AUTOMATION 2013

March 20 - 22, 2013 - Industrial Institute for Automation and Measurements PIAP. 6 plenary papers and 81 regular papers covering five topic area. Bellow name of the sessions and title of the papers with abstracts

PLENARY SESSION

 Prof. dr hab. inż. Edward Jezierski Instytut Automatyki, Politechnika Łódzka

Impedance control – theory, implementations, applications

In modern robotics there frequently arise situations where the robot has to effectively and safely operate in different conditions, resulting from the properties of the environment. In the absence of interactions between the robot and the environment, we are talking about free movements of the robot, and then the controlled values are the position and velocity of the end-effector. However, when the robot operates in a contact with a stiff environment the control must be such that it does not damage the robot and the environment. Such control is very desirable in assembly tasks or during cooperation with human being, e.g. in social or rehabilitation robots. The static and dynamic properties of the kinematic chain of the robot must be adapted to the environment and to the control goal, as well. In this case the simplest method of control is to adjust the stiffness of the kinematic chain. A more advanced control, which is known in the literature as impedance control of the robot, is based on changing both the stiffness and the damping of the kinematic chain

Impedance is a term commonly used in electrical engineering, especially related to linear systems with sinusoidal extortions. It is a measure of relationship between the value of a sinusoidal AC voltage and the value of a current in a quasi-steady condition. The paper presents essential similarities of dynamic features of basic mechanical and electrical components, and defines the concept of impedance control of the robot in a different way than it was suggested by Hogan.

The possible ways to control the robot impedance are discussed. Particular attention is paid to the impedance control of the kinematic chain of robots that are equipped with pneumatic and electric drives. The results of own research on the two-level impedance robot control system are presented. The role of different types of sensors in the implementation of impedance control is highlighted.

In the final part of the paper some examples of impedance control of robots are reported and commented. Those applications include assembling robots, rehabilitation robots, and mobile robots.

2.

Mikko Sallinen, PhD, Tapio Heikkilä, PhD VTT Technical Research Centre of Finland

Intelligent robotics for flexible manufacturing: solutions for industrial needs

In this paper, we present technologies for intelligent robotics including sensing planning, programming by off-line and on-line by utilizing CAD information, localization, force control and inspections. Approach is to illustrate algorithmic and programmed solutions implemented into commercial products such as laser rangefinder, force sensors and industrial robots. The system is controlled by external real-time unit which enables to adjust to variations of the workobjects. Aim of the development of these technologies has been to be able to make short series or even prototype production for high quality products.

We will introduce industrial applications where developed technologies have been implemented such as localization of large workohjects, cleaning/polising of surfaces of objects and inspection of surfaces of workobjects.

3.

Zdzisław Kowalczuk, Michał Czubenko

Katedra Systemów Decyzyjnych, Wydział Elektroniki Telekomunikacji i Informatyki, Politechnika Gdańska

xEmotion - a computational model of emotions dedicated to intelligent decision-making systems

The paper presents a cybernetic approach to the task of modelling human emotions based on the psychology theories (both appraisal and somatic theories are applied). The proposed system is designed for integration into an intelligent system of decision-making - IDS. It can, for instance, be used as an application engine, as well as, a control system in autonomous unit.

Keywords: Artificial intelligence, computation model of emotions, decision-making system, fuzzy approach, intelligent system

4.

Witold Respondek, INSA de Rouen, France

Linearization of nonlinear control systems: concepts, methods, applications

We will discuss various concepts of linearization of nonlinear control systems: via change of coordinates in the state-space, via static feedback, and via dynamic precompensation. For each notion of linearization, we will give necessary and sufficient conditions for linearizability (if they exist) and provide methods to find linearizing transformations. Describing linearizable system will require some tools from differential geometry, like Lie brackets, vector distributions and their involutivity. We will introduce them and show that they appear in nonlinear control theory in a natural way. We will illustrate the presented results with the help of physical, mainly mechanical, examples.

5.

Jan Maciej Kościelny, Anna Sztyber Instytut Automatyki i Robotyki, Politechnika Warszawska

Measurements in on-line diagnosis of mechatronic devices and industrial processes

This paper concerns measurements in diagnosis of mechatronic devices and industrial plants. Real time diagnosis realized by computer diagnosis systems is considered. It is obvious that without measurements there is no possibility of diagnosis. Selection of physical quantities which should be measured is an important problem. Sensor placement for successful fault detection, isolation and identification plays crucial role in early stage of diagnosis system design.

In this paper diagnosis schemes with and without models of a system were described. Basic forms of description of relations process variables - diagnostic signals and diagnostic signals –faults were presented. Idea of diagonal diagnostic matrix as an optimal form of diagnostic relation with its limitations was discussed. From this idea follows concept of direct fault measurement, which was illustrated by examples of specialized measurement dedicated to fault detection.

Role of virtual sensors in diagnosis of industrial plants was presented. Analysis of influence of available set of measurements on diagnosis quality indicators was provided. Problem of optimal sensor placement for diagnosis was illustrated on examples of leakage detection in water distribution network and diagnosis of ventricle assist device.

6.

Laszlo T. Koczy

Szechenyi Istwan University, Budapest University of Technology and Ekonomics, Hungary

Communication and collaboration of robots using fuzzy signatures

Communication under fuzziness has a controversial presentation in the literature. While lack of exact information might lead to misunderstandings it might be also useful for compressing the information sent and thus it might be very efficient if all communicating parties posses the same background knowledge and codebook. Reconstruction of the original contents based on the latter is possible if the context is taken into consideration. Communication by observation on intention guessing of the other communicating agents in the lack of direct communication possibilities, combined with feedback by repeated observation might result in reliable communication when the agents, e.g. intelligent robots in a remote or dangerous work environment (underwater, space, mining etc. environments) need such communication for efficient collaboration. A simple example where robots arrange various types of boxes in a warehouse follow their respective reconstructed strategies suggested by the behavior of a master robot.

The algorithmic tool for modeling dynamically the observed environment that is proposed in this talk is the complex structured multidimensional descriptor introduce earlier by the author. Basic definitions, operations, the use in decision making and even rule bases will be explained with plentiful of examples.

For the robot collaboration application a special extension: the spatial situational map as a fuzzy signature with 2D or 3D geometric structure will also be introduced. The special operations of zooming in and zooming out fuzzy situational maps depending on the spatial movements of the robots will be presented. The procedure of evolving spatial maps by robot learning will be also explained. At the end some further possible applications of fuzzy signatures will be presented with examples.

SESSION I - AUTOMATION, ROBOTICS, MONITORING

7.

Jarosław Wikarek, PhD

Institute of Management Control Systems, Kielce University of Technology, Poland

Implementation of a decision support model of the supply chain management in the environment of constraint logic programming

The article presents the details of the implementation of the concept of a decision support model in the supply chain. To implement the model, the CLP (Constraint Logic Programming) framework called Eclipse was used. The novel way of constraints propagation is discussed, which for this class of problems improves significantly the efficiency of a search for a solution. The most important predicates implementing the ,model are presented and characterized. Several numerical examples are included to illustrate the implementation of the approach. **Keywords:** Supply Chain Management (SCM), Decision Support, Constraint Satisfaction Problem (CSP), Constraint Logic Programming (CLP)

8.

Paweł Sitek, PhD

Institute of Management Control Systems, Kielce University of Technology, Poland

Application of constraint logic programming to decision support for the supply chain management

Supply Chain Management (SCM) decisions can be considered at different levels of detail. At a strategic level they apply to the architecture in the supply chain, at the tactical level to transport fleet selection, selection of supply sources and distribution, and at the operational level, to the distribution of supplies and route selection. Many models of decision-making SCM have been developed. These are the linear (LP-linear programming) or mixed (MIP/MILP-Mixed Integer/Linear Integer Programming) models. These models are equipped with a smart form. Although they are well known in the OR (Operation Research) environment, they have significant drawbacks. First of all, they must support only linear constraints. For problems of larger dimensions search for solutions is long and inefficient. This paper proposes a CSP-based decision model for SCM and its implementation in the CLP (Constraint Logic Programming). In addition, it presents a novel way of constraints propagation using the structure of the problem.

