limb movements. In the work, the fundamentals of the design and operation of the mechatronic gait monitoring system with Nordic Walking poles were presented. The monitoring system provides the possibility for a trainer to analyse the gait of many patients online. The developed system consists of mechatronic NW poles equipped with a measuring system, which makes it possible to measure the kinematics and dynamics of poles. It is placed in a mobile device (smartphone or tablet) and connected wirelessly with a system for monitoring, analyzing and diagnosing patient movement. The monitoring system is also equipped with a self-diagnosis module, which signals any patient with basic errors and irregularities in their NW gait. The paper describes pilot tests of the NW gait monitoring system and presents the obtained gait results in the terrain, which verify the correctness of the system operation.

DEVELOPMENT AND TESTING OF THE MECHATRONIC GRIPPER WITH TWO FINGERS

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The article describes the problem of developing a novel gripper with two fingers using a differential gear. In the proposed solution, the fingers maintain parallel orientation to each other throughout the entire working area, consisting compact design of the gripper itself. The mechanism has two degrees of freedom, one for closing fingers and second for rotating the gripper. The novel approach is the way of drive transmission by using a differential gear connected to two DC motors located behind the gripper mechanism, which contributes to the reduction of its dimensions near the working area. There are force sensors on the fingers of the gripper allowing to grasp the object with a given force. A controller has been integrated in the gripper, which implements the developed control algorithm, including the coupling of the motors in the differential drive and feedback from the force measurement carried out by force sensors. Geometry has been selected for the proposed gripper scheme. The mechanism simulation tests were carried out in a program for dynamic analysis of multibody systems. The prototype of the gripper was assembled. Structure parts were made in FDM technology

FEMM EXAMINATION OF THE GRIPPER WITH MAGNETORHEOLOGICAL CUSHION

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Nowadays, advanced grippers use intelligent devices and materials such as Magnetorheological (MR) fluids to increase object handling capabilities. Gripper constructions are varied and based on the choice between the versatility of the shape of the objects to be grabbed and the ability to orient them in space. An example of a universal solution is jamming gripper, which adapts to the shape of the object, but limits its ability to manipulate the object itself in space. In turn, devices based on the kinematics of gripping jaws lack the ability to adapt to the geometry of the object being gripped. This article describes the Finite Element Method Magnetics (FEMM) analysis of the design of an innovative MR cushion solution that is the pad of the jaw gripper, which is meant to be a human equivalent. Furthermore it is susceptible to make a physical contact with the surface of the object and stiffening as a result of the generated magnetic field to provide a secure grip.

EXPERIMENTAL RESEARCH ON THE MECHATRONIC NORDIC WALKING POLES

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Walking with Nordic Walking poles is commonly used for the rehabilitation of patients after various diseases (strokes, myocardial infarction, limb injuries). The condition for the effectiveness of rehabilitation is the correct performance of gait while walking with poles. For testing gait parameters, mechatronic Nordic Walking poles were equipped with sensors that measure pole orientation, the force acting on the ground, and grip strength. In the work, the issues of constructing the test stand that simulates upper limb movements in gait with Nordic Walking poles was conducted. The general purpose of the research was to evaluate the correct operation of the mechatronic measuring system placed on the Nordic Walking poles. The motions of parts of the developed test stand, with three degrees of freedom, correspond to the movements of the three main segments of the upper limbs (arm, forearm and hand). The control and measuring system of the stand allows limb kinematics obtained from real measurements on the human limb to be simulated. This allowed the correct working of the measuring system placed in the Nordic Walking pole to be verified.

A PRELIMINARY INVESTIGATION OF AN AUTONOMOUS VEHICLE VALIDATION INFRASTRUCTURE FOR SMART CITIES

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The research and development of autonomous vehicle has entered the era of commercialization. While the vehicle self-driving technology has been growing rapidly, the validation for autonomous vehicle in terms of driving model, human factor model and traffic model is still maturing. Most of previous infrastructures are mainly focused on validation of those three models separately resorting either on real driving test at physical infrastructure or software simulation in virtualized infrastructure. However, neither the real driving test can cover all possible scenarios of autonomous driving and human factors, nor the virtualized software simulation can generate a feasible model for practical on/off-road driving. Furthermore, future autonomous transport in smart cities requires comprehensive validation. In order for autonomous vehicles to meet the autonomous transport in such complex traffic environment, an integrated testing and simulation infrastructure has been built targeting the systematic validation for autonomous vehicles: the Multi-User Environment for Autonomous Vehicle Innovation (MUEAVI). A preliminary investigation of a new autonomous vehicle validation infrastructure that can serve a multitude of research projects for smart city is presented.

SESSION 2
ROBOTICS I

MANIPULATOR TELEOPERATION BY USING THE POSITION OF THE HAND REGISTERED BY VISION SYSTEM

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Nowadays, numerous studies are conducted on the methods of video control of industrial manipulators. One of the most common solutions is use of a Kinect camera, which does not guarantee satisfactory results. The main problem arising from the use of a vision system to control industrial robots is accuracy and dynamics of reading. The article presents system to control robot position with six degrees of freedom. This system use information about the position of the palm, located by two camera. The first camera is responsible for the position of the robot in the YZ plane. The second camera is responsible for the position in the X axis. Main goal of paper is to research accuracy of proposed positioning system.

ALGORITHM FOR PLANNING, GENERATING AND SIMULATING TRAJECTORIES FOR A GROUP OF DRONES

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The methodology of generating trajectories for a group of drones (Unmanned Aircraft System - UAS) was presented in the paper. The software enables flight planning for up to several thousand Unmanned Aerial Vehicles (UAV). The algorithm chooses the i-th UAV's position (Di) in pair with the target position Pj in order to obtain minimum value of the sum of all pair distances DiPj. The system can work in real time even for a large groups of UAV's, which is very difficult using standard gradient methods, especially for low computing resources.

PROTOTYPE AND SIMULATION MODEL OF A ROBOTIC HAND

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This elaboration describes the whole process of robotic hand design and modelling in order to improve some of the key performance aspects of tendon driven mechanisms. The hand model is simulated in Simscape Multibody Environment to accurately predict the performance of various designs. Some of developed mechanical solutions lead to reducing the wear, improving torque figures and enhancing rigidity.

WHEELED ROBOT PATH PLANNING IN NATURAL ENVIRONMENT

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In this work we present a method to obtain the obstacle-free path optimized under shortest travel time condition in a a priori known map, with velocity profile generation. The method is in fact a set of three submethods: the pathfinding algorithm (PA), the optimization algorithm (OA) and the velocity profile generation algorithm (VPGA). The PA is used as a subfunction for the VPGA genetic algorithm that searches for the PA parameters which give the time-optimal path. As the last step the VPGA algorithm is used to obtain the velocity profile for the robot. The velocity profile takes into consideration areas where the path is close to the obstacle. In those areas the robot velocity is reduced to make it less sensitive for errors that can cause a collision. The velocity profile is not computed in the GA fitness function due to computation cost. The solution fitness is approximated using extracted path characteristics, which approach is much more effective.

