

## AUTOMATION 2009

April 1-3, 2009 - Industrial Institute for Automation and Measurements PIAP.

3 plenary papers and 74 regular papers covering six topic area.

Bellow name of the sessions and title of the papers with abstracts.

### PLENARY SESSION

1.

**Optimization in motion planning for tightly cooperating robots** - *dr inż. Wojciech Szykiewicz, Instytut Automatyki i Informatyki Stosowanej Politechniki Warszawskiej, dr inż. Jacek Błaszczak, Naukowa i Akademicka Sieć Komputerowa NASK, prof. dr hab. Krzysztof Malinowski, Instytut Automatyki i Informatyki Stosowanej Politechniki Warszawskiej, Naukowa i Akademicka Sieć Komputerowa NASK*

Application of advanced optimization techniques to solve the path planning problem for tightly cooperating robots is discussed in this paper. The approach to path planning is formulated as a "quasi-dynamic" nonlinear optimization (NLP) problem with equality and inequality constraints in terms of the joint variables. The essence of the method is to find joint paths which satisfy the given constraints and minimize the proposed performance index. For numerical solution of the NLP problem the IPOPT solver is used, which implements a nonlinear primal-dual interior-point method one of the leading techniques for large-scale nonlinear optimization.

2.

**New activities in advanced robotics** - *prof. dr hab. inż. Andrzej Masłowski, Komitet Robotyki POLSPAR, Politechnika Warszawska, Instytut Automatyki i Robotyki, Przemysłowy Instytut Automatyki i Pomiarów PIAP*

Presented key-note paper shows, based on the works of **the International Advanced Robotics Programmme IARP**, worldwide, distinguished research activities in the advanced robotics, particularly mobile robotics and robot systems able to dispense with human exposure to difficult activities in harsh, demanding or dangerous conditions or environments. The range of application areas under consideration include space, underwater, nuclear, tunnelling, agriculture, medical and healthcare, civil engineering and construction, intelligent manufacturing, fire fighting and emergency rescue operations, safety and security. Shown robot systems *have one or more of the following characteristics*: an ability to sense and adapt to their environment, to be mobile as well as to be a team of the services, domestic applications and personal robots working in above mentioned area of applications. General evaluation of the strategic impact of advanced robotics and based on its technologies into IARP participating countries has been done.

3.

**Modelling of flow in cerebral supplying arteries** - *prof. dr hab. inż. Krzysztof M. Cieśliski, Instytut Automatyki i Robotyki PW*

The paper summarizes the results of experiments with liquid flows in the model of brain supplying arteries and the Circle of Willis, prepared on the basis of anatomical specimens. The most typical artery shapes and dimensions were modeled. Pressure distribution in 10 characteristic points is provided, and so are the flow rates in the anterior, middle and posterior section of the brain. Tests were run in the conditions reproducing the physiological states (i.e. when the supplying arteries were fully patent) and in pathological conditions, when the internal carotid artery and basilar arteries were obstructed on one or both sides. Thus obtained results were compared with the results of simulations using the linear and non-linear electric models.

## SESSION I - AUTOMATION, ROBOTICS, MONITORING

4.

**Building distributed control system using web services technology** - *dr hab. inż. Jerzy Zajac, prof. PK, mgr inż. Grzegorz Chwajol, Politechnika Krakowska*

Contemporary Internet technologies open new opportunities for building open, reconfigurable control systems. The paper presents selected elements of multiagent control system AIM developed at Cracow University of Technology. The communication among distributed elements of control system is performed by means of Web services technology.

5.

**Interface agents for multiagent control system on an example of TOR production center** - *dr hab. inż. Jerzy Zajac, prof. PK, mgr inż. Adam Kmiecik, Politechnika Krakowska*

The paper presents a concept of interface agent which integrates logical and physical parts of multiagent manufacturing control system on an example of TOR Production Center situated in The Laboratory of Automated Production Systems Division at Cracow University of Technology. The way how the agent acts was shown. It takes advantage of division elementary activities into actions consisting of tasks.

6.

**Controlling the dynamic system of machining axial symmetric low rigid elements** - *doc. dr inż. Aleksandr Dracow, Państwowy Uniwersytet Techniczny w Togliatti, Rosja, doc. dr inż. Georgij Taranenko, Narodowy Uniwersytet Techniczny w Sewastopolu, Ukraina, prof. dr hab. inż. Wiktor Taranenko, Politechnika Lubelska, dr hab. inż. Antoni Świąć, prof. nazw., Politechnika Lubelska, mgr inż. Witold Hałas, Państwowa Wyższa Szkoła Zawodowa w Chełmie*

The metal-cutting technological system update by the tangent control circuit for the precision and productivity increasing is substantiated and approved. The automatic control system for the operating this technological system is observed.

7.

**Controlling the vibratory machining of long shaft** - *doc. dr inż. Aleksandr Draczow, Państwowy Uniwersytet Techniczny w Togliatti, Rosja, doc. dr inż. Georgij Taranenko, Narodowy Uniwersytet Techniczny w Sewastopolu, Ukraina, prof. dr hab. inż. Wiktor Taranenko, Politechnika Lubelska, dr hab. inż. Antoni Świć, prof. nazw., Politechnika Lubelska, mgr inż. Witold Hałas, Państwowa Wyższa Szkoła Zawodowa w Chelmie*

The article is devoted to the problem of dynamic of the low-rigid work pieces by the affection vibration. The method of control of technological parameters to intensify of the stress relaxation and increasing of the part geometrical stability is substantiated.

8.

**Quality control of long shafts electrochemical processing** - *doc. dr inż. Aleksandr Draczow, Państwowy Uniwersytet Techniczny w Togliatti, Rosja, doc. dr inż. Georgij Taranenko, Narodowy Uniwersytet Techniczny w Sewastopolu, Ukraina, prof. dr hab. inż. Wiktor Taranenko, Politechnika Lubelska, dr hab. inż. Antoni Świć, prof. nazw., Politechnika Lubelska*

Automatic control system for the electrochemical machining process of low rigid shafts is described. The system minimizes axial residual stress level by the pickling metal variable layer to billet profile and provide decrease of billet distortion.