Keywords: Supply Chain Management (SCM), decision support, Constraint Satisfaction Problem (CSP), Constraint Logic Programming (CLP), hybrid modeling

9.

Radosław Boroński, MSc Eng; Grzegorz Bocewicz, PhD Department of Electronics and Computer Science, Koszalin University of Technology, Poland

Indexes driven mechanism for grouped SQL queries

This paper discusses the problem of automatic minimization of a response time for a database workload by a proper choice of indexes on production systems. The main objective of our contribution is to illustrate the database queries as a group and search for good indexes for the group instead of an individual query. We present queries block relation conditions for applying the concept of grouped queries index selection. We also introduce genetic algorithm that we use in experimental test. Numerical results are presented to show quality of the recommended approach.

Keywords: index, genetic algorithm, database, grouped queries

10.

Justyna Patalas-Maliszewska, PhD; Assoc. Prof. Sławomir Kłos, PhD, DSc University of Zielona Góra, Poland

Model evaluation of the effectiveness of business processes in terms of managing knowledge workers

This article elaborates on the model of managing knowledge workers. The authors aim at analysing a effectiveness of business processes in the sale functional area in enterprises based on the research results. Specifically, likely consequences of managing knowledge workers as "sale specialist" on the effectiveness of internal business processes are studied. This was followed by a discussion on the results of the literature and empirical studies. The summary shows the directions of a further work. Keywords: knowledge workers, business processes, effectiveness

11.

Assoc. Prof. Sławomir Kłos, PhD, DSc; Justyna Patalas-Maliszewska, PhD Institute of Computer Science and Production Management, Faculty of Mechanical Engineering, University of Zielona Góra, Poland

The analyse of automation level of logistic process in small and medium enterprises

The paper presents the results of survey research of 300 Polish small and medium enterprises. The project "The prototype of e-business service platform" was realized in cooperation with MaxElectronik company as a part of "Initech" Ministry of Science and Higher Education and founded by the National Centre for Research and Development based on the contract ZPB/8/67012/IT2/10. The research was focused on the identification of business process automation level. To analyze the automation level, the following business processes are identified: sales process, logistic process, human resource management process, financial management process. The main goal of the research was analyze of possibilities time reduction of the processes by implementation SAAS system (software as a service) in the enterprise. In the article only a part of the research is presented that is concerned with the automation of logistic process in small and medium enterprises. **Keywords:** enterprise resource planning, business process, logistic process, modeling, survey research

12.

mgr inż. Jacek Pękala

Instytut Technologii Maszyn i Automatyzacji Produkcji, Politechnika Krakowska

Data completeness verification algorithm in the process of its exchange between production enterprise systems with syntax analysis included

The paper presents newest version of data completeness verification algorithm used in the process of its transformation elaborated for the information exchange between different systems in manufacturing company. Data conversion mechanism used in information flow between enterprise systems was characterized. Problems of data loss during the conversion process were described. Results of working of the program which implements the algorithm were presented.

Keywords: data completeness verification algorithm, data transformation, data exchange, syntax analysis

13.

prof. dr inż. Tadeusz Missala Przemysłowy Instytut Automatyki i Pomiarów PIAP

Incidents and Catastrophes – what they teach us

The synthetic description of two local polish catastrophes: fire in EC Żerań and railway incident on CMK are presented, as well as two nuclear catastrophes: Fukushima and Czarnobyl. The contravening of safety rules that leaded to the catastrophes is indicated. **Keywords:** safety, incidents, catastrophes, railway, power industry

14.

dr inż. Marian Wrzesień, mgr inż. Łukasz Olejnik, inż. Piotr Ryszawa Przemysłowy Instytut Automatyki i Pomiarów PIAP

IDS/IPS Systems to detect and prevent intrusions into computer networks

There were presented systems: IDS (called Intrusion Detection System) and IPS (Intrusion Prevention System). These systems are used for intrusion detection (IDS) and intrusion prevention (IPS), respectively. These technologies are implemented in the Cisco 3845 router working at the interface between the LAN and WAN network PIAP-LAN – as part of a software router. Using Cisco signatures requires a current support for the used router. Discusses the architecture of IDS and IPS systems. terms of topology, IPS systems can be divided into network solutions, including probe-based passive monitoring port connected to the switch, analyzing all packets in a network segment and inline – with the probe placed between two network segments, with no IP address and operating in transparent bridge mode transmitting all packets on the network. Both network topologies can be used to work in specific environments HIDS and NIDS architecture. Have discussed the characteristics and parameters of IDS and IPS systems. It also presents methods and tools for configuring both intrusion prevention systems.

Keywords: hacking, security, IDS, IPS, Network, Security

15. Jerzy Graffstein, PhD Institute of Aviation, New Technology Centre Department, Warsaw, Poland

Anti-collision system with radar obstacle detector

In the article the construction of anti-collision system with radar obstacle detector is presented. Cooperation between individual subsystems and devices is described in the paper. Functionality of subsequent sub-systems is discussed. Significant parameters characterising the system and its elements are presented.

Keywords: anti-collision system, collision avoidance system, avionics

16.

Prof. Jerzy Osiński, PhD Eng, DSc; Przemysław Rumianek, MSc Eng; Piotr Żach, PhD Eng Institute of Machine Design Fundamentals, Warsaw University of Technology, Poland

Monitoring of raw materials resources from end-of life vehicles

In this paper work discussed the evaluation of the composition of the waste In terms of their use as an energy source, the results of sampling fraction of light coming from the shredder of ZŁOMPOL in Tarczyn. It was found that waste from end of life vehicles can be a significant source of energy. In particular fractions containing polymer materials with a high energy value. The problem is the significant level of pollution – waste will contain, among other heavy metal.

Keywords: recycling, waste, monitoring, energy, end-of life vehicles

17.

Prof. Aleksander Jastriebow, DSc*'**, Katarzyna Piotrowska, MSc*

*Kielce University of Technology, Poland

**Kazimierz Pulaski University of Technology and Humanities in Radom, Poland

Analysis of fuzzy cognitive maps in prediction of individual household electric power consumption

This paper is devoted to the simulation analysis of application of a fuzzy cognitive map (FCM) in prediction of electric power consumption by an individual household. Fuzzy cognitive maps and multi-step supervised learning based on gradient method and real data were described. Model of the system for prediction of individual household electric power consumption was implemented on prepared software tool ISEMK (intelligent expert system based on cognitive maps). Simulation research of multi-step learning and testing of FCM were done based on real data. Chosen results of simulation were presented.

Keywords: fuzzy cognitive maps, prediction system, multi-step supervised learning, gradient method

18.

dr inż. Robert Bączyk, mgr inż. Maciej Jóźwiak

Instytut Automatyki i Inżynierii Informatycznej, Wydział Elektryczny, Politechnika Poznańska

Model and design of installation for the process of extraction and preliminary preparation of natural gas

In this paper we describe the subsequent steps of the process of extraction and preconditioning of natural gas. This paper discusses issues of the system design and its modeling. The choice of process equipment is presented. The paper presents the derivation of mathematical model of the process and the results of simulation are presented. At the end of the paper some conclusions are presented. **Keywords:** extraction and preconditioning of natural gas, pressure reduction, system design, modeling and simulation, selection of the controller parameters

19.

prof. dr hab. inż. Jerzy Osiński, mgr inż. Przemysław Rumianek, dr inż. Piotr Żach Instytut Podstaw Budowy Maszyn, Politechnika Warszawska

Automation of processes of alternative fuels production

This study considers the possibility of using waste energy; authors state that in our country wastes are the great source of energy. In the article the quantities involved and the composition of the various Polish regions were given. The problems resulting from the combustion of alternative fuels – the need for high-performance exhaust gas cleaning equipment and the most common toxic components of exhaust – also were discussed.

Keywords: waste, recycling, alternative fuels, combustion

20.

mgr inż. Maciej Cader, dr inż. Maciej Trojnacki

Przemysłowy Instytut Automatyki i Pomiarów PIAP

Analysis of the applicability of additive technology to fabrication of mobile robots construction

The article presents the research results of the mechanical properties of non-metallic materials used in additive manufacturing for the production of structural components of mobile robots. Article also concerns one of the technology, i.e., FDM for the production of reconfigurable robots construction elements. This paper also describes the methodology for the preparation of selected parts of the robot to manufacture them using FDM technology.

