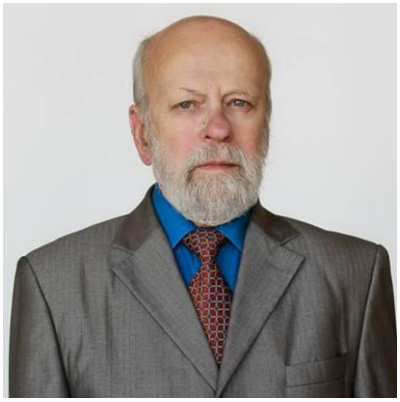
KEYNOTE SPEAKERS

GRAPH-STRUCTURAL MODELING AND ANALYSIS OF FINITE FLUCTUATIONS



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The problem of loops accounting in the incidence matrices of digraphs and ormetagraphs is considered in the first part of the report devoted to graphostructural modeling. Metagraphs are a link in the chain of development of graph structures following after graphs and hypergraphs. A metagraph is defined as a triple M=(V,MV,MA), where V is a set of vertices, MV MV is a set of meta-vertices that are hyperedges of the hypergraph H=(V,MV) associated with the metagraph, MA – is the set of meta-arcs that are arcs of the digraph G=(MV,MA). The incidence matrix I(V,MA) of a metagraph without loops defines a Laplacian admitting the decomposition L(V,MA)=I(V,MA)·IT(V,MA) = D + A(+) – A(–),where D is the valence matrix (degrees of vertices), A(+) is the adjacency matrix of vertices lying in the same meta vertices, A(–) – is the adjacency matrix of vertices lying at different ends of the meta-arcs. The problems associated with the formation of incidence matrices in the presence of loops in graphs and metagraphs and an approach based on the block representation of incidence matrices are discussed. The second part of the report is devoted to the main task of analyzing changes in variable quantities that is the constructing a mathematical model using the existing mathematical model of the dependence of quantities of the dependence of changes in these quantities. The fundamentals of the analysis of changes, the difference between the analysis of finite changes and classical mathematical analysis, its main provisions based on the first (Lagrange) and second (Bonn) mean theorems, direct algebraic analysis of finite changes are discussed.

OPPORTUNITIES FOR IEEE MEMBERS (workshop)

Yousef IBRAHIM
Prof.
Australia,
Federation University Australia,
Gippsland Campus

Yousef Ibrahim (B.Sc. Mech. Eng.; M. Tech. Systems Eng.; PhD Robotics, FIEAust., SMIEEE) is currently a Professor of Engineering with Federation University Australia, Gippsland Campus. He joined Monash University where he established the first course in industrial robotics and robotics laboratory. In 1992 he developed Grad Cert of Reliability Engineering with funds from the State Electricity Commission of Victoria (SECV) and the Victoria Education Foundation. In 1997 he developed the master degree program in maintenance and reliability engineering. This program is going strong with 45 intakes in 2014. Yousef also initiated and developed the Monash's degree in mechatronics which is currently offered at both Clayton and Kuala Lumpur campuses. In 1998-2000 he was the mechatronics subprogram leader to help in the establishment of mechatronics programs in six Thai universities as part of AusAID program to the Royal Thai Government. With commitment to serve regional Gippsland industry through his expertise in industrial automation, Yousef founded the Gippsland Regional Automation Centre (GRACe) in 2005. GRACe was established as $1Million project through a grant from the State Government and two industrial partners. This is to help Gippsland regional industry to become more sustainable by enhancing its national and international competitiveness through intelligent automation. Yousef is also on a ministerial advisory committee to the State Minister for Innovation and Small Business. He is serving in this advisory capacity for the fifth consecutive term under different Labour and Liberal governments. He is currently convening an advisory subcommittee on the Ministerial Advisory Council for Regional Victoria. Yousef is usually invited as a guest speaker on food processing automation in Australia and overseas. He was the general chair of several prestigious international conferences including the IEEE ICIT 2009 in Australia, IEEE INDIN 2012, Beijing, IEEE ICIT 2013, South Africa and IEEE ICELIE 2013, Vienna. In addition he was a Technical Program Chair for IEEE IECON 2011, Australia and ICIT 2012, Greece. He is currently the vice-president, IEEE Industrial Electronics Society for Conferences and the Chair of the standing committee on Education. He has been visiting Professor, University of Poitiers, France 2013 and he is also a Fellow of the Institute of Engineers Australia. Yousef is currently establishing a new degree program in mechatronic systems Engineering to be offered through Gippsland Campus of Federation University Australia.