9.

**Artificial neural network for worker presence identification in dangerous zones using stereovision** - *dr inż. Andrzej Grabowski Centralny Instytut Ochrony Pracy - Państwowy Instytut Badawczy, prof. dr hab. Robert Kosiński Centralny Instytut Ochrony Pracy - Państwowy Instytut Badawczy, Politechnika Warszawska, Wydział Fizyki, dr inż. Marek Dźwiarek Centralny Instytut Ochrony Pracy - Państwowy Instytut Badawczy*

Modern production processes becomes more and more flexible. Therefore there is a need that devices used in workplace also support flexibility as much as possible. Such characteristics have Vision Based Protective Devices (VBPDs). We present a neural system for the advanced recognition of danger situation for safety control. The sequence of the images from two cameras located above the work stand is presented to the system of cellular neural networks (CNNs) realized in the PC computer. They detect a new object appearing in a Safety Field (SF), define its position with respect to the moving parts of machine (e.g. the arm of the robot) and perform the feature extraction of its image. Experiments conducted using artificial images (virtual environment) and low quality images (internet cameras) indicate that our system can work in a real time and detect successively dangerous situations.

10.

**CP-driven production process planning in multiproject environment - dr inż.**

*Grzegorz Bocewicz, prof. dr hab. inż. Zbigniew Banaszak, mgr inż. Irena Bach  
Politechnika Koszalińska*

The way enterprise capabilities are used decides about its competitiveness among other ones. In that context modeling aimed at production tasks allocation planning plays a crucial role especially at concurrently executed production orders. The introduced reference model employing constraint programming (CP) paradigm describes both an enterprise and a set of project-like production orders. Moreover, encompassing consumer orders requirements and available production capabilities, the model provides the formal framework allowing one to develop a class of decision support systems aimed at interactive production process planning subject to multiproject environment constraints.

**11.**

**Improving of production processes with the usage of tools for computer**

**visualization - dr hab. inż. Dariusz Plinta Akademia Techniczno-Humanistyczna w  
Bielsku-Bialej**

Computer technologies are the basic tools of the accumulation and exchange of information in contemporary enterprises. Software for the modelling of production systems and for the simulation of actual processes is becoming more commonly used in management processes. In this paper, there are presented practical examples of the usage of such software.

**12.**

**Strategic human resources management in SME's regarded by innovation**

**implementation - mgr inż. Eryk Szwarc, Politechnika Koszalińska, dr inż. Justyna  
Patalas, Uniwersytet Zielonogórski, prof. dr hab. inż. Krzysztof Szkatuła, Instytut Badań  
Systemowych PAN**

Small and medium enterprises (SME) in order to be competitive have to implement innovations, such as ERP system. Often, in innovation implementation human resources are discounted. In this context, strategic human resources management is consider as one of the main aim of SME's. In order to make personnel decisions usage of the AHP method is shown on the example.

**13.**

**The influence of 3D designing and computer simulation on the production of  
automated manufacturing lines - dr inż. Jacek Domińczuk, Politechnika Lubelska**

The article presents the application of 3D computer aided designing methods and other methods supporting the engineer in the development of modern tools for automated machining and assembly. Moreover, it highlights the benefits of the modelling technique in project optimization as improving functionality and the safety of operation as well as shortening the machining time, improving reliability and reducing production costs. Finally, the article draws the management outline basing on the principles of Computer Aided Designing.

**14.**

**Control systems with extra feedback from workpiece and machine tool - dr inż.**

*Jerzy Kapcia, Politechnika Gdańska*

The article presents working control system with extra feedback from machine tool and workpiece on example of sawing machine and milling machine. The idea to engineer (design) control and diagnostic systems has its roots in the golden rule: "Better prevent from damages than repair them". Thanks to their features the control process is corrected against a machine tool or a workpiece breakdowns.

**15.**

**Method for orientation of tool edges and for direct tool wear measurement - mgr inż.**

*Radosław Gościński, Politechnika Warszawska*

The new method of tool wear measurement. The original concept of a tool probe using one full strain gauge bridge for orientation of tool edges and for direct tool wear measurement. The calculation and design of patented tool probe for lathes.

**16.**

**Validation of complex automatic and robotic systems - prof. dr inż. Tadeusz Missala,**

*Przemysłowy Instytut Automatyki i Pomiarów PIAP*

System validation, i.e. proof the system comply the requirements resulting of the conditions of its application, is the important step by the system commissioning. The evaluation methodology done in the International Standards is presented, as well as the requirements resulting from system ergonomic, safety and security, including protection against the terrorist attacks.

**17.**

**Risk of repairing an object - dr inż. Paweł Szczepański Instytut Systemów**

*Mechatronicznych WAT*

In this article risk is understood as a sum of products of probabilities of individual failures by the cost of their removal. It is noticeable, that its most important defining factor is taking into account the structure of the object - its distinguishable reliability states.

**18.**

**The criteria and the coefficients of innovation in evaluation of investment "POIG"**

**projects - mgr inż. Kazimierz Majdan, Przemysłowy Instytut Automatyki i Pomiarów**

*PIAP*

The convergence of economic systems proceeds in countries of EU, mainly as the result of undertaking the modernization enterprises in industry, which are supported by the own or ordered applied researches and some developmental works. A large influence on productiveness and on market position of industrial enterprises have some innovative investments, led with a creativity, knowledge and workers' experience utilization, but

also by significant support with a public help. The sequences of multidirectional and synergic activities are showed here; whose are favorable for any grants from European Funds intended to some innovative investments. It concerns the creating, transfer and the implementation of advanced product or process technologies, in this the automation, robotics and the monitoring of any technological processes. The system joined activities of enterprise, R&D and advisory firm are presented, already undertaken in phase of idea and the preliminary conception of investment in innovative solutions. The analytic method of quality of process evaluation, according to the qualifying criteria, settled in POIG, have been passed also. The better ranking position of intentional project is the consequence of based on partnership co-operation. It also favors future effective realization of intentional solutions, finished the implementing the innovative technology and the adequate calculation of the received from POIG grant.