Keywords: additive manufacturing, production of robots elements, thermoplastic materials, extrusion

Andrzej Majcher, PhD Institute for Sustainable Technologies – National Research Institute, Radom, Poland

Automation of the process of microwave hydrothermal synthesis of nanopowders

The article presents the process of microwave hydrothermal synthesis of nanopowders automation. The essential elements of automation are: a novel reactor and its control system. The reactor has a unique design of process chamber, which used in conjunction with a batch control system allows highly efficient production of nanopowders to be obtained. The design of the reactor together with new principles of operation, structural materials, and distribution of electromagnetic field are described. The paper also presents a control system for the reactor, which allows for automatic operation in the stop-flow mode, control of process pressure, continuous monitoring of process parameters and safe operation of the device.

Keywords: automation of chemical processes, microwave hydrothermal synthesis, stop-flow mode, batch control, nanopowders

22.

Dariusz Plinta, PhD Eng, DSc

Production Engineering Department, University of Bielsko-Biała, Poland

Production management with the use of digital factory tools

Contemporary computer technologies are the basic tools of the accumulation and exchange of information in enterprises. Software of the digital factory systems is becoming more commonly used in management processes. This paper focuses on the concept of digital factory, its principles, the ways and areas of application as well as benefits for industry. **Keywords:** digital factory, computer aided management systems

23.

Andrzej Halama, Eng; Piotr Loska, MSc Eng; Piotr Szymała, MSc Eng Institute of Innovative Technologies EMAG, Katowice, Poland

Wireless control and directional navigation of a road header in drilling process

Careful observations of the global mining industry development trends, in terms of the needs and expectations of mining machinery and equipment, led the Institute of Innovative Technologies EMAG to undertake work to introduce innovative solutions in the new diagnostics and control system for road headers. In this paper we will discuss new wireless control system and extensive diagnostics of the machine, based on the SKD-2M system, with an innovative solution for directional navigation of excavation axis of road header. Solution used in the SKD-2M with technologies for monitoring stroke fore and guiding roadheader, will increase the capacity of the machine utilization, by increasing the degree of automation and prediction parameters of drill machine corresponding to the momentary conditions of mining. System will also limit damage resulting from improper use, reduce energy consumption in mining process, improve safety and will affect positively the efficiency of roadways drill, which is important, in relation to prospects the application of the system to eastern markets. **Keywords:** roadheader, control, wireless, drilling, diagnostic system

24.

Prof. Bogdan Broel-Plater, PhD Eng, DSc; Prof. Krzysztof Jaroszewski, PhD Eng, DSc Faculty of Electrical Engineering, West Pomeranian University of Technology, Szczecin

Concept of tool condition diagnostic system for micro machining

The paper deals with part of diagnostic system for micro milling machine. The short description of designed and set in motion micro machine for milling is presented. The machine supervisory control system, based on artificial intelligence diagnostic system is described. Conducted during design process, deliberations about types and structures of the neural nets and form and source of the signals are presented. The last part of the paper includes conclusions and final remarks.

Keywords: micro milling machine, diagnostic system, neural networks

25.

Grzegorz Redlarski, DSc, PhD Eng; Jacek Jaworski, MSc Eng; Piotr Mateusz Tojza, MSc Eng Electrical and Control Engineering Faculty, Gdańsk University of Technology, Poland

An application supporting the educational process of the respiratory system obstructive diseases detection

The paper presents a description of functioning of a platform supporting the detection of obstructive diseases in the respiratory system education process. A 16-parameter model of the respiratory system simulated in the MATLAB/Simulink environment was set in the role of the tested patient. It has been linked to the control layer, developed in the LabVIEW environment, using the SIT library (Simulation Interface Toolkit). This layer is responsible for the modification of the model's parameters and the generation of the results of the respiratory impedance measurements using forced oscillation method. The application is a solution that provides a lot of flexibility in the education of students studying courses related to biomedical engineering and health sciences, and can easily be implemented to work as a problem-oriented e-learning solution.

Keywords: computer application, obstructive diseases, lungs

26.

Piotr Garbacz, MSc; Wojciech Mizak, MSc Institute for Sustainable Technologies – National Research Institute, Radom, Poland

A novel approach for automation of stereo camera calibration process

The problem of stereo camera calibration has been studied for over many years by numerous researchers. A crucial task in this process is to discover the transformation between 3D world coordinates and 2D pixel image coordinates of image. The growth of the number of differ-

ent applications of stereovision systems has led to specialization of developed calibrations algorithms. Nowadays, various calibration objects and self-calibration techniques are used. This paper presents a unique automatic calibration system for a stereovision system for inspection of specimen surface under fatigue tests. In order to allow analysis of surface in both a micro and macro scale, the system has been equipped with cameras with motorized focus and zoom lenses. The proposed calibration system is based on mechatronic framework which allows the use of a set of 2D plane calibration targets with varying size of region of interest. Such a solution allows automation of calibration process and guarantees repeatability of results with an assumed error.

Keywords: stereovision, calibration, fatigue monitoring

27.

Mirosław Neska, MSc; Andrzej Majcher, PhD; Jan Przybylski, PhD Institute for Sustainable Technologies – National Research Institute, Radom, Poland

Control system of a multifunctional tester for electronically protected documents

Introduction of electronic protection into documents makes it necessary for the documents to undergo multicriteria tests, and results in a growing need for the development of specialized testers, an example of which can be constituted by a multifunctional testing device. The article presents a control system for a tester which realises the following tests: stamping, writing in, abrasion in an electronically protected document. The authors also describe the structure of hardware used and the structure of tests the devices can realise. Additionally, behavioural analysis with the use of UML activity diagrams is presented as well as technical parameters of the control system developed and its possible areas of application in a series of testing devices.

Keywords: product testing, RFID systems, document protection, impact load, abrasive load, UML activity diagram

28.

prof. dr hab. inż. Aleksander Olejnik, dr inż. Krzysztof Falkowski, dr inż. Maciej Henzel Wojskowa Akademia Techniczna, Warszawa

Magnetic Suspension Workroom of Aircraft Engine Laboratory in Military University of Technology

In the paper are presented results of realization in Military University of Technology of The Innovative Economy Programme. The main goal of the project is organization of the Aircraft Engines Research Laboratory. There are the Magnetic Suspension Workroom. There are realized the unique in Poland and European Union research investigations under passive and active magnetic suspensions, their optimization, control, supplying, etc. The Engine Laboratory will find solutions of operation problems, reliability of constructions. It makes possible modernization of investigated constructions and designing practical of new applications.

Keywords: magnetic suspension, aircraft engine

29.

Józef Szaban, PhD Eng; Ireneusz Wawrzyński, MSc Eng Emerson Process Management Power and Water Solution, Warsaw, Poland

Water management at CCGT unit

This paper discusses a water management optimization of cooling towers. Description of a problem solution as well as its industrial application is included. The used software belongs to Emerson's SmartProcess products. It has been applied to two power plants as a part of the Ovation DCS (distributed control system).

Keywords: optimization, Ovation, SmartProcess, power plant, cooling towers, Combined Cycle Gas Turbine

SESSION II - MOBILE ROBOTS SOFTWARE, EQUIPMENT AND APPLICATION

30.

Szczepan Paszkiel, PhD Eng Opole University of Technology, Poland

The population modeling of neuronal cell fractions for the use of controlling a mobile robot

The population modeling of neuronal cell fractions for the use of controlling a mobile robot is presented in this article. Present models of neuronal cells are compared to describe the problem. Population models which represent fractions (pyramidal cells and interneurons) are compared as well. A population approach for controlling a mobile robot is chosen as a result of this analysis. The process of modeling cell fractions definitely facilitates in laboratorial conditions the process of controlling when the concept of brain computer interfaces is implemented.

Keywords: modeling, neuronal cells, a mobile robot

31.

