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Section TA3. **NONLINEAR CONTROL - II**

Section TA4. **STABILITY AND CONTROL PROBLEMS IN MECHANICS - II** (Invited)

Section TA5. **BEAM DYNAMICS: MODELLING, CONTROL AND OPTIMIZATION - II** (Invited)

Section TA6. **MECHANICAL ENGINEERING APPLICATIONS - I**

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Section TM1. **ANTI-CONTROL OF CHAOS: THEORIES, METHODS, AND APPLICATIONS** (Invited)

Section TM2. **QUANTUM MEASUREMENT, FILTERING, AND QUANTUM FEEDBACK CONTROL** (Invited)

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Section TP2/1. **THEORY OF MOLECULAR AND QUANTUM CONTROL - I** (Invited)

Section TP2/2. **THEORY OF MOLECULAR AND QUANTUM CONTROL - II** (Invited)

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Section TP5/1. **TURBULENCE AND CONTROL**

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Friday, August 22

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Section FA1. **SYNCHRONIZATION**

Section FA2. **QUANTUM INFORMATION AND CONTROL**

Section FA3. **OPTIMAL ISOLATION OF MECHANICAL DISTURBANCES** (Invited)

Section FA4. **CONTROL OF DISTRIBUTED SYSTEMS - I**

Section FA5. **SELF-ORGANIZATION, COMPLEXITY AND CONTROL - II**

Section FA6. **BIOMEDICAL APPLICATIONS**

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Section FM1. **CONTROL OF CHAOS - II**

Section FM2. **CONTROL OF NANOSTRUCTURES**

Section FM3. **CONTROL OF MECHANICAL SYSTEMS**

Section FM4. **CONTROL OF DISTRIBUTED SYSTEMS - II**

Section FM5. **CHEMICAL ENGINEERING APPLICATIONS**

Section FM6. **CHAOS AND RHYTHM: PRODUCTION AND PERCEPTION OF SPEECH** (Invited)

Section WP1.

Control and Synchronization in Chaotic Systems (Invited)

Noise-Enhanced Phase Synchronization of Weakly Coupled Chaotic Oscillators
J. Kurths, C.S. Zhou (*Germany*)

Experimental Characterization of the Transition to Phase Synchronization of Chaos
S. Boccaletti, E. Allaria, R. Meucci, F. T. Arecchi (Italy)

Phase Synchronization in Ensembles of Coupled Phase Systems
V.N. Belykh (*Russia*)

Controlled Phase Synchronization in Oscillatory Networks
V.N. Belykh, G.V. Osipov (*Russia*)**, J. Kurths** (*Germany*)

Chaos Control of Nonlinear Current Oscillations in Semiconductor Heterostructures
E. Schöll, A. Amann, W. Just, J. Schlesner, J. Unkelbach (*Germany*)

Using Nonisochronicity to Control Phase Synchronization in Ensembles of Nonidentical Oscillators
B. Blassius (*Germany*)

Section WP2.

Geometric and Optimal Control Methods for Quantum Dynamical Systems (Invited)

Controllability of Open Quantum Systems: the Two Level Case
C. Altafini (*Italy*)

Design of Laser Pulses for STIRAP Processes with Geometric Control Techniques
U. Boscain (*France*)**, G. Charlot** (*Italy*)

Controllability and Diameter of Single-Input Quantum Systems
A. Agrachev (*Italy*)**, T. Chambrion** (*France*)

Resonance in n-level Quantum Systems
U. Boscain (*France*)**, G. Charlot** (*Italy*)

The Dynamical Inverse Problem for a Nonlinear Schrodinger Equation Using Boundary Control
M. Tomas-Rodriguez, S.P. Banks (*UK*)

Optimal Control of Coupled Spins in Presence of Longitudinal and Transverse Relaxation
D. Stefanatos, N. Khaneja (*USA*)**, S.J. Glaser** (*Germany*)

Section WP3.

Nonlinear Control – I

Stabilization of Nonlinear Systems by Derivative Control
I.E. Zuber (*Russia*)

Synthesis of Optimal Feedback for Nonlinear Control Systems
N.V. Balashevich (*Belarus*)

Reducibility and Reduction of Discrete-Time Nonlinear Control Systems: Comparison of Two Approaches
Ü. Kotta (*Estonia*), **E. Pawluszewicz** (*Poland*), **S. Nõmm** (*Estonia*)

LMI Technique for Stabilization of a Linear Plant by a Pulse-Modulated Signal
A.N. Churilov, A.V. Gessen (*Russia*)

Robust Stabilizing Control of Discrete-Time Jumping System via Static Output Feedback
P.V. Pakshin, D.M. Retinsky, A.V. Ryabov (*Russia*)

Generalized Flat-Algorithm for Solving Two Points Control Problem
A.M. Kovalev (*Ukraine*)

Section WP4.

Stability and Control Problems in Mechanics - I (Invited)

Theory of Parametric Resonance: Modern Results (Invited)
A.P. Seyranian (*Russia*)

To the Stability of Non-Conservative Systems in One Degenerate Case
S.A. Agafonov (*Russia*)

Ultralow Parasitic Eigenvalues for Oscillation Problem of a Guided Elastic Flying Vehicle that Contains Integrating Section in a Feedback Loop
S.V. Arinchev (*Russia*)

Nonconservative Stability Problems for Axially Compressed Rectangular Plate
M.V. Belubekyan, V.M. Belubekyan (*Armenia*)

Non-Conservative Oscillations of a Tool for Deep Hole Honing
A.M. Gouskov, S.A. Voronov (*Russia*)**, E.A. Butcher, S.C. Sinha** (*USA*)

Section WP5.

Beam Dynamics: Modelling, Control and Optimization - I (Invited)

Control of Momentum-Compaction Factor in Synchrotron with "Resonant" Lattice (Invited)
Yu. Senichev (*Germany*)

Control of Space Charge Redistribution to Correct Aberrations in Charged Particle Beams
Yu.V. Zuev (*Russia*)

Actual Problems of Beam Physics Computing
S.N. Andrianov (*Russia*)

Optimization and Beam Control in Large-Emittance Accelerators: Neutrino Factories
C.J. Johnstone, M. Berz, D. Errede, K. Makino (*USA*)

Mathematical Control Model for Beam Dynamics Optimization
D.A. Ovsyannikov, A.D. Ovsyannikov (*Russia*)

Section WP6.