## 19.

**Foresight of priority, innovative technologies in favor of automation, robotics and the techniques of measurement** - *mgr Jan Piwiński, dr inż. Roman Szewczyk, prof. dr inż. Tadeusz Missala, Przemysłowy Instytut Automatyki i Pomiarów PIAP, prof. dr hab. inż. Janusz Kacprzyk, Polska Akademia Nauk, dr inż. Jan Tomasik, Politechnika Warszawska*

The purpose of project 'Foresight of priority, innovative technologies in favor of automation, robotics and the techniques of measurement' is indication innovative technologies, ways of its development and directions of strategic research, the development (progress, evolution) of which will have a key meaning in next 20 years in a range of automation, robotics techniques of measurement in Poland. Realization of the project will be mainly directed on the requirements of domestic enterprises and research and development area. Paper presents main ideas of the project as well as unique foresight methodology developed in Industrial Research Institute for Automation and Measurements.

## 20.

**Vector data archiving based on the incremental backup copies** - *dr inż. Marian Wrzesień, Przemysłowy Instytut Automatyki i Pomiarów PIAP*

The implementation of the vector archiving of the information data created by servers based on the Windows operating system is presented. As the target destination for the archived resources the Linux Fedora Core 9 server is used. The archiving system provides the transfer of the incremental backup copy formed everyday by the local application servers to the destination server, where the vector archiving method of the transferred resources is applied. For the assurance an appropriate integration of the information systems which are working under various software platforms, the samba software implemented on the Linux server is used. The transfer between servers as well as the synchronization of the information resources intended to be archived are controlled by such software as SyncBack, rsync, rsnapshot and cron. It is emphasized, that the indicated method leads to the minimization of the data transfer duration as well as the minimization of the space that is required for the archived data in the store medium.

## SESSION II - MOBILE ROBOTS SOFTWARE, EQUIPMENT AND APPLICATION

21.

**Autonomous hexapod robot – development of an improved mechanical design and control system** - mgr inż. Dominik Belter, mgr inż. Krzysztof Walas, dr hab. inż. Piotr Skrzypczyński, Politechnika Poznańska

Walking machines are a very interesting class of mobile robots because of their unique locomotion capabilities in rough terrain. This high mobility makes a walking robot an attractive choice for search and rescue missions, in the areas unreachable for wheeled robots. This work describes a development of a new hexapod robot, based on the experiences from the development and use of the robot Ragno. The mechanical design and control architecture issues are characterised. The article shows also solutions to some problems encountered during the use of the earlier robot design.

22.

**About gait of two legged anthropomorphic walking robot – DAR** - prof. nzw. dr hab. inż. Krzysztof Jaworek, mgr inż. Marcin Głębocki, Politechnika Białostocka

In this paper was described how to build two legged machine (robot) named DAR. The construction of this robot has eight degrees of freedom and consists: trunk and two legs equipped with two relatively big two feet. Kinematics pairs of robot – DAR are propelled by DC motors, with regulated instantaneous power (similar from “servomotors” e.m. produced by group of muscles of human legs during walking). Model of instantaneous power was taken from shape of instantaneous power developed by group of muscles of a man, during walking in sagittal plane, over relatively flat surface – in laboratory condition. Proposed robot– DAR is e-time smaller then a man (where: e – is Euler number). Model of instantaneous power developed by DC control motor of artificial joints of a robot – DAR was elaborated by using Froude number Fr.

23.

**About gait safety factor of two legged anthropomorphic walking robot – DAR** - prof. nzw. dr hab. inż. Krzysztof Jaworek, mgr inż. Marcin Głębocki, Politechnika Białostocka

In this paper was described how to build two legged machine (robot), in domestic circumstances, called by authors two legged machine – DAR. The construction of robot has eight degrees of freedom and consists of trunk and two legs equipped with two big feet. Kinematics pairs of machine – DAR are propelled by DC motors, with regulated instantaneous power (similar from “servomotors” of human legs developed by a man muscles). Model of instantaneous power developed at three main “joints” at real the machine – DAR “were taken” from instantaneous power developed from normal of human walk, in sagittal plane, under laboratory condition. In machine – DAR is provided regulation of it’s speed and is calculated maximal speed by means of (nowhere

published) Gait Safety Factor – GSF. Coefficient GSF will be calculated in the machine – DAR on-line by the (MFR) method well known from identification methods during “gait” of the two legged machine – DAR, on complex plane, named Gauss plane.

**24.**

**Autonomous students robot– application of the LEGO Mindstorms NXT system in constructions of mobile robots** - *dr inż. Michał Gnatowski, Instytut Podstawowych Problemów Techniki PAN, Kacper Kulczycki, Wydział Fizyki Uniwersytetu Warszawskiego*

In this article a construction of a caterpillar mobile robot is presented. The robot was created by students, belonging to Scientific Group of Artificial Intelligence, by the Faculty of Physics of the University of the Warsaw. In the description, particular emphasis stayed for possibilities and restrictions, resulting from applying of the ready construction system of the LEGO company, and available open source software for this platform.

**25.**

**Small-dimension mobile robot for indoor reconnaissance** - *mgr inż. Łukasz Różycki, dr inż. Maciej Trojnecki, Przemysłowy Instytut Automatyki i Pomiarów PIAP*

This work is concerned about small mobile robot for indoor reconnaissance. A review of existing mobile robots with specific driving systems and with hybrid solutions is presented. Robot idea and designing process are described. Most important technical, designing and technological problems which appeared during drawing up robot construction model are discussed.

**26.**

**The Modeling, programming and computer simulation of mobile robot climbing the stairs** - *dr inż. Maciej Trojnecki, Przemysłowy Instytut Automatyki i Pomiarów PIAP*

This work is concerned about modeling, programming and computer simulation of a small mobile robot. In the paper a robot dynamic model was worked out. This model takes into account sequence of the robot climbing the stairs. Based on this model the simulation software using Matlab/Simulink package was prepared. Additionally, the robot animation using Virtual Reality Toolbox was realized.