Piotr Trojanek, MSc Eng; Maciej Stefańczyk, MSc Eng; Tomasz Kornuta, MSc Eng Institute of Control and Computation Engineering, Warsaw University of Technology, Poland

Modelling of data flow in component-based robot perception systems

The paper presents results of research on the development of robot perception systems. On the basis of the selected exemplary system, typical problems occurring during design of such systems were indicated. Those problems motivated the work set out to formalize the data flow by the use of metamodelling – the key technology of model-driven engineering. The obtained metamodel facilitates development of such systems and enables further creation of tools for models' editing, validation and automatic generation of relevant source code skeletons. Additionally, requirements for a robot perception systems runtime environment were identified and compared with existing component-based robot software frameworks.

Keywords: robot, control system, perception, data flow, metamodel, model-driven engineering, component-based systems

32.

Grzegorz Redlarski, DSc Eng; Aleksander Pałkowski, MSc Eng; Dominik Ambroziak, MSc Eng Faculty of Electrical and Control Engineering, Gdańsk University of Technology, Poland

Optical glyphs based localization and identification system

Optical glyphs are non-complex graphic signs that contain encoded information. By utilizing techniques of image processing and pattern recognition, it is possible to implement an effective global system for autonomous vehicle navigation. The simplicity of the system allows it to be easily implemented, without having to rebuild monitoring equipment. It also provides the possibility to use, during the design process, of widely available *open source* software. This paper presents an algorithm, whose task is to find the symbols of objects contained in the database and determine their position and orientation in the global coordinate system of the camera. The speed and reliability of the system has been demonstrated on the basis of experimental studies using real mobile robots.

Keywords: camera-based tracking, image processing, mobile robot navigation, optical glyphs, pattern recognition

33.

Benedykt Jaworski, Dominik Bilicki, Dominik Belter, PhD Institute of Control and Information Engineering, Poznań University of Technology, Poland

Measurement fusion method for indoor localization of a walking robot

The article presents visual localization system for walking robots. The method uses two independent visual procedures to determine position and orientation of the robot's body: Parallel Tracking and Mapping (PTAM) and the procedure which returns position of the camera in relation to the known marker. The heuristicbased data fusion method is proposed. The method takes into account properties of both modules to estimate real position of the robot. The properties of the method are presented using ground truth data from experiment on the robotic arm.

Keywords: visual localization system, data fusion, mobile robot

34.

Karol Majek*, Michał Pełka*, dr inż. Janusz Będkowski*, mgr inż. Maciej Cader**, prof. dr hab. inż. Andrzej Masłowski* *Instytut Automatyki i Robotyki, Politechnika Warszawska

**Przemysłowy Instytut Automatyki i Pomiarów PIAP w Warszawie

Project of autonomous inspection robot

In the article the project of autonomous inspection robot is shown. Instead of commercial applications, proposed approach with relatively lower prize offer satisfactory functionality. Proposed approach is based on State of the Art mobile platform equipped with developed 3D laser measurement system 3D. Laser 3D is developed based on Fused Deposition Modeling FDM technology. Autonomous mobile robot is using IMU (Inertial Measurement Unit) wit GPS (Global Positioning System) to navigate in outdoor environment. The approach offers 3D cloud of points augmented by normal vectors looking form user point of view. Normal vectors are computed using PCA (Principal Component Analysis) method in on-line fashion. The proof of concept was demonstrated based on the experiment in the real environment. As a result the modern research platform is developed, which can be used for further inspection systems' analysis. **Keywords:** inspection robot, laser measurement 3D system, PCA (Principal Component Analysis)

35.

Krzysztof Walas, PhD

Institute of Control and Information Engineering, Poznań University of Technology, Poland

Foot design for a hexapod walking robot

This article describes the process of development of the robotic foot for the six-legged walking robot Messor. In order to allow the robot to negotiate uneven surfaces and to walk on a compliant ground, the foot includes the sensing device which provides information on contact forces between the foot and the ground. At first, the foot with single-axis force measurement unit is described. Next, design of the tri-axial sensing device is shown. Knowledge gathered during development of the single-axis device was transferred to build a new foot with extended capabilities. In the article description of the manufactured real devices is given. **Keywords:** walking robot, hexapod, foot, design

36.

Marta Rostkowska, BEng; Michał Topolski, BEng; Piotr Skrzypczyński, DSc, PhD Institute of Control and Information Engineering, Poznań University of Technology, Poland

A modular mobile robot for multi-robot applications

This paper presents the process of designing and constructing a desktop-size mobile robot aimed at multi-robot applications. We present the mechanical structure, the electronics and the software, focusing on the modularity concept, which determines the educational values of the entire design. The decision process underlying the design is presented in details: choosing motors, sensors and crucial electronics components, implementing communication buses, and construction of the additional modules. Possible multi-robot applications of this design are outlined at the end.

Keywords: mobile robot, microcontroller, multi-robot systems, odometry, communication

37.

Mikołaj Wasielica, MSc; Marek Wąsik, MSc; Piotr Skrzypczyński, DSc, PhD Institute of Control and Information Engineering, Poznań University of Technology, Poland

Design and applications of a miniature anthropomorphic robot

This paper presents the prototype of a miniature anthropomorphic robot. This robot was designed as a low-cost hardware platform for implementing basic skills of a humanoid: efficient gaits, balance maintenance, effective programming of complicated motion sequences. We provide a detailed description of the mechanical and electronic design, present the basic software modules, and demonstrate some applications of this robot. The prototype was tested extensively participating in numerous competitions and live performances. **Keywords:** anthropomorphic robot, biped walking, servomotor, microcontroller, robot programming, motion capture

38.

Janusz Będkowski, PhD Eng

Institute of Automatic Control and Robotics, Warsaw University of Technology, Poland

Qualitative Spatio-Temporal Representation and Reasoning for robotic applications

This paper discusses the methodology of Qualitative Spatio-Temporal Representation and Reasoning (QSTRR) for robotic applications. The goal is to develop reasoning mechanism that will allow modelling the environment and performing spatiotemporal decisions. A new approach is related to environment modelling based on robot's perception, therefore new concepts (spatial entities) are obtained automatically, and then used in reasoning. This paper presents the results of the three experiments. Each experiment focuses on different robotic applications, such as mobile spatial assistive intelligence for spatial design, spatial design used for robotic arm integration with the environment and supervision of a teleoperated robot. Each of the experiments is considered as the proof of concept of the proposed methodology. Thus, it can be efficiently used for developing sophisticated robotic application where human-robot interaction and integration are considered as an important goal.

Keywords: qualitative reasoning, mobile robot, industrial robot, semantic modeling

39.

Wojciech Biegański, MSc Eng; prof. Andrzej Kasiński, DSc, PhD Eng

Institute of Control and Information Engineering, Poznań University of Technology, Poland

Initial tests of a trinocular vision system for the underwater exploration

This paper describes the basic idea of operation and assumptions of the Trinocular Vision System (TVS) designed to support the underwater exploration with the use of the autonomous vehicle. The paper characterizes the optical proper-ties of the inland water environment, and the process of the image formation in that environment. The paper presents the aim of the image fusion and also the design process of a multimodal vision system, i.e. the selection of its components confirmed by prior research in the context of underwater operation. **Keywords:** image fusion, underwater vision system, multimodal vision system, AUV

40.

Bartosz Brzozowski, MSc; Przemysław Kordowski, Eng; Zdzisław Rochala, PhD; Konrad Wojtowicz, Lt MSc Faculty of Mechatronics and Aerospace, Military University of Technology, Warsaw, Poland

Project of a miniature 3D LIDAR for VTOL UAVs

An avionics module, based on a commercially available LIDAR, which perform scans in a single plane, was developed. The module enables to obtain three dimensional point map of the area around aircraft. Spherical coordinates of each point are forwarded to the main avionics computer, where final computations are done accordingly to the implemented algorithm. Received data can be used to determine areas dangerous for flight, specify flight trajectory that avoid obstacles or just for visualization of the aircraft surroundings. In this article designed structure of the module was presented as well as developed operational algorithm. Finally, obtained measurement results were discussed and usage constraints consequential to a specific structure of the module were presented. **Keywords:** LIDAR, UAV, avionics module, anti-collision system

41.