INTEGRATED FRAMEWORK FOR AUTONOMOUS MOBILE PLATFORM BASED UNMANNED AERIAL VEHICLE OPERATION

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In this paper, we present an integrated framework for autonomous mobile platform based UAV operation. The UAV tasks entail autonomous start and landing, as well as mobile platform following with the planned return to the base. We present the system structure including the PixHawk autopilot modifications, on-board computer set-up and the mobile base landing area configuration. We show the experimental results from the tests performed in quasi-real and in real conditions. Finally, we show the quantitative and qualitative performance description of the proposed system.

TRANSFER LEARNING ALGORITHM IN IMAGE ANALYSIS WITH AUGMENTED REALITY HEADSET FOR INDUSTRY 4.0 TECHNOLOGY

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Modern technology lines in Industry 4.0 standard use many complex smart systems to improve the speed of production. Manufacturing becomes more flexible and, on the other hand, more demanding for a process operator. This article presents mixed reality glasses that supports the work of the operator integrated via a cloud with a technology line. Transfer learning algorithm is shown in a set of artificial neural network algorithms belonging to the Deep Learning class to analyse the image from ML headset. This algorithm is designed to recognize the current occupation of the storage tray with direct transmission of information to the control and measurement system.

DEVELOPMENT OF A HYBRID ENERGY STORAGE SYSTEM FOR A MOBILE ROBOT

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Li-ion cells are characterized by high energy density and low power availability. Supercapacitors are the contrary: they have low energy density and high power availability. A comprehensive approach to constructing a battery containing Liion cells and supercapacitors is presented. This results in better li-ion current discharge characteristics and high power density of such a hybrid energy bank. Mobile robots require a very efficient power electronic system. The better the system is the longer remote work can be performed which reduces cost and make the robot more flexible. Increased battery quality and performance are crucial in improving the whole mobile robot power system.

COLLABORATIVE ROBOT SYSTEM FOR PLAYING CHESS

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In recent years, number of collaborative robots industrial applications has made a significant increasment. Implementation of collaborative robots is a safe and effective way for designing robot-human cooperation systems. Combined with constantly developing artificial intelligence, collaborative systems are actually able to solve complex problems that require some sort of intelligence. For humans, board games are a good example of the visualization of robot intelligence. Such systems require estimation and detection of board and pieces in manipulator workspace, some kind of decision-making algorithms and robot control system to move pieces. The flagship of such systems are chess playing robots. The chess game has a defined and easy to understand set of rules which makes it interesting example of intelligent robotics systems application. In this paper, we present an implementation of collaborative robots for chess playing system which was designed to play against human or another robot. The system is able to track state of the game via camera, calculate the optimal move using implemented decision-making algorithm, detect illegal moves and execute pick-and-place task to physically move pieces. We test the developed system in a realworld setup and provide experimental results documenting the performance of proposed approach.

SESSION 3
ENERGY HARVESTING SYSTEMS

CHARACTERISTICS OF ELECTROMECHANICAL CLAMPING MECHANISM WITH ASYNCHRONOUS ELECTRIC MOTOR

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The study investigates certain operating characteristics of the developed electromechanical actuator of a clamping mechanism for a lathe. The research was conducted using a previously designed special computer program which displays results in the form of graphs. The time dependencies of investigated characteristics have been found and analysed. The theoretical research results facilitate clarification of the peculiarities in operation and creation of the clamping mechanisms with an asynchronous motor. In particular, they contribute to defining appropriate adjustments for specified operating conditions and optimal parameters for structural elements of mechanisms of this type.

INVESTIGATIONS OF AN ORIGINAL SMALL POWER INDUCTION HEATER

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An original construction of an induction heater was presented in the paper. The device is equipped with a control system for feedstock temperature. In order to obtain a sufficient value of electromagnetic field in the work area, a current resonance phenomenon was used. The maximum power of the inductor was assumed to be 2 kW, which allows to heat a steel pipe of 20 mm diameter and 3 mm wall thickness up to 1000˚C. An original system allowing automatic adjustment of the temperature was developed. The algorithm allows to autonomously adjust the resonance frequency, which is depending on the material of the feedstock. In order to control the feedstock temperature a discrete PID controller was implemented. Measurements were carried out for a cylindrical inductor and for a resonance frequency of approx. 71 kHz.

INDUCTION HEATING FOR A SILICONE / ETHANOL COMPOSITE ACTUATOR

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Nowadays, intensive development in the field of smart materials and the possibilities of their application are observed. One of the promising materials is the silicone / ethanol composite liquid-vapor phase transition of ethanol. It consists of drops of ethanol in a silicone matrix. It has the ability to achieve strain up to several hundred percent and exert significant force, while being relatively easily manufactured and inexpensive. This work presents a linear actuator based on this material, which uses induction heating to quickly provide heat necessary for the system to operate. A prototype was built in which the active material reached an elongation of over 75% when heated to 85 ° C. The paper presents basic information about the silicone / ethanol composite, describe the concepts of actuator design and physical basis of its operation. The results of the experimental study of the mechanical properties of the built prototype are presented.

POWER SUPPLY SYSTEM ANALYSIS FOR TETHERED DRONES APPLICATION

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This article presents the results of research involving the comparison of energy consumption of a multirotor battery-powered drone and a drone supplied by a cable from a base station located on the ground. It is worth mentioning that an original solution of a drone power supply system was involved in the research. The supply system uses an electric cable, a system of voltage converters connected to a portable generator and a battery system constituting a local energy storage. As part of the field experiments, the energy demand of drones as a function of their take off mass was determined. The tests were carried out by measuring the average current consumed by the device, instantaneous currents and power that was supplied to multi-rotor platforms. The results of the analysis were also analyzed and the possible reasons for slight discrepancies in the results obtained were indicated.