**27.**

**Virtual model simulations and industrial trial runs of the mobile diagnostic spider-robot** - *mgr inż. Zbigniew Borkowicz, mgr inż. Maciej Cader, mgr inż. Grzegorz Grzesiak, mgr inż. Grzegorz Kowalski, Przemysłowy Instytut Automatyki i Pomiarów PIAP, mgr inż. Jacek Ciechański, mgr inż. Konrad Rokicki, Paweł Wittels, Politechnika Warszawska*

The paper describes last steps of the R&D and the implementation of the spider-robot. The spider-robot was tested at the laboratory and in the industrial pulverised fuel fired boilers and fluidised bed boilers. The virtual model of the mobile robot was prepared

with CAD-3D and put to the tests using MATLAB program and ADAMS simulation system environment. The test and research results *was used to improve* the robot design by modifying the details of the components and technology.

**28.**

**Computational intelligence applied in cognitive supervision of the web connected multi-robotic system** - mgr inż. Janusz Będkowski, mgr inż. Piotr Kowalski, prof. dr hab. inż. Andrzej Masłowski, Politechnika Warszawska

Following paper is focused on the computational intelligence applied in cognitive supervision of the web connected multi-robotic system. The cognitive model of the human operator is described. The concept of the implementation of the cognitive model of human – operator is shown. The computational intelligence algorithms' usage in cognitive supervision is described, therefore the implementation of the classification and regression methods are presented. The development of the system components using Compute Unified Device Architecture (CUDA) is shown, therefore the increased performance is proven.

**29.**

**Multirobot transportation system** - dr inż. Michał Gnatowski, Instytut Podstawowych Problemów Techniki PAN

In this article a model of group of mobile robots which executes a transportation task in an industrial environment is presented. The robots move on a previously defined graph. The task is that collision or deadlock must not occur and the path and execution time must be optimal for the whole team. The presented system is distributed with minimal communication among agents.

**30.**

**Selected problems of visualisation of motion of underwater vehicle in simulation program** - dr inż. Józef Malecki, mgr inż. Marcin Szulc, Akademia Marynarki Wojennej

In the paper hardware and software description of the virtual visualisation module of the simulator of ship stand of control of unmanned underwater vessel's motion is presented. A technology of processing of digital hydrographical data for 3D presentation of a shape of the sea bottom and navigational obstacles in the undersea space using GIS software is described.

**31.**

**Structure of control blocks of underwater vehicle's motion in multiagent system of underwater inspection** - dr inż. Piotr Szymak, Akademia Marynarki Wojennej

Using of autonomous underwater vehicles' team for the aim of common underwater inspection task execution causes a need of coordination particular vehicle actions. One of the solutions is multiagent system.

Multiagent system of underwater inspection will be composed of decision system – generating vectors of desired states for particular underwater vehicle and control blocks –

converting vectors of desired states into input function vectors of particular vehicle's driving systems for the common aim execution.

The paper undertakes problem of selection a structure of control blocks for underwater vehicles with different dynamics and different configuration of driving systems.

**32.**

**Influence of evolutionary parameters on operating of method of route selection for unmanned underwater vehicles** - *mgr inż. Tomasz Leszczyński, Akademia Marynarki Wojennej*

The proposal of the solving the problem of creating the evaluation function for the method of route selection for unmanned underwater vehicle is presented in this paper. Moreover, the assumptions enabling the creating this function and the suggestions of its simplification are also presented, which minimize computational complexity of calculations. Finally preliminary results of numerical research for not quite a form of the evaluation function and influence of parameters of genetic algorithm on the method are shown.

**33.**

**Picture segmentation methods in 3D laser data segmentation** - *dr Barbara Siemiątkowska Politechnika Warszawska, mgr Arkadiusz Zychewicz, dr inż. Michał Gnatowski, Instytut Podstawowych Problemów Techniki PAN*

In the article a method of building semantic map of robots' environment is presented. A robot is equipped with a laser sensor which enables to obtain 3 dimensional information of the scene. Data is stored in a colour image. The segmentation and map building processes consist of the following parts: selecting homogeneous areas in the image obtained from the data, the edges and the areas description, classification, creating a graph which describes the scene. It is assumed, that classification is performed based on previously stored rules database and additional information stored in labelled graphs. Experiments which have been done showed that 3D area segmentation, using classical pattern recognition methods which are widely used in machine vision enables to perform computations effectively. The semantic map creation process is still under development but the performed results are satisfied.

**34.**

**Data acquisition module for distributed control system** - *dr inż. Piotr Szulewski, Politechnika Warszawska*

Referring to the very popular idea of distributed control systems the conception of small data acquisition module is presented in this paper. Thanks to the microelectronic technique rapid growth it is possible to use the popular microprocessor and it's components as universal and powerful diagnostic tool. The proposal for construction simple data module and it's implementation to the real laboratory environment is provisionally illuminated.

## SESSION III - DESIGN AND INTEGRATION METHODS FOR SYSTEMS

35.

**Practical stability and asymptotic stability of cone fractional discrete-time linear systems - prof. dr hab. inż. Tadeusz Kaczorek, Politechnika Białostocka**

A new concept (notion) of the practical stability and asymptotic stability of cone fractional discrete-time linear systems is introduced. Necessary and sufficient conditions for the practical stability and asymptotic stability of the cone fractional systems are established. It is shown that: 1) the cone fractional systems are practically stable if and only if the corresponding positive systems are practically stable, 2) the positive fractional systems are practically unstable if corresponding positive fractional systems are asymptotically unstable. Simple conditions for the asymptotic stability are also established. Considerations are illustrated by numerical example.

36.

**Robust stability of continuous-time fractional systems of commensurate order with characteristic function linearly dependent on uncertain parameters - prof. dr hab. inż. Mikołaj Busłowicz, Politechnika Białostocka, mgr inż. Tomasz Kalinowski, Studium Doktoranckie, Politechnika Białostocka**

The problem of robust stability of linear continuous-time fractional order systems of commensurate order with characteristic polynomial linearly dependent on uncertain parameters is considered. It is shown that the Edge Theorem known from the theory of robust stability of families of natural degree characteristic polynomials can be used to robust stability analysis of the systems. Computer method for checking of the conditions of this theorem is given. The considerations are illustrated by numerical example.