Aerospace Applications

Tracking Trojan Asteroids in Periodic and Quasi-Periodic Orbits around the Jupiter Lagrange Points Using LDV Techniques
F. Ariaei, E. Jonckheere, S. Bohacek (*USA*)

Controlled WIG Flight - Stability and Efficiency Problems
A.V. Nebylov (*Russia*)

Reliable H2 Static Output-Feedback Tracking Control Against Aircraft Wing/Control Surface Impairment
F. Liao, J.L. Wang, G.-H. Yang (*Singapore*)

Some Peculiarities of Operative "Okean-O" Control
V.A. Udaloy, N.M. Ivanov, N.L. Sokolov, V.U. Pazdnikov (*Russia*)

An H∞-Technology for the Detection and Damping of Divergent Oscillation in Updatable Inertial Systems
A.V. Chernodarov, V.N. Kovregin (*Russia*)

Strongly Nonlinear Dynamics of a Gyrostat Respinup by Weak Control
Ye.I. Somov, G.P. Titov, S.A. Butyrin, V.A. Rayevsky, A.G. Kozlov (*Russia*)

Poster Session

Quantum Stochastic Weyl Operator
L. Accardi (*Italy*), **A. Boukas** (*Greece*)

Kinematic and Geometric Description of the Solid Motion in the Gravity Field
V. Adamyan, G. Zayimtsyan, L. Manandyan (*Armenia*)

Kinematic Technique of Ideal Gas Thermodynamic Surface Forming
V. Adamyan, G. Zayimtsyan, V. Adamyan (*Armenia*)

On the Stability and Vibrational Stabilization of a Class of Nonlinear Systems
A.Yu. Aleksandrov, A.V. Platonov (*Russia*)

Resonance and Speed-Gradient Design of Control Algorithms for Dissociation of Diatomic Molecule Ensembles
M. Ananjevsky, A. Efimov, A. Fradkov, A. Krivtsov (*Russia*)

Phase Relations in the Synchronized Motion of Two-Pendulum System
B.R. Andrievsky (*Russia*)

Coherent Control of Vibrational-Rotational Transitions in Diatomic Molecule under the Action of Bichromatic Laser Field
V.A. Astapenko (*Russia*)

Modeling of Excited States of a Crystal Basing on the Frequency-Phase Synchronization of Vibrations of Crystal Site Lattice
L.A. Bityutskaya, S.G. Zhitskey (*Russia*)

Root Estimator of States
Yu.I. Bogdanov (*Russia*)

Modeling and Identification of the Structure Defects in Dielectric Diodes
V.M. Bogomol'nyi (*Russia*)

Speed-Gradient Control of Cooled Atom Dynamics in Potential of Standing Wave
S.V. Borisenok, Yu.V. Rozhdestvensky, A.L. Fradkov, B.R. Andrievsky, B.G. Matisov (*Russia*)

Scale Splitting Control for an Atom Wave Packet Coherent Scattering in Modulated Standing Wave
S.V. Borisenok, Yu.V. Rozhdestvensky, G.G. Udov (*Russia*)

Control of Chaotic Behavior in High Order Dynamical Systems
A. Boukabou, N. Mansouri (*Algeria*)

Multiscale Stochastic Dynamics in Finance
E. Capobianco (*The Netherlands*)

Wavelets in the Propagation of Waves in Materials with Microstructure
C. Cattani (*Italy*)

An Electromagnetic Model for Charged Particle with Spin
A.A. Chernitskii (*Russia*)

Nonlinear Parametric Processes in Modern Quantum Information
F. De Martini (*Italy*)

On Detection of Belonging of Two Points to One Trajectory
A.V. Demin (*Russia*)

Control of Spacial Structures in a Semiconductor-Gas Discharge System with a Semi-Insulating GaAs Cathode
E. Gurevich (*Russia/Germany*), **Yu. Astrov** *(Russia)*, **H.-G. Purwins** (*Germany*)

Adaptive PID Controller for Nonlinear Systems with H∞ Tracking Performance
H.F. Ho, Y.K. Wong, A.B. Rad (*China*)

Chaos in Germanium Oscillistor
Kh.O. Ibragimov, K.M. Aliev, I.K. Kamilov, N.S. Abakarova (*Russia*)

The Control of Hysteresis Loops Parameters of Vanadium Dioxide Films by Semiconductor - Metal Phase Transition
A. Ilinskii (*Russia*)

Control of Quantum State by Decoherence
K. Imafuku (*Japan*)

Non-Linear Dynamical Behavior in a Railway Bogie Model
V.G. Inozemtsev, T.A. Tibilov (*Russia*)

Adaptive Nonlinear Control of Induction Motor Using Neurals Networks
N. Kabache, B. Chetate (*Algeria*)

Estimation of Transport Times for Chaotic Dynamical Control Systems
S.M. Khryashchev (*Russia*)

Construction Principles and Control over Transport Systems Organization in Biological Tissues
N.N. Kizilova (*Ukraine*)

Identification of the Level of Management Based on Power Law Scaling
E.V. Kleparskaya (*Russia*)

Influence of the Harmonic Disturbance on Control Motions of a Mechanical System
G. Kostin (*Russia*)

Control Discrete Systems and Their Applications to Beam Dynamics Optimization
E.D. Kotina (*Russia*)

Physical Control and Monitoring in Modern Medicine
V.K. Koumykov (*Russia*)

1/f Fluctuations under Heat and Mass Transfer with Phase Transitions
V. Koverda, V. Skokov (*Russia*)

Kolmogorov Complexity: How a Paradigm Motivated by Foundations of Physics Can Be Applied to Robust Control
V. Kreinovich, I.A. Kunin (*USA*)

Identification of Non-Measurable Parameters of Ferroelectrics by Optimization Method
S.A. Kukushkin, A.V. Osipov, P.Yu. Guzenko (*Russia*)**, V.V. Spirin** (*USA*)

Integration of Simulation Methods in Control System for EB Processing
V.T. Lazurik, V.M. Lazurik, G.F. Popov, Yu.V. Rogov (*Ukraine*)

Modeling and Controlling the Heart Conductive System
A. Loskutov, S. Rybalko, E. Zhuchkova (*Russia*)

Uncontrollability Set for Multi-Input Dynamical Systems Depending on Parameters
A.A. Mailybaev (*Russia*)

Modeling of Negative Resistance for Resistive Transducers Linearisation
Kh. Mamikonyan (*Armenia*)

Nuclear Magnetic Resonance and Stochastic Dynamics Methods in Identification of Fractal Structures in Hydrated Layers of Porous Crystals
A. Mamykin, M. Knyazev, N. Tabolina (*Russia*)

Stability of the Discrete Population Model with Two Delays
R.M. Nigmatulin, M.M. Kipnis (*Russia*)

Fokker-Planck Equation for Charged Particle Beams
Z. Parsa (*USA*)**, V. Zadorozhny, V. Yavorskij, S. Rudenko** (*Ukraine*)

Complex Systems Control Taking into Account the Internal Homogenious Structures
V.N. Pilishkin (*Russia*)**, I. Tollet** (*Finland*)

Mechanism of Impulse Flows Synchronization in Neuronal Network of Visual System
N.P. Podvigin, T.V. Bagaeva, J.M. Markova, D.N. Podvigina (*Russia*)**, E. Poeppel** (*Germany*)

Quantum System Identification
M. Raginski (*USA*)

Simulation Models to Obtain X-Ray Spectra Using the Compton Scattering Technique
J. Ródenas, S. Gallardo, M.C. Burgos (*Spain*)

Thin Films Induced by Nanometric Powders Flotation
I. Sandu, I. Morjan, I. Voicu, R. Alexandrescu, F. Dumitrache, I. Soare, I. Ploscaru, M. Fleaca, E. Popovici (*Romania*)