RECENT DEVICE TOPOLOGIES AND CONTROL METHODS IN RESIDENTIAL PV POWER CONVERSION

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The grid-connected solar inverters are the key devices interfacing solar power plant with utility and play crucial role in residential PV applications. Although three-phase inverters were industry standard in large photovoltaic (PV) power plant applications, the microgrid regulations increased the use of single-phase inverters in residential power plants and grid interconnection. This speech presents a detailed review on single-phase grid-connected solar inverters in terms of their improvements in circuit topologies and control methods. The content provides a differentiating approach by focusing on novel circuit topologies and control methods of string and micro inverters. The single and multi-stage solar inverters are reviewed in terms of emerging DC-DC converter and unfolding inverter topologies while the novel control methods of both stages will be presented in a comprehensive manner. The isolated and transformer less circuit topologies have been investigated by experimental and commercial devices. The soft computing, evolutionary and swarm intelligence-based algorithms will also be summarized in MPPT methods section while current injection and grid-connection control methods of unfolding inverters stage are presented with and without PLL architecture.

THE LINEAR MATRIX INEQUALITY TECHNIQUE IN CONTROL SYSTEMS

Mikhail V. KHLEBNIKOV
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V.A. Trapeznikov Institute of Control Sciences RAS

A lot of modern problems of automatic control are characterized by large dimensions, the presence of uncertainty in the description of the system, the presence of uncontrollable exogenous disturbances, and a number of other factors that complicate the application of classical methods of the control theory. In this regard, the technique of linear matrix inequalities (LMIs) is very promising. The talk is devoted to the results of new studies that significantly develop the LMI technique and use it to solve the applied problems.

We consider the application of the LMI technique in three main directions:

- we consider the problem of rejection the unknown-but-bounded exogenous disturbances. The LMI technique allows to reduce the controller design straight to the problem of semidefinite programming;
- also, we consider a new approach to the design of sparse feedback in linear control systems; it can be interpreted as reduction of the control resource required to handling the system. The problem reduces to the minimization of special matrix norms subject to the LMI constraints;
- we propose the LMI-based design procedure which guarantees “as small as possible” deviations in the closed-loop control systems by means of properly chosen linear feedback.

A PLATFORM-BASED APPROACH TO IMPLEMENTATION OF FUTURE SMART DISTRIBUTED ENERGY CONTROL SYSTEMS

Sergey P. KOVALYOV
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JSC RTSoft project curator

Smart distributed energy is a combination of advanced power and information technologies that enable reliable and efficient management of electrical grid segments with distributed energy sources. Smooth operation of such segments requires high level of unification and automation for such procedures as information exchange between participants of management cycles, optimal operation planning for equipment included into physical or virtual groups, clearing of financial transactions, etc. In order to meet such requirements with minimal time and labor, it is proposed to compose and operate applied control systems within the framework of a digital platform. The platform architecture is presented based upon reusable functional microservices. Platform applications that automate various business functions of smart distributed energy control are outlined. Algorithms are presented as part of the platform’s mathematical means, for automatic modeling and analyzing electrical modes, forecasting load/generation, and solving optimization control problems. Procedures for composing and operating digital twins of smart distributed energy facilities over the platform's data bases and streams are described.

MACHINE LEARNING ALGORITHMS IN RECOMMENDATION SYSTEM FOR DIAGNOSIS OF BREAST CANCER ACCORDING TO MICROWAVE RADIOTHERMOMETR

Alexander LOSEV
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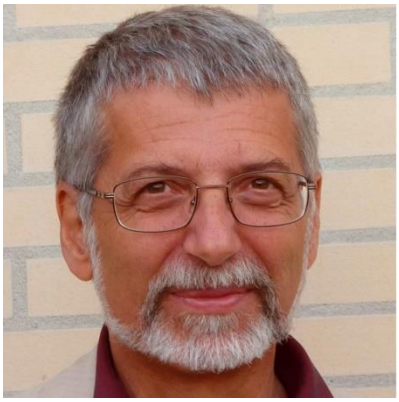
Volgograd State University