Prof. Aleksander Olejnik, PhD, DSc*; Robert Rogólski, PhD*; Tomasz Mosiej, Eng*; Grzegorz Chmaj, PhD**

*Department of Mechatronics and Aeronautics, Institute of Aviation Technology, WAT Military University of Technology, Poland

**AGH University of Science and Technology, Department of Robotics and Mechatronics, Poland

MP2128^g autopilot integration and verification for stabilization and control of mini-UAV aircraft in autonomous flight

The article describes the MP2128^g autopilot integration issues regarding light small UAV aircraft. The paper contains shortened autopilot capabilities and installation description in reference to stabilization and autonomous flight accomplishment. In addition to air segment, also ground control station software description is included. The article contains feedback loop adjustment process for several phases of flight. As the study result can be found report of the conducted autonomous flight over preprogrammed route. The study confirms possibility of use of tested avionic equipment for reconnaissance with application of mini-UAV. **Keywords:** UAV, autopilot, flight control system

SESSION III - DESIGN AND INTEGRATION METHODS FOR SYSTEMS

42.

Full Prof. Mikołaj Busłowicz, PhD Eng*; Adam Makarewicz, MSc Eng**

*Białystok University of Technology, Faculty of Electrical Engineering, Poland

**Doctoral Study, Faculty of Electrical Engineering, Białystok University of Technology, Poland

Analysis of chaotic dynamics of the Ikeda system of fractional order

The paper considers the Ikeda chaotic system of fractional order. Using numerical simulations effects of fractional order, delay and parameters on chaotic behaviour of the system is investigated. Simulations are performed using Ninteger Fractional Control Toolbox for MATLAB

Keywords: chaos, fractional system, Ikeda system, time-delay

43.

Full Prof. Mikołaj Busłowicz, PhD Eng

Faculty of Electrical Engineering, Białystok University of Technology, Poland

Stability of fractional discrete-time linear scalar systems with one delay

In the paper the problems of practical stability and asymptotic stability of fractional discrete-time linear scalar systems with one constant delay are addressed. Standard and positive systems are considered. New conditions for practical stability and for asymptotic stability are established.

Keywords: linear system, discrete-time, scalar, fractional, delay, stability

44.

Łukasz Sajewski, PhD Eng Faculty of Electrical Engineering, Białystok University of Technology, Poland

Positive minimal realizations of continuous-discrete linear systems with transfer function with separable denominator or numerator

The positive minimal realization problem for continuous-discrete linear single-input, single-output (SISO) systems is formulated. Two special case of the continuous-discrete systems are analyzed. Method based on the state variable diagram for finding positive minimal realizations of given proper transfer functions is proposed. Sufficient conditions for the existence of positive minimal realizations of given proper transfer functions with separable numerator or transfer functions with separable denominator are established. Two procedures for computation of positive minimal realizations are proposed and illustrated by numerical examples.

Keywords: continuous-discrete, minimal, positive, realization, existence, computation

45.

Andrzej Ruszewski, PhD

Faculty of Electrical Engineering, Białystok University of Technology, Poland

Stability conditions of fractional discrete-time scalar systems with pure delay

In the paper the problem of stability of fractional discrete-time linear scalar systems with state space pure delay is considered. Using the classical D-decomposition method, the necessary and sufficient condition for practical stability as well as the sufficient condition for asymptotic stability are given.

Keywords: asymptotic stability, practical stability, fractional order, discrete-time linear system

46.

dr inż. Mirosław Gajer

AGH Akademia Górniczo-Hutnicza, Katedra Informatyki Stosowanej

Optimization of electrical energetic systems with the use of evolutionary computations

The topic of the paper is about the optimization of the mode of work of electrical energetic systems. This kind of optimization is considered as multi-objective optimization. The main criteria that are taken under account are the amount of fuel burnt in energetic blocks in the time unit and total thermal losses in power transmission lines. In the paper in order to solve such multi-objective optimization problem the computational technique base on the use of evolutionary algorithms was implemented.

Keywords: electrical energetic systems, multi-objective optimization, evolutionary computations

47.

mgr inż. Amadeusz Nowak, mgr inż. Roman Regulski Zakład Urządzeń Mechatronicznych, Politechnika Poznańska

Vehicle parking control with fuzzy logic

The article concerns the automatic parking of a vehicle problem and control that uses fuzzy logic rules. It presents the essence of the issue and used simplifications. The simulation in MATLAB/Simulink program and visualization of the process were elaborated, allowing to execute experiments concerning parking and fuzzy control. Rule base of the fuzzy logic controller was automatically generated with numerical data, based on the Wang+ algorithm. Additional experiments were made to check influence of changing controller structure on parking quality. It is designed educational exercise, based on the controller and LEGO Mindstorms set. **Keywords:** fuzzy logic, parking, MATLAB, Simulink, LEGO Mindstorms

48.

Tadeusz Kaczorek, PhD Eng, DSc

Faculty of Electrical Engineering, Bialystok University of Technology, Poland

Approximation of positive stable continuous-time linear systems by positive stable discrete-time systems

The positive asymptotically stable continuous-time linear systems are approximated by positive asymptotically stable discrete-time linear systems by the use of Pade type approximation. It is shown that the approximation preserves the positivity and asymptotic stability of the

systems. The stabilization problem of positive unstable continuous-time and corresponding discrete-time linear systems by state-feedbacks is also addressed.

Keywords: approximation, continuous-time, discrete-time, linear positive system, stability

49.

Wojciech Trzasko, PhD Eng Faculty of Electrical Engineering, Białystok University of Technology, Poland

Reachability and controllability of positive fractional-order discrete-time systems

In the paper the positive linear discrete-time noncommensurate fractional-order systems described by the state equations are considered. Definition and necessary and sufficient conditions for the positivity, reachability and controllability to zero are given and proven. The considerations are illustrated by a numerical example.

Keywords: non-commensurate fractional-order, positive, discrete-time systems, reachability, controllability

50.

Rafał Kociszewski, PhD

Faculty of Electrical Engineering, Białystok University of Technology, Poland

Observability of linear discrete-time systems with different fractional orders

In the paper the observability problem for the linear discrete-time positive systems with different fractional orders is presented. Necessary and sufficient conditions for observability of this class of dynamical systems are given. A method for computing the initial state is proposed. Considerations are illustrated by theoretical example. Numerical calculations have been performed in the MATLAB program environment. **Keywords:** fractional, positive, discrete-time, system, observability

51.

Rafał Kociszewski, PhD

Faculty of Electrical Engineering, Białystok University of Technology, Poland

Observer synthesis for linear discrete-time systems with different fractional orders

The paper is devoted to observer synthesis for linear discrete-time positive fractional systems with different fractional orders. The problem of finding a nonnegative gain matrix of the observer such that the observer is positive and asymptotically stable is formulated and solved by the use of linear programming (LP) and linear matrix inequality (LMI) methods. The proposed approach to the observer synthesis is illustrated by theoretical example. Numerical calculations and simulations have been performed in the MATLAB/Simulink program environment.

Keywords: fractional, positive, discrete-time, system, observer, linear programming, linear matrix inequality

52.

dr inż. Mariusz Piotr Hetmańczyk

Instytut Automatyzacji Procesów Technologicznych i Zintegrowanych Systemów Wytwarzania, Wydział Mechaniczny Technologiczny, Politechnika Śląska

The prediction oriented diagnostic vectors

The paper contains a proposal for a formalized notation of the current states of selected process parameters, in the form of the prediction oriented diagnostic vectors (PUWD). The author presents also an analysis and the recording requirements in case of described vectors, with particular emphasis on the nature of the co-operation of complex assemblies of machines, focusing on the ability to trace the structure of the dependencies (physical and informational) between elements. The vector contains a description of the quantitative and qualitative consideration of the analyzed subsystems of technical agents. The form and contents of diagnostic data (as a basis for prediction goals) is shown on the example of an industrial distributed drives environment.