Oscillatory Self-organization Processes at Enantiotropic Transformations of Iron Sulfate Based Deposits
N. Sergeeva, V. Korsakov, Y. Nakanishi, S. Mjakin, V. Gnatyuk (*Russia*)

Nonlinear Modeling and Predictive Control of Molten Carbonate Fuel Cells Stack
Shen Cheng, Yu Li-yun, Cao Guang-yi (*China*)

Comparative Study of Interference Elimination in Heavy Metals Control by Anodic Stripping Voltammetry Method
E.A. Sosnin, V.N. Batalova, E.Yu. Buyanova, V.F. Tarasenko (*Russia*)

Parametrically Induced Stochastic Synchronization
O.V. Sosnovtseva, V.V. Astakhov, A.V. Shabunin, P.A. Stalmakhov (*Russia*)

Intelligent Control System for Improved System Performance for Pumps Operating in Parallel in Process Industries
A. Sundaram (*Singapore*)

Equations with Partial Derivatives and Differential Equations Used for Simulating Acausal Pulses
C. Toma (*Romania*)

Stability of the Delay Logistic Equation of Population Dynamics
M.Yu. Vagina (*Russia*)

On Two Classes of Partial Stability Problems
V.I. Vorotnikov (*Russia*)

Section TA1.

<u>**Control of Chaos by Periodic Perturbations** (Invited)</u>

Mechanisms of Non-Feedback Controlling Chaos and Suppression of Chaotic Motion (Invited)
A. Loskutov, S. Rybalko (*Russia*)

A Novel Polynomial Method for Taming Chaos in a Wide Class of Nonlinear Oscillators
V.M. Preciado, R. Chacon (*Spain*)

Multistability in a Driven Nonlinear System Controlled by Weak Subharmonic Perturbations
V.N. Chizhevsky (*Italy/Belarus*)**, R. Corbalan** (*Spain*)

Homoclinical Chaos Suppression
A. Loskutov, A. Janoev (*Russia*)

Homoclinical Chaos and Control: Analytical Methods
M.A.F. Sanjuan (*Spain*)

Section TA2.

Experimental Control of Molecular Systems (Invited)

Optimal Control of Molecular Femtochemistry (Invited)
G. Gerber (*Germany*)

Combinatorial Photonics, Controlling Chemistry with Tailored Strong Field Laser Pulses (Invited)
R.J. Levis (*USA*)

Open and Closed Loop Control of Complex Molecules with Shaped fs Pulses (Invited)
M. Motzkus (*Germany*)

Section TA3.

Nonlinear Control – II

Numerical Algorithms for Nonlinear Observer-Based Control
S.B. Tkachev, S.G. Alexeenkov (*Russia*)

On Uncontrollable Non-Linear Dynamic Systems: Analytic Solutions for Integral Manifolds
J.D. Stefanovski (*Macedonia*)**, G.M. Dimirovski** (*Turkey*)

Design Procedure of Minimum Phase Affine Systems
A.P. Krishchenko (*Russia*)

Control of Delayed Measured Systems and Impulse Length Limitations in Difference Control
J.C. Claussen (*Germany*)

Model Order Reduction and Parametrization of Nonlinear Numerical Models
H. Müller, S. Götz, M. Bestehorn (*Germany*)

A Method of Constructing Programmed Motion for Nonlinear and Nonstationary Systems by Indirect Controller
A.N. Kwitko (*Russia*)

Section TA4.

Stability and Control Problems in Mechanics - II (Invited)

How Do Small Velocity-Dependent Forces (De)Stabilize a Non-Conservative System?
O.N. Kirillov (*Russia*)

Metelitsyn's Inequality and Stability Criteria for Mechanical Systems
A. Seyranian (*Russia*), **W. Kliem** (*Denmark*)

Potential Weakly Damped Autonomous Systems Exhibiting Periodic Attractors
A.N. Kounadis (*Greece*)

Stability and Response Bounds of Non-conservative Linear Systems
C. Pommer (*Denmark*)

On Equations with Partial Derivatives Which Correspond to Invariant Manifolds of Mechanical Systems
V.D. Irtegov (*Russia*)

Stability of Free Elastic Structures at Nonconservative Loading
A. Sharanyuk (*Russia*)

Section TA5.

Beam Dynamics: Modelling, Control and Optimization - II (Invited)

Validation of Transfer Maps Using Taylor Models (Invited)
M. Berz, K. Makino (*USA*)

Nonlinear Transfer Map Treatment of Beams through Systems with Absorbing Material
K. Makino, M. Berz, D. Errede, C. Johnstone (*USA*)

Control and Optimization in Safe Nuclear Energetics Problem
Yu.A. Svistunov, M.F. Vorogushin (*Russia*)

Braking Radiation in Problem of Identification and Management of Radioactive Waste
N.P. Dikiy, A.N. Dovbnya, V.L. Uvarov (*Ukraine*)

Control Theory to Accelerator Research and Self-Focused Bunched Beam
Z. Parsa (*USA*)**, V. Zadorozhny, A. Rudenko** (*Ukraine*)

Section TA6.

Mechanical Engineering Applications – I

Elasticity of the Long-Length Shafts of Rotation Transmission Mechanical Systems as a Source of Information in the Tasks of Control and Preventing of Extreme Emergency
V.Yu. Rutkovsky, V.M. Sukhanov (*Russia*)

Adaptive Approach to Monitoring of Gas-Turbine's Transmission Shafts
S.D. Zemlyakov, V.M. Glumov (*Russia*)

Electromagnetic Suspension of Vertical Turbomachine for Nuclear Power Plant
F.M. Mitenkov, N.G. Kodochigov, V.V. Drumov, S.E. Belov, V.S. Vostokov, I.V. Drumov, O.B. Klochkov, A.V. Khodykin (*Russia*)

Nonlinear Dynamics and Control of a Wind-Milling Gyroplane Rotor
Ye.I. Somov, O.Ye. Polyntsev (*Russia*)

Robust H2 Vibration Control of Beams with Piezoelectric Sensors and Actuators
G. Foutsitzi (*Greece*), **D. Marinova** (*Bulgaria*), **E. Hadjigeorgiou** (*Greece*), **G. Stavroulakis** (*Greece/Germany*)

An Improved Tactile Matrix Microsensor Package
V.D. Todorova, M.T. Mladenov (*Bulgaria*)

Section TM1.

Anti-control of Chaos: Theories, Methods, and Applications (Invited)

On the Modified Marotto Theorem
C.P. Li (*China*)

Switching Control for Multi-Scroll Chaos Generation: An Overview
J.-H. Lü (*China*)**, X. Yu** (*Australia*)**, G. Chen** (*China*)

Fuzzy Chaos Generators for Nonlinear Dynamical Systems
Z. Li (*Germany*)

Sustained Chaos and Control by Means of Weak Periodic Excitations: Application to a Class of Nonlinear Electronic Circuits
V.M. Preciado, R. Chacon (*Spain*)**, V. Tereshko** (*UK*)

Model Based Anticontrol of Chaos
Ö. Morgül (*Turkey*)

Difference Scheme with Instant Transition "from Order to Chaos"
A.F. Goloubentsev, V.M. Anikin, Y.A. Barulina (*Russia*)

Section TM2.