37.

**Design of fractional order controller for a class of plants with delay - prof. dr hab. inż. Mikołaj Busłowicz, Politechnika Białostocka, mgr inż. Tomasz Nartowicz, Studium Doktoranckie, Politechnika Białostocka**

The paper considers the design problem of fractional order controller satisfying gain and phase margin of the closed loop system with time-delay inertial plant with integral term. The proposed method is based on using Bode's ideal transfer function as a reference transfer function for the open loop system. Computer method for synthesis of fractional controller is given. The considerations are illustrated by numerical example and results of computer simulation.

38.

**Stabilization of fractional-order inertial plants with time delay using fractional PID controllers - dr inż. Andrzej Ruszewski, Politechnika Białostocka**

The paper presents the stability problem of control systems composed of a fractional-order PID controller and a inertial plant of a fractional order with time delay. Using the classical D-partition method, a simple and efficient computational method for

determining stability regions in the controller parameters space are given. The presented method is also used for obtaining stability regions for specified gain and phase margins requirements.

**39.**

**Output reachability and output controllability of positive fractional discrete-time systems** - *dr inż. Rafał Kociszewski, Politechnika Białostocka*

Necessary and sufficient conditions for the output reachability and output controllability for linear positive fractional discrete-time systems are formulated and proved. Simple methods for computation of the control sequences steering the output of the fractional system from zero and nonzero initial state to the desired value of the output are presented. Considerations are illustrated by numerical examples.

**40.**

**Stability of models of linear continuous-discrete systems** - *prof. dr hab. inż. Mikołaj Busłowicz, Politechnika Białostocka*

The problem of asymptotic stability of linear dynamic continuous-discrete systems is considered. Computer methods for asymptotic stability analysis of the Fornasini-Marchesini and the Roesser models are given. The methods proposed can be used for asymptotic stability analysis of the other known models of continuous-discrete systems. The considerations are illustrated by numerical examples.

**41.**

**Robust stability of continuous-discrete system with characteristic function linearly dependent on one uncertain parameter** - *prof. dr hab. inż. Mikołaj Busłowicz, Politechnika Białostocka, mgr inż. Michał Sokółski, Studium Doktoranckie, Politechnika Białostocka*

The problem of robust stability of linear continuous-discrete systems with characteristic polynomial linearly dependent on one uncertain parameter is considered. This problem is equivalent to the problem of robust stability of convex combination of two polynomials of two independent variables. Frequency domain methods for robust stability analysis of such a combination are given. The method proposed are based on the zero exclusion condition known from the theory of robust stability of families of polynomials of one variable. The considerations are illustrated by numerical example.

**42.**

**Computation of positive realization of hybrid linear SISO systems described by the second Fornasini-Marchesini model** - *mgr inż. Łukasz Sajewski, Politechnika Białostocka*

The realization problem for positive linear hybrid systems with single input and single output (SISO), described by the second Fornasini-Marchesini model is formulated. The method based on the state variable diagram for finding a positive realization of a given proper transfer function is proposed. Sufficient conditions for the existence of a positive

realization of a given proper transfer function are established. A procedure for computation of a positive realization is proposed and illustrated by a numerical example.

**43.**

**Relative pointwise completeness of positive continuous – discrete time systems - dr inż. Wojciech Trzasko, Politechnika Białostocka**

The paper considers a class of linear 2D positive continuous-discrete time systems. The definitions of pointwise completeness and relative pointwise completeness are introduced and necessary and sufficient conditions are given. The considerations are illustrated by numerical example.

**44.**

**Identification parameters of fuzzy systems with immune algorithms dr inż. Bogumiła Mrozek, Politechnika Krakowska**

Fuzzy modeling is one of disciplines which is often used in systems identification, control, fault diagnosis, classification and decision support systems. Fuzzy model Sugeno-type is often used in data-driven identification. Construction methods based on fuzzy clustering originate from data analysis, where the concept of fuzzy membership is used to represent the degree to which a given data object is similar to some prototypical object. Over the last few years, there has been an increasing interest in the area of Artificial Immune Systems (AIS) and their applications. In this paper, the applications of the clonal selection have been proposed to obtain fuzzy models from data.

The clonal selection principle establishes the idea that only those cells which recognize the antigens are selected to proliferate. A computational implementation of the clonal selection principle explicitly takes into account the affinity maturation of the immune response. The algorithm, named CLONALG, is primarily derived to perform the machine-learning and pattern recognition tasks. Then it is adapted to solve optimization problems. The numerical learning data are used to determine number of rules and parameters of membership functions in initial fuzzy model with clustering algorithms (Fuzzy Logic Toolbox was used). This initial data-driven fuzzy model is compared with the same model obtained by clustering with clonal selection.

**45.**

**Using multidimensional digraph theory in analysis of positive systems - dr inż. Konrad Andrzej Markowski, Politechnika Warszawska**

In this paper presented the classical graph theory. Introduce the elementary definitions. Presented the one-dimensional digraphs and presented generalization on multi-dimensional digraphs. At the end presented connection between multi-dimensional digraph and positive one- and multi-dimension systems.

**46.**

**Algorithm of determination realization of positive two dimensional systems with delays - dr inż. Konrad Andrzej Markowski, Politechnika Warszawska**

In this paper a method for determination positive realization of two dimensional systems described by general model with delays using multidimensional digraphs theory is presented. The proposed method is illustrated by numerical examples.

**47.**

**Predictive controllers with presumed trajectory of control changes and efficient mechanism of output constraints handling - dr inż. Piotr Marusak, Politechnika Warszawska**

A method of taking into consideration constraints put on output variables in predictive control algorithms with presumed trajectory of control changes is presented in the paper. Thanks to different choices of function describing this trajectory one can influence behavior of the predictive controller. Thus, the algorithms under consideration offer bigger freedom of shaping properties of the controllers than the conventional algorithms. The proposed mechanisms of taking into consideration output constraints are relatively simple. Moreover, in favorable conditions, they make possible to take these constraints into consideration on the whole prediction horizon also in the case of analytical algorithms.