Keywords: diagnosis, monitoring, states prediction, distributed systems, diagnostic vectors

53.

dr inż. Mariusz Piotr Hetmańczyk

Instytut Automatyzacji Procesów Technologicznych i Zintegrowanych Systemów Wytwarzania, Wydział Mechaniczny Technologiczny, Politechnika Śląska

An application of the FMECA methodology to build of structures of mechatronic systems oriented on states prediction

The paper presents an evaluation of the FMECA methodology used to analysis of a course of the work of distributed industrial systems, where exist the possibility of a definition of a uniform structure of relationships between the current states, and effects caused by them. Described manner of utilization of the FMECA methodology, in case of selected criterions, differs from the traditional consideration of the method. It allows, however, to evaluation of a predictive model, based on expert knowledge in relation to the already developed applications. In addition, the proposed approach is element consistent with presented by the author Computer Control and Diagnostics System of Distributed Drives, which is the foundation for the development of the described method.

Keywords: diagnosis, monitoring, states prediction, distributed systems, FMECA methodology

SESSION IV - AUTOMATION AND ROBOTIC EQUIPMENT

54. dr inż. Tomasz Winiarski, Konrad Banachowicz Instytut Automatyki i Informatyki Stosowanej, Politechnika Warszawska

The acquisition system of general force of contact between robotic manipulator and the environment

The article considers an acquisition system of general force measured between manipulator's end-effector and the environment using six axis force transducer mounted in manipulator wrist and additional inertial measurement unit. The proposed solution significantly improves the initial force measurement by reducing the influence of tool weight, gravitational force and inertial force. It can be used to develop a cheap industrial robot to a service robot test platform.

Keywords: robot, manipulator, inertial measurement unit, general force

55.

Jakub Szałatkiewicz, Roman Szewczyk, Eugeniusz Budny, Tadeusz Missala, Wojciech Winiarski Industrial Research Institute for Automation and Measurements

Determination of PID control parameters of plasmatron plasma reactor

The paper presents determination of PID controller parameters for application of plasmatron powered plasma reactor designed and build in Industrial Research Institute for Automation and Measurements. Plasma reactor is the key element of the test setup, designed to research, processing and recovery of metals from waste of electric and electronic equipment, focusing on electronic printed circuit boards. Experiment was carried out with power of 36 kW. In experiment two temperatures were measured in two points of the reactor chamber, allowing verification of thermal response. Basing on identification of thermal parameters of the plasma reactor carried out in previous paper [7], the PID controller was chosen, as suitable to control second order inertia object. Parameters of used PID controlled were determined using MATLAB-Simulink toolbox. Calculated PID model was utilized for plasma reactor parameters control, allowing examination of energy saving by reducing of plasmatrons power, and stabilization of process parameters. **Keywords:** PID, recycling, electronic waste utilization, plasma technology

56.

Tomasz Bojko, PhD Eng; Maciej Grzanka, Eng; Wojciech Rejmer, MSc Eng TB-Automation, Kraków

A novel type of piezoactuated micropositioning system - simulation and experimental tests

A study of the novel type of piezoelectric actuated micropositioning system for pick-and-place type applications is reported. The objective of this work is to present mechanical design of micropositioning system, simulation test of main mechanical parts and to verify simulation test by real experiment. It also mentions the study of selected aspects of actuation system based on flexible joints and piezostack actuators, FEA simulations of flexible joints, connections and interactions between mechanical parts, and modular design of micropositioning system is also mentioned. Finally experimental results of individual mechanical modules are reported. **Keywords:** micropositioner, piezoactuator, flexures, positioning system, FEA simulations

57.

dr inż. Tomasz Bakoń

Zakład Gospodarki Energetycznej, Szkoła Główna Gospodarstwa Wiejskiego

Modeling of separate grids with possibility of phase voltage waveforms and faults shaping

This paper presents universal laboratory model of separated grid powered by IGBT converter. Constructed laboratory setup allows free shaping of phases voltage waveforms, dynamic grid and load reconfiguration also short-circuits, faults and errors modeling. **Keywords:** separate grid, modeling, fault, converters

58.

mgr inż. Piotr Kardasz Wydział Elektryczny, Politechnika Białostocka

Reconstruction of noisy sinusoidal signal based on limited number of samples using an evolutionary algorithm

The paper presents an experiment involving the use of an evolutionary algorithm to reconstruct the sine wave signal with white noise added based on limited number of its random samples. The experimental results show that such an algorithm is able to identify the test signal with a high accuracy even when the noise level is high (SNR = 0 dB). The behavior of the algorithm used is examined, the convergence and accuracy of results are tested, depending on the parameters of the reconstructed signal. The directions for further research are outlined. **Keywords:** evolutionary algorithm, signal reconstruction

59.

Roman Trochimczuk, PhD Eng

Faculty of Mechanical Engineering, Bialystok University of Technology, Poland

Mechatronic modeling of telemanipulator system for minimally invasive surgery

This work proposes a mechatronic model of surgical robot which allows the analysis of relations and flows (of the mass, energy and information) between components as well as specification of their hierarchy in the system. The processing of information and its transmission in the system basis in regard to mechatronic surgical telemanipulator will be also discussed.

Keywords: mechatronic modeling, telemanipulator, robot surgery, minimally invasive surgery, transmission of information

60.

Prof. Waldemar Uździcki, PhD*; Remigiusz Aksentowicz, MSc*; Paweł Bachman, MSc*; Marcin Chciuk, MSc*; Jan Pavlovkin, PhD Eng**

*University of Zielona Góra, Poland

**University of Matej Bel, Banská Bystrica, Slovakia

Improving the energy efficiency of pneumatic extraction systems by automating the process of air flow rate adjustment

An important problem and a fundamental flaw associated with the operation of pneumatic extraction systems is their high energy consumption. One way to reduce energy consumption is to use a frequency converter to adjust the speed of the fan motor. This paper presents an automatic control system based on feedback from the flow velocity of air in the main pipe system. The solution effectively helps improve the energy efficiency, that is, reduces energy consumption.

Keywords: energy efficiency, pneumatic hood installation, feedback, air flow velocity

61. dr inż. Piotr Gawłowicz, mgr inż. Paweł Bachman, mgr Marcin Chciuk

Wydział Mechaniczny, Uniwersytet Zielonogórski

Reduction of hysteresis loop in the magnetorheological brakes by an appropriate choice of magnetic circuit materials of construction

In this article magnetorheological brakes undesirable properties associated with the phenomenon of magnetic hysteresis are described. Characteristics made from steel and transformer plates brakes are compared. On the end is shown that the brakes, which magnetic circuit from transformer plates is made less hysteresis have.

Keywords: magnetorheological brakes, magnetorheological fluid, haptic device, hysteresis

62.

Marcin Jamro, MSc; Bartosz Trybus, PhD

Rzeszów University of Technology, Department of Informatics and Control, Poland

Configurable Operator Interface for CPDev Environment

The paper presents a graphical extension to the IEC 61131-3 CPDev programming environment. The extension called CPVis provides development tools and runtime components to create an operator interface for control software. CPVis editor is used to design display pages. Graphic objects are selected from libraries and represent visual controls on the display. The target operator panel runs CPVis graphics runtime to process the display configuration. Update of the display is done by reflecting changes of variable values processed by CPDev virtual machine.

Keywords: operator interface, HMI, control systems, visualization

63.

dr hab. inż. Zbigniew Świder, prof. dr hab. inż. Leszek Trybus Katedra Informatyki i Automatyki, Politechnika Rzeszowska

Extended PID algorithm for industrial temperature controller with self-tuning

PID controller with set-point weighting allows to correct set-point response without affecting disturbance response. This is done by means of a factor β in the difference β *W*–*Y* which determines proportional action of the controller (*W* denotes set-point and *Y*, plant output). By decreasing β one can reduce or even eliminate overshoot of set-point response. It turns out however, that for relay tuning with typical gain and phase margins the overshoot may remain even for β =0. So the paper presents an extension to the set-point weighting approach to eliminate the overshoot completely. Here, in addition to the original modification of proportional action, also the integral action is determined not by the error *E* but by the difference *W*_{*f*}-*W*, with *W*_{*f*} generated by a lead-lag filter. **Keywords:** PID control, set-point weighting, relay self-tuning

Reywords. PiD control, set-point weighting, relay sen-tuning

64. inż. Sebastian Wójcicki, dr inż. Tomasz Rutkowski

Wydział Elektrotechniki i Automatyki, Politechnika Gdańska

Project and implementation of a universal programmable controller

The paper describes project and implementation of a low-cost but functional and universal programmable logic controller PLC in compact case and dedicated utility application for that PLC, which allow user to its effective programming. The main central processing unit of presented controller is based on 32 bit ARM STMicroelectronics microcontroller. Presented PLC controller is equipped with standard peripherals, which are used in industrial technological installations: digital I/O, analog I/O, encoder interface. The controller may communicate with PC computers or other devices via USB and RS-232 interfaces and CAN bus. Presented in article utility application is developed in C# language for Windows platform. Utility application allow user to: develop control programs with graphical programming language FBD, controller programming, simple diagnosis and variables monitoring during running controller (on-line mode). In order to track the values of selected variables the built-in LCD display may be used by user. Additionally, using the buttons available on the controller case the user, for example, may perform "tuning" of the selected parameters of running control program. **Keywords:** PLC, microcontroller, industrial control systems

65. Paweł Sokólski, MSc Eng SPZP CORRPOL, Gdańsk, Poland

Idea of adaptive control implementation in anti-corrosion protection systems of underground steel structures

The paper discusses the use of modern control methods such as adaptive regulator in anti-corrosion protection systems. Based on available market solutions in the field of cathodic protection, an "intelligent" control system, which increases protection effectiveness, while minimalizing the currents flowing in the system, is proposed.