SESSION 4
BIOMATERIALS

PREPARATION AND INVESTIGATION OF BIOACTIVE ORGANIC-INORGANIC NANO-COMPOSITE DERIVED FROM PVB-CO-VA-COVAC/HA

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Novel nano-composite composed of poly vinyl butyral co vinyl alcohol co vinyl acetate (PVB-co-VA-co-VAc) covered with bone skeleton like hydroxyapatite (HA) and coating the graphene (G) was produced through the combined phase separation technique and physical evaporation deposition (PVD) method. The chemical formula of HA is (Ca10(PO4)6(OH)2) and recently HA was interested for researchers as a bioactive protocol ability by substitution link of co-polymers with collagen in large specific area, high thermal stability and chemical stability, high ionic exchange capacity and ability to regenerate itself. PVB-co-VA-co-VAc has strong adhesive properties with different groups such as hydroxyl group through the hydrogen bonds (non-covalent interactions), metal coordination, host-guest interactions, ionic attractions and hydrophobic reactions. The hydroxyl groups enable the PVB-co-VA-co-VAc outstanding adhesion to many substrates obtaining the metal surfaces such as calcium and phosphorus and increasing moisture resistance. PVB-co-VA-co-VAc has good binding capacity on the calcium surface and it can be providing bioactive properties as well. In this case the surfaces of the specimens of nano-composite with weight percentage value (15 %) of PVB-co-VA-co-VAc was characterized by using TG/DSC, XRD, FTIR, BET, Zeta potential and in-vitro analysis. Furthermore, for the investigation mechanical properties of composite, compressive test at room temperature was utilized and the nano-composite was almost in the almost well range of improvement mechanical test. Bioactivity test (in vitro) was performed in the solution body fluid (SBF) for 14 and 30 days and the bonding between calcium and phosphate ions was created on the surface of samples and as a result the measurements were showed that nano-composite PVB-co-VA-co-VAc/HA is bioactive.

ANTIMICROBIAL PROPERTIES OF MUCIN-BASED SALIVA SUBSTITUTE CONTAINING XYLITOL

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Xerostomia is a disease characterized by a chronic feeling of dry mouth associated with a reduced amount and quality of saliva. When caused by salivary glands irreversible damage as a result of anti-cancer therapies, it requires the administration of artificial saliva that will restore the physiological functions of natural saliva. In addition to the moisturizing and lubricating effects, it is also important to restore the antimicrobial properties of healthy saliva. Patients suffering from xerostomia occurring as a result of cancer treatment, are often immunocompromised and susceptible to infections. Here, the solution developed based on mucin and xanthan gum with the addition of xylitol, a five-carbon sugar alcohol (C5H12O5) with a potential antimicrobial effect, was proposed as a saliva substitute. The ability of this preparation containing xylitol to inhibit proliferation, adhesion, and biofilm formation of C. albicans, C. tropicalis, C. glabrata fungal strains, and S. mutans bacteria was examined using spectrophotometric techniques. Xylitol at a concentration of 2%mas. and higher, exhibit the ability to prevent microbial, adhesion, and proliferation which translates into a reduced amount of formed biofilm and its survival in single-strain systems.

THE INFLUENCE OF PH AND TEMPERATURE ON STABILITY OF ARTIFICIAL SALIVA BASED ON PORCINE GASTRIC MUCIN

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Natural saliva performs many important functions in the human body. Maintaining its production at a constant level is a very important aspect of the proper functioning of the oral cavity. However, due to certain factors, a reduction of salivary secretion is observed. In such situations, saliva substitutes are used, which should have similar properties to natural saliva. Such properties are fulfilled by our saliva preparations based on porcine gastric mucin. Its oligosaccharide chains affect the physicochemical and rheological properties of saliva substitutes. In the work, the influence of two factors: temperature (4°C, 21°C) and pH (2, 7) on physicochemical (pH, electrolytic conductivity, surface tension, contact angle) and rheological (viscosity, viscoelasticity) properties of saliva preparations were tested in the study. Saliva substitutes were prepared based on pure deionized water or phosphate buffer solution (PBS) with the addition of porcine gastric mucin. Measurements were made after 1, 3, 5, 7 days after the preparation of the solutions. The obtained results showed that under the influence of the temperature and pH, the stability of the mucin-based preparation is disturbed, especially in the case of water-based solutions. This is associated with a change in the spatial conformation of the mucin structure. Therefore, solutions based on mucin may lose their specific functional properties. This is due to improve hydration and lubrication between the surfaces of the mouth, or the lack of adequate protection against bacteria.

WETTABILITY AND MOISTURE ANALYSIS ON NATURAL FIBER REINFORCED EPOXY RESIN HYBRID COMPOSITES

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A study on wettability and moisture absorption behavior of various natural fiber hybrid composites with varying weight fractions are presented in this paper. Banana, pineapple, hemp, and flax fibers were used as reinforcement and epoxy resin along with hardener used as matrix material. Composites were fabricated on the basis of the rule of hybridization mixtures. The hand lay-up technique was used for the fabrication of composites and a total of five different composites were fabricated by varying the weight fraction of the composite for comparison purposes. The wettability test was done by using the contact angle measurement technique to find out the wettability of composite surface by liquid droplet on it. Moisture analysis was done by calculating the gain percentage of water was measured on a periodic basis at an interval of 24 hours and the results were observed for comparison purposes.

SESSION 5
MACHINE AND ITERATIVE LEARNING CONTROL

NEURAL NETWORK-BASED CALIBRATION FOR ACCURACY IMPROVEMENT IN LATERATION POSITIONING SYSTEM

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Mobile robot positioning is a crucial problem in modern industrial autonomous solutions. Lateration Positioning Systems base on the distance measurements to estimate the object's position. These measurements are however often affected by numerous sources of noise: obstacles, multi-pathing, signal propagation speed etc. Effective calibration methods are therefore required to eliminate these errors to achieve precise positioning. In this paper, we present the application of neural networks to improve the accuracy of a UWB lateration system. We present the network architecture and demonstrate how it can be used to alleviate the effects of multi-pathing and environment anisotropy in a real positioning setup. We furthermore compare the efficiency of the neural network with the state-of-the-art calibration methods.

DEEP LEARNING-BASED ALGORITHM FOR MOBILE ROBOT CONTROL IN TEXTURELESS ENVIRONMENT

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For the implementation of stereo image-based visual servoing algorithm in the eye-in-hand robotics applications, one of the main concerns is the accurate point feature detection and matching algorithm. Since the visual servoing is carried out in the textureless environment, the feature detection process is even more challenging. To fulfil the requirement of a robust and reliable point feature detection process, in this paper we present the novel deep learning-based algorithm. The approach based on convolutional neural networks and algorithm for detection of manufacturing entities is proposed and detected regions of interest are utilized for the improvement of the point feature detection algorithm. The proposed algorithm is experimentally evaluated in real-world settings by using wheeled nonholonomic mobile robot RAICO equipped with stereo vision system. The experimental results show the improvement of 58% in the accuracy of matched point features in the images obtained during the visual servoing process. Moreover, with the implementation of the proposed deep learning-based approach, the number of successful experimental runs has increased by 80%.