Quantum Measurement, Filtering, and Quantum Feedback Control (Invited)

Quantum Filtering and Optimal Feedback Control (Invited)
V. Belavkin (*UK*)

On the Duality of Quantum Filtering and Optimal Feedback Control in Quantum Open Linear Dynamical Dystems
S.C. Edwards, V.P. Belavkin (*UK*)

Multi-Agent Stochastic Control: Models Inspired from Quantum Physics
J.S. Baras (*USA*)

The Scientific Language Spoken by Optical Instruments
Y.S. Kim (*USA*)

Uncertainty Relations for Generalized Quantum Measurements and Completely Positive Maps
M. Ozawa (*Japan*)

Section TM3.

Stability and Control Problems in Mechanics - III (Invited)

Dynamic Stability of Free-Free Beam Subjected to End Rocket Thrust and Carrying a Heavy Payload at Its Nose
T. Ohshima, Y. Sugiyama (*Japan*)

Influence of Force Structure on the Stability
V.A. Goncharenko, V.I. Goncharenko (*Ukraine*)

Computational Approach to Damped Beck's Column
Y. Sugiyama, S.-U. Ryu, M. Hamatani, T. Iwama (*Japan*)

Optimal Excitation of Oscillations by a Limited Control Force
A.O. Belyakov (*Russia*)

Regularizing Generalized Linear Systems by Means of Derivative Feedback
M.I. Garcia-Planas (*Spain*)

Section TM4.

Control of Oscillations

Spatial Problems of Nonlinear Dynamics: Motivation and Analysis
I.V. Miroshnik, E. Olkhovskaya (*Russia*)

Elements of Physical Oscillation and Control Theory
S.L. Chechurin, L.S. Chechurin (*Russia*)

Localization/Nonexistence Condition of Periodic Orbits of Polynomial Systems and Its Applications
K.E. Starkov (*Mexico*)

Drift Bifurcation of Dissipative Solitons: Destabilisation due to a Change of Shape
S.V. Gurevich, H.U. Bödeker, A.S. Moskalenko, A.W. Liehr, H.-G. Purwins (*Germany*)

Frequency-Domain Conditions for Cycle-Slipping in Discrete Systems with Periodic Nonlinearity
V.B. Smirnova, N.V. Utina, A.I. Shepeljavyi (*Russia*)

Phase Multistability of Self-Modulated Oscillations
A.M. Nekrasov (*Russia*)**, O.V. Sosnovtseva** (*Russia/Denmark*)

Section TM5.

Mechanical Engineering Applications – II

Model of Optoelectronic Measuring Intelligent System
I.V. Denisov, Yu.N. Kulchin, O.V. Kirichenko, V.A. Sedov, R.S. Drozdov, E.V. Denisova (*Russia*)

Nonlinear PI Control of Eccentricity Compensation Problem
B. Behar, F. Lamnabhi-Lagarrigue, T. Ahmed-Ali (*France*)

On a Robust Control of Parabolic Obstacle Problem
M. Blizorukova, V. Maksimov (Russia)

Stability of Viscoelastic Elements of Constructions under Hydrodynamic Action
P.A. Velmisov, Yu.A. Reshetnikov, A.A. Molgachev (*Russia*)

Spinning Mass as an Information Sensor for Astrophysics Research
B.Yu. Bogdanovich, I.S. Shchedrin, N.V. Egorov, V.N. Smirnov (*Russia*)

Introducing Climax: A Novel Strategy to a Tri-Wheel Spiral Robot
A.H. Javadi, P. Mojabi (*Iran*)

Section TM6.

Plasma Modeling and Control in Tokamaks (Invited)

Improving Plasma Stabilization System in ITER by Excluding Non-Efficient Poloidal Coils
D.A. Ovsyannikov, A.D. Ovsyannikov, A.P. Zhabko, E.I. Veremey, B.A. Misenov, V.A. Belyakov, A.A. Kavin (*Russia*)

Derivation of the Linear Models for the Analysis of the Plasma Current, Position and Shape Control System in Tokamak Devices
V.A. Belyakov, A.A. Kavin (*Russia*)

Analysis of Initial Stage of Plasma Discharge in Tokamaks: Mathematical Model Formulation, Simulation Results, Comparison with Experiments
V.A. Belyakov, V.I. Vasiliev, K.M. Lobanov, L.P. Makarova, A.B. Mineev (*Russia*)

Design of Non-Static Controllers for Plasma Stabilization
E.I. Veremey, M.V. Korovkin (*Russia*)

Absolute Minimum of Mean-Square Functional in Plasma Optimal Stabilization
S.V. Pogojev (*Russia*)

Robust Stability of the Linear Time-Delay Systems with Indefinite Delay
A.P. Zhabko, D.V. Zaretsky (*Russia*)

Section TP1/1.

Control of Chaos - I

Time-Delayed Feedback Control Method and Unstable Controllers (Invited)
K. Pyragas (*Lithuania*)

Chaotification via Feedback Control: Theories, Methods, and Applications (Invited)
G. Chen (*China*)

Section TP1/2.

Control of Chaos – Applications

Principles of Direct Chaotic Communications (Invited)
A.S. Dmitriev, A.I. Panas, K.V. Zakharchenko (*Russia*)

Non-Linear Processes and Control of Chaos in Chemical Technology (Invited)
E.M. Koltsova, M.V. Cherenkov, E.Yu. Korchagin (*Russia*)

Section TP2/1.

Theory of Molecular and Quantum Control - I (Invited)

Dynamical Control of Decay and Decoherence in Complex Quantum Systems (Invited)
G. Kurizki, A.G. Kofman (*Israel*)**, F.T. Arecchi, G. Mantica** (*Italy*)

Adaptive Control of Quantum Computing Systems (Invited)
R.L. Kosut, H. Rabitz (*USA*)

Section TP2/2.

Theory of Molecular and Quantum Control - II (Invited)

Geometric Quantum Control (Invited)
J.W. Clark, T.J. Tarn, D.J. Lucarelli (*USA*)

Universal Single-Qubit Quantum Interfaces: Quantum Controllers and Quantum Observers in One
S. Lloyd, A. Landahl, J.-J.E. Slotine (*USA*)

Short-Time Isotope Separation by Quantum Control of Intramolecular Dynamics of Polyatomic Molecules. NO2 Nonadiabatic Electronic Dynamics
O.M. Sarkisov, S.Ya. Umanskii, A.S. Vetchinkin, Yu.A. Zotov (*Russia*)

Section TP3/1.