Keywords: adaptive control, identification, microcontroller, anticorrosion protection

66.

Paweł Sokólski, MSc Eng*; Tomasz Rutkowski, PhD Eng**

*SPZP CORRPOL, Gdańsk, Poland

**Gdańsk University of Technology, Poland

Hybrid of neural networks and hidden Markov models as a modern approach to speech recognition systems

The aim of this paper is to present a hybrid algorithm that combines the advantages of artificial neural networks and hidden Markov models in speech recognition for control purposes. The scope of the paper includes review of currently used solutions, description and analysis of implementation of selected artificial neural network (NN) structures and hidden Markov models (HMM). The main part of the paper consists of a description of development and implementation of a hybrid algorithm of speech recognition using NN and HMM and presentation of verification of correctness results.

Keywords: artificial neural networks, hidden Markov models, MFCC, speech recognition, control

67.

prof. dr hab. inż. Andrzej Milecki*, mgr inż. Paweł Bachman**

*Wydział Budowy Maszyn i Zarządzania, Politechnika Poznańska

**Wydział Mechaniczny, Uniwersytet Zielonogórski

Admittance and impedance control in electrohydraulic drive with haptic joystick control system

This paper describes the possibility of controlling the electrohydraulic drive by "haptic" joystick in the admitance and impedance system. The results of tests, performed using the non-linear model and a real electrohydraulic drive, are presented. Also examined, as the control process affected introduction of additional haptic touch. For this purpose, the system without feedback and with haptic feedback was tested.

Keywords: haptic devices, electrohydraulic drives, admittance and impedance control, magnetorheological fluid, modeling

68.

Dominik Rybarczyk, MSc Eng*; Piotr Owczarek, MSc Eng*; Jarosław Gośliński, MSc Eng**

*Faculty of Mechanical Engineering and Management, Poznań University of Technology, Poland

**Faculty of Electrical Engineering, Poznań University of Technology, Poland

Application of Hardware in the Loop technology for testing servo drives with synchronous motor

The article describes the proportional valve with synchronous motor type PMSM used in electrohydraulic servo drive. System has been tested using the Hardware in the Loop technique. It means that most of the elements, in addition to the synchronous motor, were implemented on the PLC as a discrete model. The time characteristics of the servo drive were checked by a step-response method. **Keywords:** electrohydraulic servo drives, synchronous motor, hardware in the loop

69.

mgr inż. Roman Regulski, mgr inż. Amadeusz Nowak Zakład Urządzeń Mechatronicznych, Politechnika Poznańska

Applications of speech recognition systems to control and voice communication with mechatronic devices

This paper presents examples of the use of automatic speech recognition systems to build human-machine voice interfaces. Also this paper briefly describes how these applications can work. The rest of the article shows the concept of usage speech recognition system based on own driver which cooperate with washing machine controller.

Keywords: automatic speech recognition, voice control, human-machine interface, washing machine controller

70.

Jarosław Gośliński, MSc Eng*; Piotr Owczarek, MSc Eng**; Dominik Rybarczyk, MSc Eng**

*Faculty of Electrical Engineering, Poznań University of Technology, Poland

**Faculty of Mechanical Engineering and Management, Poznań University of Technology, Poland

Absolute angle estimation by means of an IMU in a manipulator with electrohydraulic servodrives

The problem of estimation of the manipulator's arm angle using the inertial measurement unit (IMU) is discussed. This unit was attached to the arm allowing identification of the arm's angle relatively to the global coordinate system. The manipulator was also equipped with two incremental encoders. Results of conducted experiments allowed to compare the pitch angle of the robot arm, estimated from the IMU and calculated from the encoder unit. In the study the influence of the IMU sensor position on the quality of estimates was verified. Parameters of the estimation algorithm have been also checked. Finally, the selected estimation algorithm was verified during the operation, where manipulator moved at various speeds and angles. Aim of this study was to test the angle estimation method using an IMU in the mechanical system with hydraulic drives.

Keywords: Kalman Filter, IMU, electrohydraulic manipulator, encoder

71.

Jarosław Gośliński, MSc Eng*; Piotr Owczarek, MSc Eng**; Dominik Rybarczyk, MSc Eng**

*Faculty of Electrical Engineering, Poznań University of Technology, Poland

**Faculty of Mechanical Engineering and Management, Poznań University of Technology, Poland

The use of Kinect sensor to control manipulator with electro-hydraulic servodrives

The article describes the control of the 2-axis electrohydraulic manipulator by the human-hand motion. To recognition of skeleton points the Kinect sensor was used. In this application the information about coordinates of shoulder, elbow and hand was used to compute of inverse kinematic in manipulator. In investigation the accuracy of control by human's hand motion was tested. The aim of study was to find a new of control method without commonly used joysticks to create human-machine interface. **Keywords:** Kinect, electro-hydraulic manipulator , human-hand control, human posture recognition

72.

Agnieszka Pręgowska, MSc Eng; Robert Konowrocki, PhD Eng; prof. Tomasz Szolc, PhD Eng, DSc Institute of Fundamental Technological Research, Polish Academy of Sciences, Warsaw, Poland

Semi-active vibration control using a rotary magnetorheological damper - experimental verification

From all kinds of vibrations, torsional ones are very important as naturally associated with fundamental rotational drive system motion. The aim of this paper is to present semiactive control of torsional vibrations of the working machine drive systems, which is performed using a rotary damper with the magnetorheological fluid. The main purpose of this research is minimization of vibration amplitudes in order to increase fatigue durability of the most responsible machine elements. The special control strategies are proposed for steady-state torsional vibrations suppression. The semi-active control method is based on a principle of on-line selection of optimum damping coefficient values, which is realized by application of the magnetorheological fluid. The analysis performed in the paper combines experimental verification using the laboratory test rig with theoretical computations. This experiment was designed in the form of the laboratory drive system co-operating with two asynchronous motors generating properly programmed driving and retarding electromagnetic torques. **Keywords:** semi-active control, torsional vibrations, rotary dampers, magnetorheological fluid, electromechanical driver system

73.

Krzysztof Falkowski, PhD Military University of Technology, Warsaw

Loops with molecular current as a magnet model

This paper presents a magnet model. It assumes surface molecular current in the active wall. The surface current is a result of order atoms in magnet. A mathematical model and finite element method analyzes of magnets are presented. **Keywords:** magnet, passive magnetic bearing, active wall, molecular current

74.

Krzysztof Falkowski, PhD Eng; Maciej Henzel, PhD Eng Military University of Technology, Warsaw, Poland

Nacelle actuation system with linear electric motor

This paper presents the results of research work on the construction of nacelle actuator with linear tubular electrical motor. The laboratory model was designed at the Military University of Technology. It was verified by finite element method. The test provided information for dynamic simulation and it can be used to verification of linear tubular motor construction. **Keywords:** actuator, linear motor, magnets

75.