DOUBLE DEEP Q-LEARNING APPROACH FOR TUNING MICROWAVE CAVITY FILTERS USING LOCALLY LINEAR EMBEDDING TECHNIQUE

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From past two decades, Microwave Cavity Filter is the buzzword in communication arena. They are highly valued owing to their high-Q factor and robustness. Once assembled, the filter needs to be properly tuned to compensate for various design imperfections and manufacturing tolerances, which till date is carried out manually. To overcome these limitations a Computer-Aided Tuning (CAT) method has been proposed using Double Deep Q-Learning (DDQN) Algorithm to fine tune Microwave Cavity Filters. Owing to copious data obtained using a commercial filter, the researchers have used Locally-Linear Embedding (LLE) approach for dimension reduction. The algorithm has been tested via simulation of a 9th order filter. Furthermore, four screws were used for training and testing the algorithm. The proposed algorithm could tune the considered filter in 23 steps only. The quick tuning, received towards the end of the research, proves that the algorithm is effective in facilitating the tuning process.

CUBIC SVM NEURAL CLASSIFICATION ALGORITHM FOR SELF-EXCITED ACOUSTICAL SYSTEM

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This paper proposes a special classification system based on artificial neural networks. The algorithm was used to interpret the results for the Self-Excited Acoustical System (SAS) for ultrasonic stress measurement in elastic structures. The results obtained with the SAS system were transformed by Short-Timed Fourier Transform (STFT), and the resulting characterization images were used to train the artificial neural network using the Cubic SVM (Support Vector Machine) algorithm. Trained ANN was then used to classify materials on the basis of time-frequency characteristics. The article shows the principle of operation of the SAS system for materials such as stone, metal and composite material. The theoretical basis for usage of time-frequency transformations was presented, as well as the principle of operation of the Cubic SVM algorithm for classification tasks.

USING DATA MINING TOOLS IN WALL-FOLLOWING ROBOT NAVIGATION DATA SET

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Discovering knowledge in databases is a process for searching clear patterns, not previously known, but with high potential in decision support and characterization of the data. The purpose of data mining is to use the appropriate algorithm for finding dependencies and schemas in the prepared data set, and then representing them in a formal form understandable by the user. In this work, we want to show the possibilities of using data mining and statistical methods to analyze data obtained from mobile robot SCITOSG5 during the simple wall-following task.

APPLICATION OF ARTIFICIAL NEURAL NETWORKS TO HEAT TRANSFER SIMULATIONS OF THIN FILM STRUCTURES IRRADIATED BY LASER

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In the presented work, heat transfer in one dimensional numerical model of thin films irradiated by ultrashort laser pulses is discussed. In proposed mathematical model some laser parameters are given as interval numbers, which simulate the noise that can happen in reality. The direct problem has been solved using the rules of directed interval arithmetic. As numerical solution of such problem may be computationally demanding, the authors propose using artificial neural networks as fast approximators of interval results of important parameters for technological processes. In the numerical example, artificial neural network was trained from the numerical model to estimate the maximum temperature (as an interval number) and time when it is achieved. The accuracy and computational time of the problem solutioning using artificial neural network were measured and compared to lattice Boltzmann method.

CONTROL STRATEGY OF HYDRAULIC CYLINDER BASED ON DEEP REINFORCEMENT LEARNING

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Authors developed a novel control strategy of hydraulic cylinder based on deep reinforcement learning. The control parameters of hydraulic cylinder are difficult to regulate for practical applications, and problems of force and oil pressure disturbance occur during the operation process. A class of reinforcement learning agents developed for hydraulic systems is designed based on the deep deterministic policy gradient and proximal policy optimization algorithms. The agents are trained by a significant number of system data. After learning completion, they can automatically control the hydraulic system online and consequently the system can always maintain a good control performance. Experiments are conducted to verify the proposed control strategy. Results show that the proposed method can achieve better performance that conventional proportional-integral-derivative regulator and effectively overcome the effects of disturbance.

ALGORITHM FOR REAL-TIME BINARY CLASSIFICATION OF ADENOMAS AND NORMS IMAGES OBTAINED BY CONFOCAL MICROSCOPY

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Diseases of the thyroid and parathyroid gland today are a common and urgent problem. Diagnosis of these diseases is currently carried out by medical professionals by invasive intervention in order to take biopsy samples. Simplification and automation of this process by analyzing images of confocal microscopy using artificial neural networks can improve the accuracy of diagnosis and get rid of the need for invasive intervention, which makes research in this area relevant. The authors analyze various approaches and propose an optimal algorithm for solving the problem of recognition and classification of thyroid images obtained using confocal microscopy in real time.

SESSION 6
CONTROL OF MECHATRONIC SYSTEMS II

MODERNIZATION OF THE FATIGUE TEST STAND CONTROL SYSTEM USING THE IDEA OF A VIRTUAL INSTRUMENT

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The paper presents the solution for monitoring the operation of the MZGS 100 type fatigue test stand. Originally, the test stand enable testing at manual settings. The measurements of load conditions were only used to monitor the process without feedback in the control system. The control and measuring system was developed based on the idea of virtual instruments. The control system uses standard measuring system solutions and their coupling with the executive elements of the station was made using the LabVIEW graphic programming environment. The proposed solution allows the functionality of the stand to be extended with new fatigue testing procedures, e.g. tests under programmed block loads. The machine's overload protection has also been improved.

MODEL-BASED DESIGN OF THE VEHICLE DYNAMICS CONTROL FOR AN OMIDIRECTIONAL AUTOMATED GUIDED VEHICLE (AGV)

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This paper presents the concept of an omnidirectional automated guided vehicle (AGV) and the model-based design of the vehicle dynamics control. To increase the movement flexibility of the AGV the omnidirectional maneuverability should be particularly taken into account in the concept of the new AGV. In contrast to conventional AGV, which uses normal conventional wheels to transmit the driving torque to the road surface, mecanum wheels are used in the new AGV to ensure omnidirectional maneuverability in the realization of the chassis. To perform the planar motion of the AGV as quickly and exactly as the specified trajectory, the vehicle dynamics control is model-based designed, whereby the kinematic and dynamic behavior of the AGV is firstly described by a mathematical model according to the simplified physical vehicle model. By analyzing the mathematical model, the suitable control algorithm is selected and thus the control structure, as well as the control parameters, are determined.