Nonsmooth Dynamics – I

Modeling and Simulation of Non-Smooth Mechanical Systems (Invited)
J. Awrejcewicz, G. Kudra, P. Olejnik (*Poland*)

Complexity and Chaos in Piecewise-Smooth Dynamical Systems
Zh.T. Zhusubaliyev, E.A. Soukhoterin (*Russia*)**, E. Mosekilde** (*Denmark*)

Dynamics of Current Regulator with Hysteresis Control and Clocked Commutation in Application to Power Electronic Systems
Yu.V. Kolokolov, S.L. Koschinsky (*Russia*)**, C. Hatziadoniu, G. Galanos** (*USA*)

Section TP3/2.

Nonsmooth Dynamics – II

Impacting Oscillators - the Sensitivity of Motion to External Disturbances
K. Czolczynski (*Poland*)

A Generalized Maxwell-Slip Friction Model Appropriate for Control Purposes
V. Lampaert, F. Al-Bender, J. Swevers (*Belgium*)

An Identification of Pulse System Dynamics on the Basis of Fractal Regularity Use
Yu.V. Kolokolov, A.V. Monovskaya (*Russia*)**, K.H. Adjallah** (*France*)

Modelling Physical Hysteresis and Control of a Fine Piezo-Drive
Ye.I. Somov (*Russia*)

Section TP4/1.

Chaotic Dynamics-I

"Strange Nonchaotic Attractor" in 3D Autonomous Differential System
M.V. Loginova, V.S. Anishchenko (*Russia*)

Applications of a New Ultimate Bound on the Trajectories of the Lorenz System to Synchronization and Estimation of the Hausdorff Dimension
A. Pogromsky (*The Netherlands*)**, G. Santoboni** (*Italy*)**, H. Nijmeijer** (*The Netherlands*)

Numerical Estimates of Local and Global Motions of the Lorenz Attractor
B.G. Kukharenko (Russia)

The Determined Chaos in Disturbed by Temperature Dynamic Systems with Gyros
V.E. Dzhashitov, V.M. Pankratov (*Russia*)

Section TP4/2.

Chaotic Dynamics-II

Impacting Oscillators – the Problem of Visualization of Basins of Attraction
T. Kapitaniak, K. Czolczynski (*Poland*)

Complex Dynamics of Double-Loop Tracking System
V.P. Ponomarenko (*Russia*)

Stochastic Dynamics of FitzHugh-Nagumo Model near the Canard Explosion
A. Shishkin, D. Postnov (*Russia*)

Baker Transformation as Autoregression System
A.F. Goloubentsev, V.M. Anikin, S.A. Noyanova, Y.A. Barulina (*Russia*)

Section TP5/1.

Turbulence and Control

Ideal Turbulence: Definition and Models (Invited)
A. Sharkovsky, E. Romanenko, S. Berezovsky (*Ukraine*)

Control of Turbulence in Jets by Acoustic Means (Invited)
P.S. Landa, A.S. Ginevsky (*Russia*)

Section TP5/2.

Self-organization, Complexity and Control – I

Physics, Control, and Kolmogorov Complexity (Invited)
I. Kunin (*USA*)

Granular Matter: Transition To Equilibrium Under Gravity
N.B. Loguinova (*Russia*)

Property of Isodynamism as a Principle of Guaranteeing / Elimination of Given System Evolution
I.V. Izmailov, B.N. Poizner (*Russia*)

Section TP6/1.

Modeling and Identification

Adaptive Design for Estimation of Unknown Parameters in PDE
P.L. Chow, R.Z. Khasminskii, A. Ovseevich (*Russia*)

Nonlinear Mathematical Modeling of Aircraft Wing Flutter in Transonic Range
H. Matsushita, T. Miyata, M. Kawai (*Japan*)**, E. Mosekilde** (*Denmark*)

Modeling of Manufacturing Systems Using Neural Networks
A. Shtay, T. El-Fauly, G.M. Aly (*Egypt*)

Frequency Spectrum Control in a Dielectric Wakefield Accelerating Waveguide
A. Altmark, E. Sheinman (*Russia*)**, A. Kanareykin** (*USA*)

Section TP6/2.

Adaptive and Intelligent Control

Adaptive Control of Vibration for Systems with Non-Stochastic Uncertainty Measure and Bounded Disturbances
N.M. Filatov (*Russia*)

Effective Neural Network Approach to Image Recognition and Control
G. Ososkov (*Russia*)

Inverse Learning Control Using Neuro-Fuzzy Approach for a Process Mini-Plant
Y.Y. Nazaruddin, J. Waluyo, S. Hadisupadmo (*Indonesia*)

Physical Diagnostics and Fault Relevant Feedback Control
A.V. Timofeev (*Russia*)

Section FA1.

Synchronization

Section FA2.

Quantum Information and Control

Quantum Error Correction for Continuously Detected Errors
C. Ahn (*USA*), **H.M. Wiseman, G.J. Milburn** (*Australia*)

Quantum State Protection with Quantum Feedback Schemes
D. Vitali, S. Zippilli, P. Tombesi (*Italy*), **J.-M. Raimond** (*France*)

Laser Control of Quantum Dynamics
P.A. Golovinski, P.V. Ryasnoy, V.M. Nazarov (*Russia*)

On Preparation of the Atomic W-states
V.N. Gorbachev, A.A. Rodichkina, A.I. Trubilko, A.I. Zhiliba (*Russia*)

Spin Systems and Minimal Switching Decompositions
J. Clemente-Gallardo, F. Silva-Leite (*Portugal*)

Quantum Processors and Controllers
A.Yu. Vlasov (*Russia*)

Section FA3.

Optimal Isolation of Mechanical Disturbances (Invited)

Control Science for Injury Prevention (Invited)
D.V. Balandin, N.N. Bolotnik (*Russia*), **W.D. Pilkey** (*USA*)

H_∞ Optimal Control of a Parametrically Disturbed Pendulum
D.V. Balandin, M.M. Kogan, A.A. Fedukov (*Russia*)

Optimal Protection of Two-Degree-of-Freedom System from Shock and Vibration
S.V. Purtsezov (*Russia*)

Time Substitution Method in a Shock Protection Problem for Nonlinear Hamiltonian Systems
V.A. Proursin (*Russia*)

Maximum Robustness Control for Isolation of Mechanical Disturbances
V.V. Koulaguin (*Russia*)

Section FA4.

Control of Distributed Systems - I

Some New Advances in the Theory of Dynamic Materials (Invited)
K. Lurie, S. Weekes (*USA*)

Switched Chattering Control of Electrical Servo-Motors and Backlash/Friction Attenuation
Y. Orlov, L. Aguilar (*USA*), **J.C. Cadiou** (*France*)

Design of Finite Controllers for a Class of Infinite Systems for the H_∞-Control Problem
V.A. Brusin, A.V. Bovyrin (*Russia*)

Navier-Stokes Equation Controlled by Degenerate Forcing: Controllability of Finite-Dimensional Approximations
A. Agrachev, A. Sarychev (*Italy/Russia*)

Section FA5.