**48.**

**An explicit nonlinear predictive control algorithm based on neural modes - dr inż. Maciej Ławryńczuk, Politechnika Warszawska**

This paper describes a nonlinear Model Predictive Control (MPC) algorithm based on MLP (Multi Layer Perceptron) neural models. The neural model is linearised on-line around the current operating point. The value of the manipulated variable is calculated explicitly without any optimisation. The obtained solution is projected onto the admissible set of constraints imposed on the magnitude and the increment of the manipulated variable. The algorithm is computationally efficient because it needs repeating on-line a matrix decomposition task and solving linear equations. The algorithm gives good closed-loop control performance, comparable to that obtained in nonlinear MPC, which hinges on nonlinear optimisation.

## **SESSION IV - AUTOMATION AND ROBOTIC EQUIPMENT**

**49.**

**The Robin Heart system in vivo experiments – arrangement report - dr Zbigniew Nawrat, Fundacja Rozwoju Kardiologii, Zabrze, Śląski Uniwersytet Medyczny w Katowicach**

The presented work presents the current works led in Zabrze's team connected with project of Robin Heart surgical robot as well as the Robin Heart Uni System mechatronic surgical tools. The project enters in phase of experiment on animals. For the experiment, which will be carried out in January 2009 three operations on pigs: cholecystectomy, TECAB - the operation the coronary by-pass on beating heart as well as the repair operation of mitral valve are planned. The goal of these experiments are to show the

constructors the area of indispensable changes which they will be introduced to worked out devices before study of technology of serial production and clinical initiating.

**50.**

**The Robin Heart uni system mechatronic surgical tools** -*dr Zbigniew Nawrat, Fundacja Rozwoju Kardiochirurgii, Zabrze, dr inż. Paweł Kostka, Fundacja Rozwoju Kardiochirurgii, Zabrze, Politechnika Śląska w Gliwicach, mgr inż. Wojciech Dybka, mgr Wojciech Sadowski, mgr inż. Kamil Rohr, Fundacja Rozwoju Kardiochirurgii, Zabrze*

Present medicine develops in considerable measure thanks to the use of newest achievements of sciences as well as new methods, techniques and technologies introduction. Presented article is the review of directions of surgery tools development used in mini invasive surgery with special regard of own, currently performed experiences arrangement – project Robin Heart Uni Tools.

**51.**

**A low-cost, open architecture SCARA-type robot** - *mgr inż. M. Pabel, mgr inż. M. Prokopiak, P.P.H. WObit, Poznań, dr hab. inż. P. Skrzypczyński Politechnika Poznańska*

In this paper the design and software of a low-cost SCARA-type robot are presented. This robot has an open, modular architecture of the controller which can be easily extended by adding both additional effectors (robot axis) and sensors. The user of this robot has a broad choice of the communication interfaces to connect the robot to a PC, and a simple, user-friendly graphical programming environment. The main purpose of the developed robot is education, however the robot can be also an attractive choice for small or medium enterprises seeking a low-cost robotic solution to their packaging, sorting or assembly tasks.

**52.**

**The parametric configuration R-J3iB FANUC robot to work in master mode in the network PROFIBUS DP** - *mgr inż. Andrzej Nierychłok, dr hab. inż. Gabriel Kost, prof. Pol. Śl., Politechnika Śląska w Gliwicach*

This is a PROFIBUS DP network configuration in the system of production. Standard solution, in which the device master is supported using the PLC replaced by an alternative solution in which the FANUC company robot controller acts as a device master. Such rarely used, small structures characteristic of the network makes a lot of difficulties in terms of configuration driver robot-master. The example of this type of solution are at work.

**53.**

**The computer system of proportional steering the SONY cameras in modern tv-studio systems** - *mgr inż. Daniel Reclik, dr hab. inż. Gabriel Kost, Prof. nzw w Pol. Śl., Politechnika Śląska w Gliwicach, mgr inż. Katarzyna Baldys, Uniwersytet Śląski, mgr Stefan Falkiewicz, TVP Szczecin*

This paper describes the recording realization in mobile TV-studio systems. The main feature of this system is the possibility of remote motion control of robot cameras SONY in proportional way. Thanks to created computer program, this system permits steering of four cameras at the same time by using 4-axial computer joysticks. This paper also describes the advanced image processing and video recording used in worked out system, which were necessary to television broadcast realization in traditional way and via Internet.

**54.**

**A trajectory coordination model of two cartesian manipulators with drives dynamics - dr inż. Adam Słota, Politechnika Krakowska**

A model of two planar Cartesian manipulators including dynamics of electric drives with DC motors is presented in the paper. For position set values generation an algorithm of trajectory coordination with proportional-integral correction of programmed linear motion to the final position is used. For selected values of model parameters simulations were carried out and results are presented.

**55.**

**Mechatronics systems in motor rehabilitation - mgr inż. Wojciech J. Klimasara, mgr inż. Andrzej Bratek, mgr inż. Marek Pachuta, mgr inż. Zbigniew Pilat, Przemysłowy Instytut Automatyki i Pomiarów PIAP**

In this paper are shortly presented the mechatronic systems for support the motor rehabilitation of patients after stroke or orthopedic illness. The first system called RENUS-1 is designed for support the upper limb rehabilitation and the second system – RENUS-2 – is for the rehabilitation of lower limb. Both systems are created and built in the Industrial Institute for Automation and Measurements. They are the results of research tasks in the PW-004/ITE/02/2004 project covered by Multiyear Program that was coordinated by Institute of Operating Technology PIB in Radom.