The report is devoted to issues related to the development of recommendatory systems for breast cancer diagnostics based on microwave radio thermometry data. Microwave radiometry is a modern method of medical diagnostics based on the measurement of the own electromagnetic radiation of human tissues in the infrared and microwave ranges of waves. Over the past two decades, this method has proven itself in many areas of medicine. In doing so, a number of problems were identified. One of the most urgent of these is the development of methods for qualitative analysis and interpretation of thermometric data. At the same time, the problem of classification should be solved, that is, the assignment of the examined patient to the corresponding diagnostic class. A solution to these problems is proposed based on the construction of a specific feature space. Its construction is based on descriptive hypotheses based on current medical knowledge, as well as an analysis of the behavior of solving boundary value problems of the corresponding physical and mathematical models of thermal and radiation fields.

WHAT ARE THE CONSEQUENCES FROM THE COVID-19 FOR THE POWER ELECTRONICS?



Stanimir VALTCHEV
Prof.
Portugal, Lisboa,
Universidade Nova de Lisboa

Strange looking is our world today. We seem to be like small children lost in the complicated assessing, calculation of what is right and what is wrong, what future we have...The Covid-19brought new limitations and losses into our lives but brought possible gains too. China has 5% GDPrise in this trimester, and Europe has 10% loss of GDP in the same time. The human social behaviouris guided by a small bit of science and great part of prejudices... Where is the role of the engineers in this messy world?

During the confinement the total electrical consumption dropped drastically, but in some countries, the electricity consumption recuperated very quickly after the alleviations of the confinement in April. China and India, and some other that traditionally produce high technology, like Germany. In the end of the day, the fossil fuels suffered most from relatively high operating labour. The nuclear energy and the renewable energy sources are the big winners. The «Classical» electrical AC grids have intrinsically little energy storage and flexibility, and worst of all, the topology is not flexible. It is now unavoidable, to substitute the fossil fuels. It was made clear also, that the renewable energy sources turned everything more complicated and difficult to synchronize the biggest consumers with the smallest individual producers of energy.

A Low Voltage (LV) DC grid is capable by its nature to be a Smart Grid, easily distributing energy between «prosumers»;. The DC-DC conversion in almost all its versions applies the magnetic field as a power link. That «magnetic coupling» can be made stronger or weaker. Considering the magnetic coupling of our DC-DC converters, the wireless energy transfer is also magnetically linked, in all its versions. The magnetic field connections of the renewable energy sources into the micro-, or larger DC grid, will be more reliable and less dangerous for the human beings and the animals. The separate blocks can be easily connected magnetically even by unqualified workers and clients.

A MESHFREE METHOD WITH DOMAIN DECOMPOSITION FOR HELMHOLTZ BOUNDARY VALUE PROBLEMS

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Meshfree methods are becoming an increasingly popular alternative to classical numerical methods, using finite elements or finite differences, for the approximate solution of boundary value problems(BVP) for partial differential equations (PDE). Avoiding the time consuming and computationally demanding mesh generation and numerical integration are major advantages of these methods. Furthermore, most meshfree algorithms are simple to implement and, in smooth settings, out perform the classical schemes in terms of their convergence and accuracy. In the framework of meshfree methods, we address the numerical solution of BVPs for the non-homogeneous modified Helmholtz PDE. In particular, the unknown solution of the BVP is computed in two steps. First, a particular solution of the PDE is approximated by superposition of plane wavefunctions with different wavenumbers and directions of propagation. Then, the corresponding homogeneous BVP is solved, for the homogeneous part of the solution, using the classical formulation of the method of fundamental solutions (MFS). The combination of these two meshfree techniques shows excellent numerical results for non-homogeneous BVPs posed in simple geometries and when the source term of the PDE is sufficiently regular. However, for more complex domains or when the source term is piecewise defined, the MFS fails to converge. We overcome this problem by coupling the MFSwith Lions non-overlapping domain decomposition method. The proposed technique is tested for the modified Helmholtz PDE with a discontinuous source term, posed in an L-shaped domain.