Self-organization, Complexity and Control - II

Minimal Dissipation Processes and Estimates of Limiting Possibilities of Irreversible Thermodynamic Systems (Invited)
A.M. Tsirlin (*Russia*), **V. Kazakov** (*Australia*)

The Boolean Averaging Procedure, Common to Three Systems in Statistical Mechanics, Control and Signal Processing
M.M. Kipnis (*Russia*)

Control and Parameterization of Dynamical Nonlinear Processes During First-Order Phase Transition
L.A. Bityutskaya, E.S. Mashkina (*Russia*)

Sub-Riemannian Formulation for Non Interacting, Non Relativistic Particles in Homogeneous Magnetic Fields
F. Monroy Pérez, A. Anzaldo-Meneses (*Mexico*)

Type Theory, Computer Algebra & Dynamical Systems
A.V. Flegontov (*Russia*), **S.V. Soloviev** (*France*)

Section FA6.

Biomedical Applications

Energy Lyapunov Function for Generalized Replicator Equations
Yu.A. Pykh (*Russia*)

Nonlinear Switching Dynamics in Surface Electromyography of the Spine
P. Lohsoonthorn, E. Jonckheere (*USA*)

Bimodal Dynamics of Nephron Autoregulation
O.V. Sosnovtseva, A.N. Pavlov (*Russia*), **E. Mosekilde, N.-H. Holstein-Rathlou** (*Denmark*)

Complex Phase Dynamics in Coupled Bursters
D.E. Postnov, S.Y. Malova (*Russia*)

Chaotic Behavior by the Air Flow of the Breath of Human Being
G. Lukyanov, V. Usachev (*Russia*)

Optimal Transport for Visual Tracking and Registration
S. Haker, A. Tannenbaum, A. Goldstein (*USA*)

Section FM1.

Control of Chaos - II

Stability of Delayed Feedback Controllers for Discrete Time Systems
Ö. Morgül (*Turkey*)

Time Delayed Feedback Control of Chaos by Spatio-Temporal Filtering
A. Amann, E. Schöll, N. Baba, W. Just (*Germany*)

Music and Control of Chaos in the Brain
V.E. Bondarenko (*USA*), **I. Yevin** (*Russia*)

Energy-Optimal Steering of Transitions through a Fractal Basin Boundary
A.N. Silchenko, S. Beri, D.G. Luchinsky, P.V.E. McClintock (*UK*)

Application of Idea of Chaos Control to Stabilization of Stationary Generation in Backward-Wave Oscillator
A.M. Dolov, S.P. Kuznetsov (*Russia*)

Robust Control of Time-Delay Chaotic Systems
C. Hua, X. Guan (*China*)

Section FM2.

Control of Nanostructures

Semiconductor-Gas Discharge Electronic Devices: Stability, Patterns and Control (Invited)
Yu.A. Astrov (*Russia*)

Open-Loop-Control of Pore Formation in Semiconductor Etching
J.C. Claussen, J. Carstensen (*Germany*), **M. Christophersen** (*Germany/USA*), **S. Langa, H. Full** (*Germany*)

Synchronization of Chaos and Small Signal Amplification in Electron-Hole Plasmas of Germanium
K.M. Aliev, I.K. Kamilov, Kh.O. Ibragimov, N.S. Abakarova (*Russia*)

Coherent Atomic Beam Splitter Control for Nano-Scale Atom Wave Packet Lithography
S.V. Borisenok, Yu.V. Rozhdestvensky (*Russia*)

Application of Control Algorithm in a Sliding Mode in Specrtrum Measurement Systems and Growing of Crystals
A. Khachaturova (*Armenia*), **V. Mkrttchian** (*Australia*)

Section FM3.

Control of Mechanical Systems

Constrained Variational Approach to Nonholonomic Control Systems
T. Kai, H. Kimura (*Japan*)

Decomposition of Lagrangian Systems on the Base of the Technical Controllability Concept
V.Yu. Rutkovsky, S.D. Zemlyakov (*Russia*)

Slow Locomotion of the Three-Link Systems along a Horizontal Plane
T.Yu. Figurina (*Russia*)

Continuous Feedback Control for Scleronomous Mechanical Systems
I.M. Ananievski (*Russia*)

Hybrid Control of a Cart-Pendulum System with Restrictions on the Travel
D. Gromov, J. Raisch (*Germany*)

Singular Functions of a Nonlinear Pendulum on Finite Time Intervals
X.Y. Petrova, L.A. Mironovsky (*Russia*)

Section FM4.

Control of Distributed Systems - II

Feedback Control for a Heat Equation under a White Noise Excitation
A.S. Bratus, A.P. Ivanova (*Russia*)

Control and Stabilization of a Rotating Planar Body with Flexible Attachments
A.L. Zuyev (*Ukraine*)

Treatment of the Interface between Fine Elastic Structures and Fluids
N.D. Botkin, K.-H. Hoffmann, V.N. Starovoitov, V.L. Turova (*Germany*)

Exact Controllability in Neutral Delay Equations
D.V. Yakubovich (*Spain*), **S.M. Verduyn Lunel** (*The Netherlands*)

Robust Fault-Tolerant Control for a Class of Nonlinear Singular Systems with Uncertainty
G. Hu, J. Ren, C. Liu (*China*)

Section FM5.

Chemical Engineering Applications

Novel Electrochemical Ferroxalate Actinometer for Excilamp Intensity Measurement
E.A. Sosnin, V.N. Batalova, E.A. Zacharova, V.F. Tarasenko (*Russia*)

Adaptive Control of the Top Blown Oxygen Converter Process Considering Temperature and Unknown External Disturbances
B.M. Sokolov, A.I. Shepeljavyi (*Russia*), **A. Medvedev** (*Sweden*)

Discrete-Time Control System Design for a Reactive Ion Etching (RIE) System
N. Tudoroiu, V. Yurkevich, K. Khorasani (*Canada*)

Model Predictive Control Algorithm for Nonlinear Chemical Processes
A.A. Tiagounov, S. Weiland (*The Netherlands*)

Model Predictive Control of an Infrared-Dryer
H. Abukhalifeh, R. Dhib, M. Fayed (*Canada*)

Differential Geometry Control of a Polymer Reactor
N. Felorzabihi, N. Ghadi, R. Dhib (*Canada*)

Section FM6.

Chaos and Rhythm: Production and Perception of Speech (Invited)

Logistic Mapping as the Means of the Description of the Speech Rhythm in the Vicinity of the Critical Point
O.P. Skljarov (*Russia*)

The Control of Dynamic Regimes of the Rhythm within Feigenbaum Scenario of Route to Chaos
O.P Skljarov, T.N. Bortnik (*Russia*)

Robust Rhythm as a Consequence of the Universal Description of Complex System Dynamics in the Vicinity of Critical Point
O.P Skljarov, T.N Skljarova (*Russia*)

Calculation of Logistics Equation Parameter on Experimental Data with the Miss
D.I. Yakushev (*Russia*)

An Internet System of Partner-Learning Special Type
A.N. Poroshin, O.P. Skljarov (*Russia*)

Synergic Interaction of Components of Rarefied Comb Filtration of the Speech Signal
S.M. Petrov, A.V. Borshchev (*Russia*)

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NOISE-ENHANCED PHASE SYNCHRONIZATION OF WEAKLY COUPLED CHAOTIC OSCILLATORS

J. Kurths, C.S. Zhou (*Germany*)

Pages 353 - 357

Abstract: It is well-known that noise degrades phase synchronization of periodic oscillators by inducing phase slips. Here we study constructive effects of noise on phase synchronization in coupled chaotic oscillators. We find that in the weak coupling regime below the synchronization threshold, noise can enhance phase synchronization significantly. This counterintuitive and constructive effect of noise is demonstrated in coupled Rössler chaotic oscillators with various measures of phase synchronization.