**56.**

**On application of neural network for aided conceptual ship design - dr Maria Meler-Kapcia, Politechnika Gdańska**

In the paper the structure and error back-propagation neural network algorithm was presented to aid conceptual design for choosing of power output of ship's main engine (ME) based on the general ship's parameters (mainly its dimensions). This algorithm was elaborated in Visual Basic language and may be used for every parameters number as ship's constructed database fields. Obtained results may be used for project's verification in which similarity of ships is not used.

**57.**

**Analysis of capability of using SciLab for adding design of power ship subsystems - dr hab. inż. Ryszard Arendt, mgr inż. Andrzej Kopczyński, Politechnika Gdańska**

This paper deals with a problem of mathematical models application and simulation

environment Scilab in design process of ship power subsystems. Model of Diesel engine and ship propeller screw are presented in exemplary structure of ship propeller unit. The models will be used in expert system for aided design of ship power systems.

**58.**

**Programming an SMC LUMEL controller for a mini-distributed system in ST language** - *mgr inż. Dariusz Rzońca, mgr inż. Jan Sadolewski, dr inż. Andrzej Stec, dr hab. inż. Zbigniew Świder, dr inż. Bartosz Trybus, prof. dr hab. inż. Leszek Trybus, Politechnika Rzeszowska*

A technique for programming control-and-measurement minisystem involving an SMC LUMEL controller, distributed I/O modules and PC host computer, using ST language is presented. ST is available in CPDev engineering package. Modbus communication protocol is used. CPDev consists of a compiler, simulator and configurer of hardware resources. Control of simple central heating installation is a design example.

**59.**

**Polish compiler and controllers programmed in Instruction List language of IEC 61131-3 standard** - *mgr inż. Jan Sadolewski, Ewelina Szmyd, Politechnika Rzeszowska*

The paper presents a prototype compiler of IL (Instruction List) language from IEC 61131-3 standard. The compiler is a component of CPDev engineering environment for programming of industrial controllers. The CPDev has been developed at Technical University of Rzeszów. IL code conversion into tree expressions to be processed by the CPDev's ST compiler is described. Compilation result is an indirect binary code interpreted by dedicated virtual machines implemented in controllers with different processors (AVR, ARM, MCS-51) and PC computers.

**60.**

**Programing and visualization of Modular Production System based on B&R systems** - *dr inż. Grzegorz Wszolek, mgr inż. Paweł Zwoliński, Politechnika Śląska*

This article describes example of practical application of distributed control system in FESTO Modular Production System (MPS) which is in the Laboratory of Automatics, Mechatronics, Integrated Manufacturing Systems and Production Management Methods at the Faculty of Mechanical Engineering, Silesian University of Technology. It includes all important aspects common for replacing of control systems and configuring new solution based on CAN industrial net. Beside this information article describes newly created HMI visualization which is entirely new solution for the MPS. This solution gives real time possibility to interact with machine from active display panel. Visualization window shows all actions which take place in real model as a frame-view from each of it modules and communicates.

**61.**

**Building of rules based aircraft control system** - *dr inż. Piotr Golański, pilot mgr inż.*

*Henryk Szkudlarz, Instytut Techniczny Wojsk Lotniczych*

This paper presents the method of building of aircraft control model. Here, the focus is on the model of taking off procedure. For this purpose the fly instruction and pilot knowledge has been used. Finally, the model formalization and simulation results, has been presented.

**62.**

**Experimental research of optical modulator** - *dr inż. Izabela Krzysztofik, mgr inż. Adam Rozenau, Politechnika Świętokrzyska*

The paper presents a new pattern of optical modulator. It can be applied in the heads of self-guided missiles. There are results of experimental research and conclusions.

**63.**

**A concept of the design of a system for locating the angular position of a high-voltage power line to be mounted in aerial vehicles** - *dr inż. Janusz Tuśnio, Politechnika Świętokrzyska*

The paper is concerned with the concept of a system for detecting and determining the position of an overhead high- or medium-voltage power line in relation to an aerial vehicle. The analysis takes into account signals emitted by the line as well as the accompanying disturbances. The considerations include the advantages and disadvantages of different design variants for the particular functional blocks. The system can be used as part of a device for guiding an aerial vehicle onto a power line or for preventing their collision.

**64.**

**Guidance and control system for aircrafts' bombs** - *dr inż. Robert Głębocki, Politechnika Warszawska*

In the paper are presented some results of researches about GPS guided bombs'. Authors described the gasodynamic control system and algorithms based on predictive flight trajectories. Researches are based on computer simulations.

**65.**

**Flight control systems for smart bombs and projectiles** - *dr inż. Robert Głębocki, Politechnika Warszawska, dr hab. inż. prof. nzw. Ryszard Vogt, Wyższa Szkoła Oficerska Sił Powietrznych*

The paper presents some problems of control systems for smart bombs and missiles. Authors described important aspects of single channel, gasodynamic and aerodynamic methods of control for small flying objects like smart bombs and missiles.

**66.**

**Regulator For coal boilers with spiral feeders** - *mgr inż. Maciej Szumski, Politechnika Warszawska*

The paper includes a brief description of processes occurring during burning of coal in a coal boiler, measured characteristics of such boilers and an implementation of a burn process controller. The goal is to create control algorithms ensuring ecological and economical process of burning coal in boilers with spiral feeders. Presented is an implementation of Fuzzy Logic algorithm based on static characteristics of a boiler.

**67.**

**Synthesis of sequential control algorithms using Grafcop method** - *mgr inż. Łukasz Dworzak, mgr inż. Sergiusz Ciskowski, prof. dr hab. inż. Tadeusz Mikulczyński, dr inż. Marian Bogdan, Politechnika Wroclawska*

Described in IEC 1131-3 standard SFC (Sequential Function Chart) programming language of PLC controllers still, in spite of several years that passed since it was defined, can't find wide application. Even today SFC language can be used to program only a few PLC controllers. The most common language used to program PLC controllers is LD (Ladder Diagram) language which takes its origin from contact-relay language. Besides its undoubted advantages which are small hardware requirements – due to small storage area needed – this language processes user program cyclically forcing use of memory and making its application difficult. Developed methods of determining memory forms and application places in control algorithm are still not satisfying. In that case problem of memory usage in LD language has been raised again. The aim of carried out scientific research was to develop rapid and unequivocal method to determine memory form and place of its application in control algorithm of sequential procedures.