AUTODIAGNOSTICS FOR REMOTELY PILOTED AIRCRAFT SYSTEMS

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Ensuring safety flight of Remotely Piloted Aircraft Systems (RPAS) is complex problem due to of mass this kind of object. The RPAS increase operate in the airspace and they create a threat for general aviation. The detection of RPAS damages has important influence for a safety flight of this objects. The detection of damage before flight reduces dangerous of crash and a threat for people. In the Air Force Institute of Technology was performed work connected to Health Usage Monitoring Systems dedicated to Manned aviation especially to helicopters. Due to developing the branch relevant with Remote Piloted Aircraft Systems AFIT have started works with HUMS for RPAS. In this paper will be presented a solution based on CAN BUS solution dedicated for autodiagnostics of RPAS.

RESEARCH ON THE INFLUENCE OF METAL SURROUNDINGS AND READING METHOD ON THE ACCURACY OF UHF RFID TAGS TRACKING

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In this paper we present the results of our research on the effectiveness of data exchange between the reader and the label in an RFID system in various environment configurations. Discussed technology is particularly useful in metal cabinets intended for storage and archiving of valuable items, such as documents or specialized equipment. Our results from this research are a solution in the realm of Internet of Things, responding to the needs of Industry 4.0 in the field of processing and exchange of data on resources used in enterprises. Our tests were carried out in four ambient configurations, i.e. 2 stations with metal cabinets and 2 in the open space. Research was carried out on RFID tags, used as document markers, placed in binders in five position variants. The influence of ambient conditions and the way of reading (stationary and dynamic reading in which the antenna is in motion) on the effectiveness of scanning was examined. It was found that the way of reading has less impact on its effectiveness than the surrounding conditions. As a result, it was determined that for the correct operation of systems intended for identification and control of objects stored in metal cabinets, the construction and material of the cabinet itself is important, as well as the way of reading RFID tags, the significance of which grows in more complex systems consisting of a larger number of tags, which can be more mutually shielded.

OBJECT DISPLACEMENT ESTIMATION WITH THE USE OF MICROELECTROMECHANICAL ACCELEROMETER

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This work discusses the issues related to the estimation of the displacement of an object which linear accelerations are measured using a MEMS accelerometer. The displacement estimation is based on measured accelerations. During the tests, the object moved on a surface similar to the surface of a concrete floor. The angular orientation of the tracking object with an accelerometer is constant during the measurement. An own algorithm has been proposed for estimating the displacement of an object moving on a surface with a non-zero roughness, based on acceleration measured with the MEMS accelerometer. In experimental studies, the estimated linear displacements were compared with the measured real values of the distance traveled by the object. With the experimental results obtained in the course of tests of 4 different accelerometers, their applicability for the construction of an inertial linear displacement sensor was comparatively determined.

CONCEPTUAL MECHATRONIC DESIGN OF A METAMORPHIC MANIPULATOR'S PSEUDOJOINTS

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In this paper the conceptual mechatronic design of an autonomous pseudojoint to be used for structuring serial metamorphic manipulators will be presented. First, the design specifications of the pseudojoint and their mapping to four evaluation criteria is presented. The proposed evaluation method is based on the discrete Choquet integral. Finally, the selection of a novel pseudojoint from four design alternatives is used as a case study of the proposed method.

ULTRASONIC MOTOR WITH SPHERICAL ROTOR FOR NANOSATELLITE ORIENTATION

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Piezoelectric devices are widely used in sensing and actuating applications. Such devices can be found in photo cameras, laser beam control systems, optical and medical devices and etc. One of the possible applications where piezoelectric actuator can be used – aerospace engineering. Piezoelectric devices are sufficiently small and reliable, simple to make and easy to control. Because of the small size of piezoelectric actuator, they can be used for attitude control of small satellites. In this article innovative implementation of developed piezoelectric ultrasonic motor (USM) is presented. This motor comprises of the two ring-type piezoelectric actuators and permanent magnetic sphere as rotor. Using specific harmonic electric signal, piezoelectric actuator is excited and resonant modes are achieved. During resonant, the actuator performs 3D elliptical motion and this motion rotates the sphere. Numerical and experimental studies are performed, resonant modes and frequencies calculated, prototype of actuator was made and results of this researches are presented in the paper.

DYNAMIC CHARACTERISTICS OF A ROPE WITH A WINDER FOR POWERING UAV

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To ensure continuous, twenty four hour operation of a multi-rotor unmanned aerial vehicle (UAV), a powering rope, providing electrical power supply to the vehicle, is applied. The UAV flies over the board of a sea vessel and is equipped with a camera (vision) system. The vision system looks round the vessel to detect possible dangerous obstacles, that cannot be detected using standard collision avoidance systems, like AIS (automatic identification system) or marine radars. The powering rope is wound in the winder, mounted at the vessel's board. The winder maintains a prescribed tension in the rope to prevent it from loose hanging and consequently from chaotic movements in the wind. Model of rope's dynamics is formulated using the rigid finite element approach. Damping properties of the rope, as well as its aerodynamic lift and drag forces are included. Rope length reduction when winding is modelled. Finally dynamic characteristics of the rope are obtained and their importance for proper UAV flight control is demonstrated.

CALLIBRATION OF EOG AND ECG INSTRUMENTATION MODULES IN SMART BIOFEEDBACK SYSTEM

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Smart biofeedback systems are consisted of various instrumentation modules intended for measurement of the appropriate physiological signals. This paper emphasizes the problem of EOG and ECG signals measurement in smart biofeedback system. More precisely, it describes the problem of calibration of EOG and ECG instrumentation modules. Calibration modules for testing the metrological characteristics of EOG and ECG instrumentation modules are presented. The calibration modules are designed according to recommendations of the International Organization for Legal Metrology (OIML - Organization Internationale de Métrologie Légale) and stochastic measurement approach. This description includes the design of electronic circuits, of the appropriate printed circuit boards and of the modules interface.

FINITE-TIME TRACKING OF TRAJECTORIES IN TASK SPACE FOR STEWART PLATFORM

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This work presents the synthesis of a controller for Finite-Time Trajectory tracking in Task Space of a 6-DoF Stewart Platform. We present necessary conditions to ensure the convergence in Finite-Time of the position of the moving platform of this Parallel Robot to the specified, varying in time trajectory of movements.

MODELING AND CONTROL OF MULTIMASS SYSTEMS IN TERMS OF 2D SYSTEMS

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In this paper modelling and efficient controller design for multi-mass systems is considered by writing the dynamics as a 2D state-space model representation of a spatially interconnected system. The 2D structure arises since there are two independent variables in the model. One of these is time and the other is the number (location) of the subsystem in the sequence. This paper uses 2D systems theory to develop a control law design, which stabilizes the dynamics and enforces tracking of a reference signal.