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EXPERIMENTAL CHARACTERIZATION OF THE TRANSITION TO PHASE SYNCHRONIZATION OF CHAOS (Invited)

S. Boccaletti , E. Allaria, R. Meucci, F.T. Arecchi (*Italy*)

Page 358

Abstract: We report experimental investigation on the transition route to phase synchronization in a chaotic laser with external modulation. Such a transition is characterized by the presence of a regime of periodic phase synchronization, in which phase slips occur with maximal coherence in the phase difference between output signal and external modulation. We provide the first experimental evidence of such a regime and demonstrate that it occurs at the crossover point between two different scaling laws of the intermittent-type behavior of phase slips.

View manuscript

PHASE SYNCHRONIZATION IN ENSEMLES OF COUPLED PHASE SYSTEMS

V.N. Belykh (*Russia*)

Pages 359 - 360

Abstract: In the present talk we consider coupled dynamical systems composed of subsystems having an explicitely given "phase" as a cyclic coordinates of phase space. In this case the phase synchronization becomes the same as partial synchronization of the cyclic coordinates. We present a discussion of the following problems. 1) Regular and chaotic attractors corresponding to the phase synchronization in phase systems. 2) Homoclinic bifurcations leading to the emergence of phase synchronization. 3) Phase synchronization of two different interacting phase systems. 4) Sufficient conditions of phase synchronization in the ensembles of identical pendulum-like systems. 5) Phase synchronization in an array of coupled two-dimensional maps, such that each individual map has a cyclic coordinate and, being a Poincaré map for a flow, models homoclinic chaos. We present some results on computer simulation of coupled systems.

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CONTROLLED PHASE SYNCHRONIZATION IN OSCILLATORY NETWORKS

V.N. Belykh, G.V. Osipov (*Russia*)**, J. Kurths** (*Germany*)

Pages 361 - 371

Abstract: We propose a method of automatic phase locking of regular and chaotic non-identical oscillations. Our approach is based on the principles of feedback control which implicitly play the role of an internal self-organization mechanism in the huge variety of natural oscillators and which explicitly serve as the basis of phase locked loops. This way phase synchronization via phase locking is achieved for very low coupling and this is demonstrated for several examples: (i) two coupled regular oscillators, (ii) coupled regular and chaotic oscillators, (iii) two coupled chaotic oscillators, (iv) ensembles of locally coupled regular oscillators, (v) ensembles of locally coupled chaotic oscillators, and (vi) ensembles of globally coupled chaotic oscillators.

CHAOS CONTROL OF NONLINEAR CURRENT OSCILLATIONS IN SEMICONDUCTOR HETEROSTRUCTURES

E. Schöll, A. Amann, W. Just, J. Schlesner, J. Unkelbach (*Germany*)

Abstract: We study autosynchronization by time delayed feedback control of chaotic spatio-temporal patterns in spatially extended semiconductor models. Different control schemes, e.g., a diagonal control matrix, or global control, or combinations of both, are compared. In particular, we use two models of semiconductor nanostructures which are of current interest: (i) superlattice, (ii) double-barrier resonant-tunneling diode.

USING NONISOCHRONICITY TO CONTROL PHASE SYNCHRONIZATION IN ENSEMBLES OF NONIDENTICAL OSCILLATORS

B. Blassius (*Germany*)

Abstract: The transition to phase synchronization in ensembles of coupled oscillators is investigated. In any real application the oscillators are necessarily nonidentical and vary in their system parameters. Usually, the disorder is realized by variations in only one variable. Here, we demonstrate that unusual properties arise when disorder is affecting two characteristics of the system simultaneously. In our case, parameter mismatch between different oscillators has influence both on the natural frequency and on the nonisochronicity of oscillation. Under these assumptions we show the phenomenon of anomalous phase synchronization where coupling counterintuitively can desynchronize the ensemble of oscillators. Anomalous effects arise when nonisochronicity covaries with the natural oscillator frequency and can either increase or inhibit synchronization in the ensemble. This provides a novel possibility to control the synchronization transition in nonidentical systems by suitably distributing the disorder among system parameters.

View manuscript

CONTROLLABILITY OF OPEN QUANTUM SYSTEMS: THE TWO LEVEL CASE

C. Altafini (*Italy*)

Pages 710 - 714

Abstract: We study the quantum Markovian master equation for a two level system in presence of coherent control. We show that its behavior is essentially determined by the complete positivity assumption of the quantum dynamical semigroup and that unitary control cannot modify its irreversibility character. Control theory provides several controllability-type conditions able to capture the peculiarity of such driven system.

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DESIGN OF LASER PULSES FOR STIRAP PROCESSES WITH GEOMETRIC CONTROL TECHNIQUES

U. Boscain (*France*), **G. Charlot** (*Italy*)

Pages 715 - 719

Abstract: We apply techniques of Geometric Control Theory, to Stimulated Raman Adiabatic Passage (STIRAP) in the rotating-wave approximation (RWA). After reduction to real variables, we develop a systematic way of designing laser pulses to improve the transfer that allows to reach the target state precisely.

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CONTROLLABILITY AND DIAMETER OF SINGLE-INPUT QUANTUM SYSTEMS

A. Agrachev (*Italy*), **T. Chambrion** (*France*)

Pages 720 - 725

Abstract: Lie groups formalism and riemannian techniques are used to describe the attainable set at time *T* of left invariant single-input control systems on compact semi-simple Lie groups. This gives controllability properties and an estimation of the minimal time needed to transfer a controlled quantum system with a drift from a given initial position to a given final position.

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RESONANCE IN N-LEVEL QUANTUM SYSTEMS

U. Boscain (*France*), **G. Charlot** (*Italy*)

Pages 726 - 731

Abstract: We consider a laser-induced population transfer problem on a finite dimensional quantum system in the rotating wave approximation. For a convex cost depending only on the moduli of the controls, we prove that there always exists a minimizer in resonance. These facts are quite important because permit to reduce remarkably the complexity of the problem from dimension $2n-1$ to dimension $n-1$ (and extend some of our previous results for $n=2$ and $n=3$). Moreover proving that resonance is optimal permits to justify some strategies used in experimental physics.

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THE DYNAMICAL INVERSE PROBLEM FOR A NONLINEAR SCHRODINGER EQUATION USING BOUNDARY CONTROL

M. Tomas-Rodriguez, S.P. Banks (*UK*)

Pages 732 - 735

Abstract: The problem of determining the potential in a nonlinear one-dimensional Schrödinger equation from dynamical boundary observations is considered. The problem will be solved by a combination of a recent approximation technique for nonlinear dynamical systems, which reduces them to sequences of linear, time-varying systems, and the derivation of a spectral theory for these systems.