**68.**

**Algorithms of control electrohydraulic drive by swinging motion haptic joystick with magnetorheological fluid and force feedback** - *dr inż. Piotr Gawłowicz, mgr Marcin Chciuk, mgr inż. Paweł Bachman, Uniwersytet Zielonogórski*

The article describes control system of electrohydraulic servo drive with additional force feedback. The structure of magnetorheological rotary brake and the research of relation between torque and current are presented. The last section forms results based on the research electrohydraulic servo drive's control system with magnetorheological haptic joystick by two different control algorithms.

**69.**

**Robot arm controlled by a three-axial haptic joystick with magnetorheological fluid and force feedback** - *dr inż. Piotr Gawłowicz, mgr Marcin Chciuk, mgr inż. Paweł Bachman, Uniwersytet Zielonogórski*

The article includes multiaxial haptic joystick's specification, studies of rotary dampers with magnetorheological fluid and description of robot's control system as well as the construction of the robot used for the research. Finally, a research result is presented.

**70.**

**LQR control of smart beam with piezoelectric elements** - *prof. dr hab. inż. Zdzisław*

*Gosiewski, mgr inż. Andrzej Piotr Koszewnik, Politechnika Białostocka*

An active vibration damping system with the use of piezoelements in quasi-optimal location is presented in the paper. Identified and reduced mathematical model of open-loop system was used to verify earlier obtained the first four natural frequencies of the beam. This model was also used to design appropriate linear quadratic state-feedback regulator (LQR).

In the next stage control law was chosen and it was checked out in simulation and experimental investigations. Obtained time and frequencies domain plots have proved that designed controller very strongly damps the vibration of the active beam.

**71.**

**Optimal control of magnetic bearings for flywheel** - *dr inż. Arkadiusz Mystkowski, prof. dr hab. inż. Zdzisław Gosiewski, Politechnika Białostocka*

In the paper the optimal robust controller based on  $\mu$ -synthesis is applied to control of active control bearings (AMB) for a high speed Flywheel. A design methodology of robust controllers is presented with considering of uncertainties, nonlinearities, selection of optimal weighting functions and control law reduction. The controllers synthesized for the augmented plant model which meet analysis objectives ( $\mu \leq 1.0$ ) will stabilize the actual plant and meet specified performance objectives. The MES-model of the rotor is investigated and modal analysis is performed due to critical speeds. The simulation results are performed and all  $\mu$ -synthesized controllers developed in this study were stable over the operating range. The main goal of the paper is the experimental evaluation of the controlled magnetic bearings performances for Flywheel application. For this purpose the laboratory stand with the high speed rotor (24 000 rpm) supported magnetically was built. The dynamical behavior of the closed-loops systems in wide range of rotation speeds was performed. The stable operation, good stiffness of the rotor and robust performances of the closed-loop systems were reached.

## **SESSION V - MEASUREMENTS DEVICES AND SYSTEMS**

**72.**

**Pressure measurement in disintegrated medium** - *prof. dr hab. inż. Tadeusz Mikulczyński, dr inż. Stanisław Fita, mgr inż. Sergiusz Ciskowski, mgr inż. Łukasz Dworzak, Politechnika Wroclawska*

Application of a piezoelectric sensor for pressure measurement in disintegrated medium (e.g. moulding sand) has been presented. For non-directional pressure measurement in disintegrated medium, a piezoelectric sensor must be equipped with inertialess liquid adaptor. Results of pressure measurement during dynamic moulding sand densening process can be used for experimental verification of formulated mathematical model of dynamic densening and deformation of moulding sand. These results can be useful in determining mould's strength.

**73.**

**estimation of track cross inclination in high speed motion** - *dr inż. Stanisław Popowski, mgr inż. Witold Dąbrowski, Instytut Lotnictwa*

The article presents methods for track cross inclination estimation, performed during high speed motion of the vehicle. The process is realized in two phases. The first phase is the measurement of the appropriate gravity vector component, performed on vehicle located platform, while the transversal acceleration resulted from the motion along curved trajectory is taken into account. The second phase is the integration of the measured angular velocity. The estimation process is finalized by the fusion of the results of both phases.

**74.**

**A problem of low airflow velocities measurement** - *dr inż. Stanisław Popowski, Instytut Lotnictwa, Warszawa*

In the article some problems of low airflow velocity measurement are presented. These measurements are used in investigations of several flying objects like helicopters, gliders, ultra-light aircraft, hovercraft and UAVs. Two simple measuring methods are proposed. The first one is based on the system of turbine anemometers, while the second one is based on GPS and pressure sensor output signals fusion. Experimental results presented in the paper prove the applicability of discussed methods for substantial projects.

**75.**

**Determination of devices measurement ability in case of vector bar** - *mgr inż. Rafał Wypysiński, Politechnika Warszawska*

New method and device for accuracy testing of numerical control machines (NC) was developed in Institute of Manufacturing Technology at Warsaw University of Technology. There were many tests realized for taking a decision about whole system's ability. New methods of measurement devices testing and already worked out methods were used.

**76.**

**The chosen usage of thermographic measurements in machining** - *dr inż. Jerzy Józwik, Politechnika Lubelska*

The article presents the areas of usage measurements in machining. The range of work includes the problems of heat generation during machining and measurement with using thermographic system. The article presents practical areas of using thermographic technique during evaluation of thermal state of cutting tool, workpiece and machine tool also. Author presents some of research and analysis results of object temperature distribution with using thermographic system.

**77.**

**Resolution and uncertainty of measurement result** - *dr Albin Czubla, mgr Paweł Fotowicz, Główny Urząd Miar*

In this paper, the way of accounting the resolution in evaluation of uncertainty of

measurement result was presented. It was based upon metrological experiences of authors, collected during performance of measurements for calibration and analysis of influence of factors concerning the measurement instrument and measurement method on uncertainty of measurement result. The special attention was paid into problems occurring in practice.