DEVELOPMENT OF A WIRELESS WEIGHING TRANSDUCER AND ITS CALLIBRATION

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This article presents research results concerning a weight transducer equipped with a WiFi interface. This solution enables conducting remote measurements of force in hard-accessible places where measurements with the use of a USB module are not possible. Additionally, the paper contains a description of a device calibration process during which the measured quantity is established. This is conducted by converting the voltage measured on an ADC transducer into the measured quantity in the form of force. Moreover, the influence of the accuracy of the calibration test bench construction on the obtained measurement results is shown. The research outcome, covering the calibration process and determining the measurement errors, and appropriate conclusions are presented in the form of tables and graphs.

SESSION 7
PIEZO-MATERIALS AND SMART MATERIALS

DESIGN AND CHARACTERIZATION OF A DUAL PIEZO-BIMORPH MICRO FLAPPING WING

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This paper describes the preliminary design and characterization of a dual piezo-bimorph driven micro flapping wing mechanism for potential application in micro aerial vehicle designs. The basic form of the mechanism is inspired by a dragonfly insect. The wing motion is actuated by two piezoelectric bender actuators. The skeletal structure of the wing is manufactured using 3D printing technology, where Kapton film is laminated to the printed ABS skeletal frame. Finite element analysis (FEA) is used to guide the design of the mechanical dynamics of the wing mechanism, where predicted resonances between 10 to approximately 250 Hz are shown. Experimental results are shown to demonstrate basic functionality and operation of the wing, particularly at and near the first resonance. The results also show good agreement with the FEA model.

INVESTIGATION OF PIEZOELECTRIC TRANSDUCER APPLICATION FOR VIBRATIONAL ENERGY HARVESTING IN MILLING OPERATION

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The paper provides results of a performed FEA simulation analysis of piezoelectric ring-type transducer used for vibrational energy generated during milling operation harvesting. For this purpose, a COMSOL MultiphysicsR 3D model consisting of a tool holder encompassing piezoelectric transducer was created, which was used to evaluate resonant frequencies and voltage output of the piezoelectric transducer experiencing deformations from milling tool vibrations. The harvester 3D model used for simulations uses a simplified end milling tool which is subjected to axial, torsional and radial forces mimicking milling operation and leading to appearance of respective vibrations in the tool. Implemented tool holder is designed in such a way that torsional and radial vibrations excited in the tool are partially transformed to longitudinal vibrations that excite D33 type piezoelectric transducer. Throughout the FEA simulation analysis design parameters of the ring type piezoelectric generator have been studied in order to evaluate how they affect the transducers and the tool holder assemblies vibrational modes, voltage output from piezoelectric transducer has been evaluated as well. The performed investigation provides insight into application of piezoelectric transducer for the purpose of energy harvesting from vibrations excited in the milling tool during operation.

THE EFFECT OF SUPERFINISHING CONDITIONS ON SURFACE ROUGHNESS OF HARDENED UNALLOYED STEEL

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Modern technologies are executed by machining difficult-to-cut materials, which include, above all, nickel, titanium, magnesium alloys, austenitic steel or hardened steel. With the development of technology, machine elements are increasingly demanding in terms of their reliability, accuracy and durability. One of the main features of the technological quality of machine parts is their wear resistance, which is most often determined by the properties of their surface layer. Appropriate properties of the surface layer of machine parts are most often shaped in machining, often preceded by heat or thermo-chemical treatment. Significant impact on the wear resistance of cooperating machine parts have, among others their surface roughness. One of the finishing methods that allows obtain a surface layer with favorable performance properties is oscillatory superfinishing, which aims to give a high smoothness to the outer surface of the workpiece. Superfinishing is mainly used after thorough turning or grinding. Superfinishing process is based on the fact that the surface of the workpiece is aligned whetstone. The whetstone are performed a feed motion and vibration motion at the appropriate frequency. The workpiece rotates around its axis with circumferential speed. The paper presents a research on the impact on the conditions of the superfinishing process on the surface roughness of shafts made of hardened C45 steel.

PECULIARITIES OF THE ROBOTISED INCREMENTAL METAL AND POLYMER SHEETS FORMING

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The objective of this research is to study the formability of thermoplastics using heat assisted single point incremental forming and to test the effectiveness of metal forming using ultrasonic sheet excitation. Both of these technological processes are realized by a single point incremental forming tool embedded in the robot's hand. A testing set-up has been developed and experiments have been conducted to study the impact of external heating on the polymer forming limits and to evaluate the reduction of friction between the tool and the sheet of metal when the latter is excited by two – way ultrasonic vibrations. This method has a potential to be an economical method for low volume manufacturing of thermoplastic polymer or metal sheet.

CONTROLLING THE POSITIONING 3D ROTATIONAL PIEZOELECTRIC DEFLECTOR USING ERF: AN EXPERIMENTAL STUDY

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The paper presents the design and study the effect of electrorheological fluids (ERF) on the 3 Dimensional Rotational Piezoelectric Deflector (3D RPD) as a positioning controlling mechanism. The 3D RPD has been widely studied. Due to inertia forces acting on the 3D RPD, a high precision positioning is difficult to obtain. The hemispherical body of the 3D RPD slips when controlling the position, as a result, a precise angular position is difficult to obtain. In this paper, a novel form of controlling the 3D RPD using ERF was introduced. The article presented an experimental study by using shear forces created by ERF as a controlling medium for the 3D RPD. A review of the characteristics ERF has made it one of the most applicable positions controlling media for the 3D RPD. The experimental results presented the torque performance of the 3D RPD without the application of the ERF and when ERF is applied. The experimental results presented in this research measured and verified the precision positioning of 3D RPD when ERF is applied and without ERF application. The results presented an improvement of the step resolution of the 3D RPD of 85% when ERF was applied.

ANALYSIS OF MAGNETIC INDUCTANCE, COIL CURRENT AND LEVITATING SPHERE DISPLACEMENT RECORDED DURING STABILIZATION EXPERIMENTS

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The Active Magnetic Levitation laboratory test-rig was extended by the magnetic field sensor to perform measurements in the space between electromagnet and the levitating sphere. The data fusion of displacement, magnetic flux and coil current sensors was used to study dependencies during the object's start-up, stable levitation and under oscillations. The non-linear and surjective characteristics of the magnetic inductance versus object displacement and versus coil current was obtained. The experimental data is illustrated by time domain diagrams. The analysed data and obtained characteristics are presented.

SESSION 8
BIOMECHANICS, BIOMEDICAL AND REHABILITATION ENGINEERING

COMPARISON OF IDENTIFIED AND SIMSCAPE MODEL OF HUMAN LEG MOTION

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This article describes the study on simulation model of exoskeleton robot based on real dataset acquired through human gait dynamic identification. Analysis of kinematic chain with emphasis on proper mapping of joints movement regarding to swing phase of gait has been conducted. Simulation model of proposed conceptual mechanism was developed using MATLAB SimScape MultiBody. The results of simulation studies were compared with the experimental one. Developed model is the starting point for further research on automatic exoskeleton and bipedal robot.