Krzysztof Falkowski, PhD Eng; Maciej Henzel, PhD Eng Department of Mechatronics and Aerospace, Military University of Technology, Poland

Determination of inductance matrixes of bearingless electric motor for magnetic levitation

The paper deals with mathematical and experimental analysis of induction in bearingless electric motor. The motor are used magnetic levitation phenomenon to bearing of the rotor. In stator are implemented two winding groups. These are bearing and motor windings. In the paper are presented the mathematical model of windings and the experimental results of induction parameter measurements. **Keywords:** bearingless motor, magnetic levitation, induction

76.

Krzysztof Falkowski, PhD Eng; Maciej Henzel, PhD Eng; Paulina Mazurek, MSc Eng Department of Mechatronics and Aerospace, Military University of Technology, Poland

Mathematical analysis of tubular linear motor

The paper deals with mathematical analysis of linear electric motor. There are characterized modern trends in aviation, especially in aircraft actuator field. There are also described operation principles of linear motor and transformation from cylindrical rotary motor to tubular linear motor. There are presented motion equation of linear motor and formula derivation of mutual inductances matrix. In three phase power supply mutual inductances are depend on slider linear movement. **Keywords:** actuator, linear electric motor, More Electric Aircraft

SESSION V - MEASUREMENTS DEVICES AND SYSTEMS

77.

prof. Roman Szewczyk, DSc, PhD Eng*; prof. Adam Bieńkowski, DSc, PhD Eng*; Jacek Salach, PhD Eng*; Dorota Jackiewicz, MSc Eng*; Dipl. Eng Peter Švec Sr, DSc**; Jozef Hasko, Eng**; Dipl. Eng. Peter Švec, PhD**; Marcin Kamiński, MSc Eng***; Wojciech Winiarski, MSc Eng***

*Institute of Metrology and Biomedical Engineering, Warsaw University of Technology

**Institute of Physics, Slovak Academy of Sciences

***Industrial Research Institute for Automation and Measurements PIAP

Thermal annealing of soft magnetic materials and measurements of its magnetoelastic properties

Paper presents both methods of the most advanced thermal annealing as well as available methods of testing the magnetoelastic properties of soft magnetic materials for technical applications. Selected features and conditions important for annealing of ring-shaped cores made of the magnetoelastic amorphous ribbons are described and an example of thermomagnetic processing is shown. Unified methodologies for testing of magnetoelastic properties of the frame-shaped and the ringshaped cores, for both compressive and tensile stresses are presented.

Keywords: soft magnetic materials, thermal annealing, magnetoelastic properties

78.

dr inż. Dariusz Rzońca, dr inż. Andrzej Stec

Katedra Informatyki i Automatyki, Politechnika Rzeszowska

Prototype of secure Industrial microserver for distributed control and measurement system

Security problems in distributed control and measurement systems are very important. Limited hardware resources often necessitate development of dedicated solutions. The paper describes a prototype microserver, providing secure communication with remote control station.

Keywords: secure server, secure data transfer, control and measurement system

79.

dr inż. Waldemar Uździcki, prof. UZ, mgr inż. Marcin Chciuk, mgr inż. Paweł Bachman, mgr inż. Remigiusz Aksentowicz Wydział Mechaniczny, Uniwersytet Zielonogórski

Design and sample application stand of measurement and registration currents and voltages in three-phase mains

This paper describes a stand to measure and record the basic parameters of the three-phase mains. Describes the construction of measuring stand and mathematical relations of the measured signals. Finally, the paper presents the results of the sample measurements. **Keywords:** measurement, recording, voltage, current, power, three-phase mains, cutting force

80.

Prof. Bolesław Porankiewicz, PhD Eng, DSc*; Paweł Bachman, MSc Eng**; Marcin Chciuk, MSc Eng**

*retired professor

**Faculty of Mechanical Engineering, University of Zielona Góra, Poland

Measuring stand for research circular saws natural frequencies and vibration modes

In the article issues associated with the measurement of saw based natural frequencies are presented. Then construction of measuring stand to observe circular saw's Chladni figures is show. The stand consists of: precise DDS signal generator, high-speed power amplifier, electromagnetic actuator, white powders and digital camera. With this stand it was possible to obtain Chladni figures for frequencies up to 5 kHz. The end of the article contains results of a sample measurement of used up circular saw. **Keywords:** circular saw, saw based natural frequencies, vibration modes, Chladni figures

81.

Paweł Bachman, MSc Eng*; Marcin Chciuk, MSc Eng*; Ján Pavlovkin, PhD Eng**

*University of Zielona Góra, Poland

**University of Matej Bel, Banská Bystrica, Slovakia

Measurement and analysis of pressure forces on pedals at driver's workplace

This paper describes a method for measuring the pressure forces on the pedals in the bus. Shows the results and the analysis of the measurements, in terms of using them to determine the level of fatigue of the driver and his driving style. **Keywords:** measurement pressure forces on pedals in a car

82.

Paweł Bachman, MSc Eng; Marcin Chciuk, MSc Eng Faculty of Mechanical Engineering, University of Zielona Góra, Poland

Stand for research of wood swelling pressure in two axies simultaneous

This paper describes a method for measuring wood swelling pressure simultaneously in two axes. Construction of the modern research stand, results of the measurements and the measurements comparison in one and in two axes at the same time are shown. **Keywords:** measuring wood swelling pressure

83. dr inż. Paweł Fotowicz Główny Urząd Miar

Capability of measurement instrument

Capability of measurement instrument is an indicator enabling evaluation of metrological quality of instrument. The measure of the capability is an expanded uncertainty calculating after measurement on the standard. The uncertainty budget consists both random and systematical effects as a bias. The aggregated uncertainty is related to limited value. This limited value may be a maximum permissible error. **Keywords:** measurement capability, uncertainty

84.

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Software solution used in industrial measurement devices to facilitate meeting the requirements of the EMC directive

This paper presents an example of a measuring device to be applied in a coal mine, for which special effort was taken at the design stage to fulfill the requirements for electromagnetic compatibility. Software solutions described in the paper are useful during the EMC certification process for the majority of programmable equipment, because slight modifications of the program can compensate imperfections of hardware design and may decide about passing the certification process.

Keywords: industrial measurements, embedded software, noise immunity, EMC

85.

Hubert Wiśniewski, MSc Eng; prof. Leszek Płonecki, PhD Eng, DSc Kielce University of Technology, Poland

A real time system for measuring wind turbine power

This paper deals with a real time system for automatic measurement of wind turbine parameters. The system was designed according to the specifications provided by a Polish company cooperating with the Kielce University of Technology on a project called "*Invention*" – *Potential of young researchers and transfer of knowledge and innovation as a support for the key areas of Świętokrzyskie economy*. **Keywords:** wind turbine, power measurement, real time system

86.

Witold Dąbrowski, PhD Eng; Stanisław Popowski, Msc Eng Institute of Aviation, Warsaw, Poland

Estimation of wind parameters on flying objects

The article presents proposal of wind parameters measurement and estimation on any flying object board. This system uses three sources of information: heading measurement (heading system or attitude heading reference system, AHRS), measurement of speed relative to air (pressure speedometer), estimation of track over Ground and route speed by means of GPS receiver. Verification of the presented solution was carried out based on off-line calculations using data logged on-board of PLZ M-20 Mewa airplane as well as on the results of error analysis.

Keywords: measurement, estimation, wind speed and direction, airspeed, heading, track over Ground, route speed

87.

Artur Kurnyta, MSc Eng Air Force Institute of Technology, Warsaw, Poland

Application of resistive ladder sensor for detection and quantification of fatigue cracks in aircraft structure

The paper presents preliminary laboratory verification of resistive ladder sensor application. The sensor, which is akin to foil strain gage, can be used for detection and length quantification of fatigue cracks. Special measurement circuit for data acquisition was developed and test specimens were prepared. Afterwards, laboratory tests on fatigue-testing machine were elaborated to explore utility and reliability of proposed method for crack detection. After analysis of acquired data, some observation and conclusion were drawn, especially about electronic circuit. Modifications in measurement system were described and simulated in Micro-Cap – an electronic circuit analysis program. The paper is concluded with summary from laboratory tests and simulations.

Keywords: fatigue crack, crack detection, resistive ladder sensor, electronic circuit simulation, Micro-Cap