BIOMECHANICAL MARKERS OF IMPAIRED MOTOR COORDINATION

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This study is devoted to movement analysis from a biomechanical perspective to evaluate coordination lesions. It aims to find the most characteristic biomechanical markers that would help to quantitatively evaluate impaired motor coordination without performing or supplementing clinical tests. A total of 54 (31 – multiple sclerosis (MS) and 23 – healthy (CO)) subjects performed the heel-to-shin test (HST) and correspondingly, kinematic parameters of lower extremity were measured by using six 9DOF wireless inertial sensors (IMUs). Three-dimensional data from IMUs was processed utilizing Madgwick's Attitude and Heading Reference Systems (AHRS) algorithm. MS group was compared to CO, as well as impaired body side with an intact among MS subjects. Obtained results revealed following meaningful parameters for coordination between MS and CO ($p<0.01$): motion time, range of motion (ROMs) of the ankle, knee in the sagittal plane; hip in frontal plane; variability and SD variation. Following biomechanical indices, namely ROMs of the ankle, knee in the sagittal plane; hip in frontal plane; hip in transverse plane, were used for the evaluation of MS body sides' ($p<0.01$). Latter biomechanical markers clearly describe impaired motor coordination and enables distinguishing from the sound. New information precisely explain movement quality and it is useful for the assessment of the impairment.

SESSION 9
SIGNAL AND IMAGE PROCESSING

HYPERSPECTRAL IMAGING METHODS IMPROVE RGB IMAGE SEMANTIC SEGMENTATION OF UNSTRUCTURED TERRAINS

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Terrain recognition for off-road unmanned ground vehicles driven on unstructured terrains are far complex in contrast to terrain recognition for road vehicles which are driven on structured terrains. Large number of terrain classes mixed-up in unstructured terrains make it difficult to classify using convolution neural networks based on RGB images. Partly it is attributed to lack of sufficiently annotated training data for neural network, and partly it is difficult to label such a large number of object classes which shows visual similarities. Introducing additional details about the scene with hyperspectral or multispectral cameras, the scene classification can be greatly improved for annotation of training data for neural network training. Using spectral signatures of different materials, hyperspectral imaging can detect different materials in the scene. This article discusses a method to annotate RGB images and semantic segmentation for autonomous driving on unstructured terrain applications by using hyperspectral imaging. The RGB images will be generated using same hyperspectral data cube by extracting certain spectral bands in the visible light spectrum. Using semantic segmentation network ResNet18, manually annotated training data will be compared with hyperspectral method assisted annotated data by classifying terrain scenarios.

INVESTIGATION OF POLISHING QUALITY OF OPTICAL SURFACES AT SMALL SAMPLES

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Flat elements are often used in optics. The most well-known are prisms, mirrors, and beam splitters. In order to produce high quality optical elements, the finishing process - polishing - is one of the most important processing steps. The purpose of this experiment was to determine the variation of two surface quality parameters, flat PV and waviness RMS, at different cutting rates. Blanks of optical glass BK7 were used for the experiments. Three parameters of cutting rates were changed: clamping force, polishing pad speed and polishing time. Each of these parameters had three values. At the lightest, medium and heaviest cutting rates, 6 flat surfaces were polished in each case for a total of 18 samples. The obtained measurement results were evaluated by the Shapiro-Wilk test. This is a normal distribution test that is used with a small number of tests. The smallest deviation from the flatness PV (1.3 μm) was obtained at the lowest cutting rates, when the lowest clamping force and rotation sped up. The parameters of this deviation almost doubled (up to 4.2 μm) when the polishing pad rotated at the maximum speed selected and under the maximum load. The surface waviness in RMS followed the same trend (the lowest obtained value was 0.3 mm, and maximum value was 1.2 μm). However, the obtained values increased more slowly with the cutting rates. Such variation in the results may be due to vibrations in the machining area.

ULTRA-WIDEBAND SIGNAL TRANSMISSION ACCORDING TO EUROPEAN REGULATIONS AND TYPICAL PULSES

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According to requirements of European Telecommunications Standards Institute regarding power spectral density mask a wavelet is the most promising radiated ultra-wideband (UWB) pulse. This paper discusses mathematical models as well as time and frequency analysis of the major UWB signals. Despite of narrowband systems, where the pulse shape distortion by the antenna is negligible, there is a significant waveform distortion related to radiation direction of antenna. The simulation software allowed to present several short duration pulses radiated by designed planar antenna which operates in frequency band 6-8.5 GHz. System performance can be improved by applying wavelets which are limited by a Gaussian envelope.

FACE RECOGNITION SYSTEM BASED ON A SINGLE-BOARD COMPUTER

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With state-of-the-art computing systems along with Graphical Processing Units a Deep Neural Network can be realized by training on any publicly available dataset in order to detect faces. In a real-time application, the inference of such a neural network may not require high computational power as while in the training procedure. In this paper, the authors proposed face recognition and face detection system based on a single-board computer. Several different single-board computers like Raspberry Pi, Banana Pi and Nvidia Jetson Nano were evaluated. The authors compared two different face detection algorithms. These two algorithms are Haar feature-based cascade classifier and the second one is a multitask cascaded convolutional neural network (MTCNN). As a face recognition algorithm, the authors used FaceNet, which directly learns a mapping from face images to a compact Euclidean space where distances correspond to a measure of face similarity. FaceNet outputs embeddings as feature vectors which are feed to face classification algorithm. The system is trained and tested on a proprietary database and is installed to monitor who enters the room. The system has over 97% accuracy. The goal of this paper is to convey the possibility of successfully incorporating face recognition and face detection systems in small, low-power devices.

HYPERSPECTRAL IMAGE BAND SELECTION USING POOLING

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Hyperspectral images contain hundreds of spectral bands. These bands contain abundant information and more often redundant information. This article presents an unsupervised band selection method to choose most significant spectral image bands from hyperspectral datacube which maximize the relavance and minimize redundancy. The outcome of the research can be used for two purposes. One of them is to fabricate multispectral sensor which is more effective in identifying the subjects of interest. The other purpose is to enhance computational efficiency in classification of the hyperspectral image by processing only the selected spectral bands. Proposed method is based on spectral pooling of hyperspectral data cube. Since spectral pooling methods cause information loss which reduces the discrimination of material classes. This article suggests a novel approach which can minimize the loss while improving material classes discrimination. The proposed technique uses min-max pooling together with reflectance intensity gradient of neighboring pixels of hyperspectral image in spectral data axis. Experiment results of classifying terrain hyperspectral datasets are presented to validate the consistency of image classification which contains several material classes. A comparative analysis has been conducted between max pooling, principle component analysis and the proposed min-max pooling.

INVESTIGATION OF THE INFLUENCE OF ACOUSTIC FIELD ON VAPOR PRECIPITATION OVER PLATING BATH

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The influence of acoustic field on vapor precipitation process taking place above the plating bath is analyzed in the article. Lateral exhaust hood was used to remove aerosol from open surface tank. It is shown that acoustic field generator generates sound waves with sound level of 130–140 dB at 1–4 kHz frequencies. Such acoustic field increases aerosol coagulation and its precipitation back to the liquid. This results in the reduction of aerosol concentration in the air, reduction of costs of air purification equipment and increase of its removal efficiency.

SESSION 10
AUTOMATION, MEASUREMENT, MONITORING AND DIAGNOSTIC SYSTEMS

MACHINE DIAGNOSIS BASED ON AMPLITUDE-PHASE CHARACTERISTICS, DETERMINED FROM THE EXPERIMENTAL AMPLITUDE SPECTRUM AND THE CALCULATED PHASE SPECTRUM

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In the process of diagnosing of machines, due to their universality and efficiency, vibroacoustic methods become more important. The basic signals of these methods are: time courses, amplitude and phase spectra. Time courses and amplitude spectra are often processed and used in current maintenance (diagnostic) practice. Currently, little attention is paid to phase spectra, due to the difficulties encountered in their measurement. However, as is known from the principles of automation, the phase spectrum by Bode's formulas can be calculated based on the amplitude spectrum. Therefore, having the measured amplitude spectrum and the calculated phase spectrum, one can determine the amplitude and phase characteristics of the machine adopted into the automation system. The amplitude-phase characteristics of the "closed" system determined in this way can be converted to the amplitude-phase characteristics of the "open" system, which allows to determine the phase and module reserves of the tested machine. In this situation (always difficult to determine) in the diagnosis process, the diagnostic thresholds result directly from the principles of automation: phase supply and module supply.

INVESTIGATING THE POSSIBILITY OF USING THE AMPLITUDE-PHASE CHARACTERISTICS OF THE TURBULENT GAS FLOW TO DIAGNOSE THE GAS PIPELINE LEAKAGE

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In the process of gas pipeline operation, one of the most important activities is to identify the gas leakage. The most difficult is to locate and estimate particularly small outflows. The proposed method uses a model in the form of a difference of phase shifts $\Delta\varphi(\omega)$ signals and amplitude gain $A(\omega)$. To determine the model in the form of amplitude-phase characteristics a test stand with equalizers is used. The signals from the equalizers (r1 and r2) and the signals related to the gas pipeline operation: pressure (p1, pc, p2) and mass flow rate (f1, f2) , as well as the simulated mass flow rate of leakages from valves (t1, tc, t2). For these signals their auto and cross power spectral densities are determined (Sxx, Syr, Syy, Srr, etc.) which are the basis for determining the spectral transfer function describing the relationship between these signals, which in turn is the basis for determining the amplitude-phase characteristics of the gas flow treated as a closed-loop system, and then the amplitude-phase characteristics of this open-loop system. From the open-loop system's amplitude-phase characteristic, the gain and phase margin of this flow are determined. The change of gain and phase margin may be related to changes in the value of leakage (pipeline damage).

INFLUENCE OF MAGNETORHEOLOGICAL FLUIDS THERMOSTABILITY CHARACTERISTICS ON THE DAMPING PERFORMANCE IN OSCILLATORY SYSTEMS

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In order to extend the temperature range for the use of magnetorheological fluids (MRFs) in viscous friction dampers of vibrational systems of various objects, the influence of the complex dispersed phase in its composition (ferromagnetic and ferrimagnetic particles of different morphology and magnetization) on the magnitude and stability of their characteristics under the influence of an external magnetic field is determined. MRF sample containing a small additive of nanosized needle-shaped zinc oxide iron particles in a magnetic field has the smallest change in shear resistance in the temperature range from 10 to 60°C. The process of damping the natural and forced vibrations of an object in a single-mass oscillatory system with a controlled magnetorheological damping device is investigated. The logarithmic damping decrement of natural oscillations increased by 2.5 times, the amplitude of the forced oscillations decreased by more than four times in a magnetic field.

DETERMINATION OF PARAMETERS OF SUPERCAPACITORS AS EXAMPLES OF FRACTIONAL-ORDER ELEMENTS

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A measuring system based on LTC3225 integrated circuit and ATmega128 microcontroller has been proposed. The purpose of the system is to calculate an electrical parameters of supercapacitors.

NUMERICAL ANALYSIS OF THE PECULIARITIES OF FLOW RATE ADJUSTMENT IN ARMATURE VIBRATING PUMP IN HYDRAULIC SYSTEMS APPLICATIONS

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The paper refers to the equipment for the espresso production process and the peculiarities of hydraulic systems and pump functioning. It presents a new approach in modelling and simulation of the armature vibrating pump by using Space-State modelling for describing the spool displacement and the differential twin-cylinder functioning. The objective of this paper is to investigate the level of the adjustability of the solenoid pump in various hydraulic pressure conditions. The tank- or reservoir type of coffee machine uses this type of pumps, and they are calculated and chosen for a specific flow rate and, as a result, these machines can deliver just one product at a time, thus reducing the productivity of the production process. The objective of the present research was to analyze the adjustability of a solenoid pump and offer a solution for the flow rate control for the hydraulic systems with this type of pump. The simulation results based on the State-Space model of the pump show that the adjustability of the hydraulic systems which use this type of pumps have some limitations. The type of designed system should consider these limitations, however, at the same time the dependence of the current through the inductor coil is linear and directly proportional to the pump functioning, and the output flow rate can be precisely controlled.

EXPERIMENTAL VERIFICATION OF SOLENOID VALVE NUMERICAL MODEL

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Computer Aided Engineering (CAE) is often used in modern design processes. In this method, a trustworthy model is developed and used for determination of the design behavior. The level of complexity of the model depends on the required precision on the one hand and available CPU time on the other. These are conflicting criteria and the compromise is to build a model of moderate complexity, which requires relatively low computational time. In any case, we need to verify the accuracy of the model and the best way to do so is to compare the obtained numerical data with experimental results. In this paper, the considered solenoid valve is a fast reacting type, with a specified stroke length. Two different Finite Element Method (FEM) models of the valve solenoid are described – an axisymmetric model and a full 3D one. For the sake of models validation a valve mockup has been built. Then, the experimental static characteristics of the coil attractive force vs. the valve stroke for given current intensities are compared with simulation results in to prove the accuracy and reliability of both developed models.


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