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OPTIMAL CONTROL OF COUPLED SPINS IN PRESENCE OF LONGITUDINAL AND TRANSVERSE RELAXATION

D. Stefanatos, N. Khaneja (*USA*)**, S.J. Glaser** (*Germany*)

Pages 736 - 745

Abstract: Experiments in coherent spectroscopy correspond to control of quantum mechanical ensembles guiding them from initial to final target states. The control inputs (pulse sequences) that accomplish these transformations should be designed to minimize the effects of relaxation and to optimize the sensitivity of the experiments. For example in nuclear magnetic resonance (NMR) spectroscopy, a question of fundamental importance is what is the maximum efficiency of coherence or polarization transfer between two spins in the presence of relaxation. Furthermore, what is the optimal pulse sequence which achieves this efficiency? This manuscript extends our previous work in the above problems. Here, we take into account both the longitudinal and the transverse relaxation mechanisms, thus generalizing our previous results, where the former had been neglected.

View manuscript

STABILIZATION OF NONLINEAR SYSTEMS BY DERIVATIVE CONTROL

I.E. Zuber (*Russia*)

Pages 1252 - 1254

Abstract: The nonlinear multivariable totally controllable system is considered. The admissible control is the feedback control by derivative. The aim is to define the feedback vector which provides total exponential stability fpr closed loop system.

The solution is performed by canonical nonlinear similarity transformation, providing Frobenious form for the object matrix of the transformed system.

The sufficient condition of existence of such a feedback vector and it's explicit form are defined.

View manuscript

SYNTHESIS OF OPTIMAL FEEDBACK FOR NONLINEAR CONTROL SYSTEMS

N.V. Balashevich (*Belarus*)

Pages 1255 - 1260

Abstract: A method of on-line constructing an optimal feedback control for nonlinear systems with bang-bang optimal control is proposed. The realization of the algorithm of constructing a closed-loop solution is oriented on fast corrections of optimal open-loop control subject to small variations of initial state. To construct a solution to a nonlinear control problem two procedures are elaborated. At first, piecewise linear approximations for initial nonlinearities of the system are introduced and an optimal control for the approximative problem is computed. Then the defining elements of this control are corrected with the use of asymptotic expansions.

View manuscript

REDUCIBILITY AND REDUCTION OF DISCRETE-TIME NONLINEAR CONTROL SYSTEMS: COMPARISON OF TWO APPROACHES

Ü. Kotta (*Estonia*), **E. Pawluszewicz** (*Poland*), **S. Nõmm** (*Estonia*)

Pages 1261 - 1266

Abstract: The problem of system reduction is studied for discrete-time nonlinear single-input single-output systems described by high order input-output (i/o) difference equations, that is, given the i/o equation, can one Ïnd a minimal representation which is equivalent to the original system with the order being as small as possible. Comparison of two notions of reducibility is provided. The reducibility properties addressed are both generalizations of the well-known notion of transfer equivalence to the case of nonlinear control systems. Two roles of transfer equivalence are covered by these extensions. The first is that of identity of the outputs for any fixed control sequence under zero initial conditions. The second role is that of pole/zero cancellation that may occur in the transfer function of equivalent systems. The relationship between two reducibility criteria related to two equivalence notions is examined and the reducibility criterion which extends pole/zero cancellation property is shown to be stronger. Finally, the computational aspects of system reduction are discussed.

View manuscript

LMI TECHNIQUE FOR STABILIZATION OF A LINEAR PLANT BY A PULSE-MODULATED SIGNAL

A.N. Churilov, A.V. Gessen (*Russia*)

Pages 1267 - 1272

Abstract: The paper concerns stabilization of an unstable linear plant by a pulse modulator in feedback. The problem is reduced to finding a solution of some linear matrix inequalities (LMI). The conditions obtained guarantee that all the control system's solutions starting in some neighbourhood of a zero equilibrium vanish as time increases. The neighbourhood description is found from the LMI.

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ROBUST STABILIZING CONTROL OF DISCRETE-TIME JUMPING SYSTEM VIA STATIC OUTPUT FEEDBACK

P.V. Pakshin, D.M. Retinsky, A.V. Ryabov (*Russia*)

Pages 1273 - 1277

Abstract: The paper considers a class of hybrid-state discrete-time control systems, described by a set of systems with the transition between them determined by a homogeneous Markov chain taking values in a finite set of modes. When the mode is fixed, the plant state evolves according to the corresponding individual linear dynamic. The necessary a sufficient conditions of stabilizability in the mean square via static output feedback control are obtained. In the case when the mode change process has uncertainties a robust version of these conditions is given. An heuristic LMI based algorithm for computation of static output feedback control is also given.

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GENERALIZED FLAT-ALGORITHM FOR SOLVING TWO POINTS CONTROL PROBLEM

A.M. Kovalev (*Ukraine*)

Pages 1248 - 1251

Abstract: For nonlinear system with one-dimensional control the solution of two points control problem by the inverse system method with using the set of trajectories is obtained. It is supposed that the system is controllable and one-dimensional measurement function exists under which the system is observable and identifiable on the set of trajectories. The class of systems considered includes so-called flat systems characterized by the property of identification on one trajectory.

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THEORY OF PARAMETRIC RESONANCE: MODERN RESULTS (Invited)

A.P. Seyranian (*Russia*)

Pages 1052 - 1060

Abstract: Linear dynamical systems with many degrees of freedom with periodic coefficients also depending on constant parameters are considered. Stability of the trivial solution is studied with the use of the Floquet theory. First and second order derivatives of the Floquet matrix with respect to parameters are derived in terms of matriciants of the main and adjoint problems and derivatives of the system matrix. This allows to find the derivatives of simple multipliers, responsible for stability of the system, with respect to parameters and predict their behavior with a change of parameters. It is shown how to use this information in gradient procedures for stabilization or destabilization of the system. As a numerical example, the system described by Carsson-Cambi equation is considered. Then, strong and week interactions of multipliers on the complex plane are studied, and geometric interpretation of these interactions is given. As application of the developed theory the resonance domains for Hill's equation with damping are studied. It is shown that they represent halves of cones in the three-parameter space. Then, parametric resonance of a pendulum with damping and vibrating suspension point following arbitrary periodic law is considered, and the parametric resonance domains are found. Another important application of damped Hill's equation is connected with the study of stability of periodic motions in non-linear dynamical systems. It is shown how to find stable and unstable regimes for harmonically excited Duffing's equation. Then, linear vibrational systems with periodic coefficients depending on three independent parameters: frequency and amplitude of periodic excitation, and damping parameter are considered with the assumption that the last two quantities are small. Instability of the trivial solution of the system (parametric resonance) is studied. For arbitrary matrix of periodic excitation and positive definite damping matrix general expressions for domains of the main (simple) and combination resonances are derived. Two important specific cases of excitation matrix are studied: a symmetric matrix and a stationary matrix multiplied by a scalar periodic function. It is shown that in both cases the resonance domains are halves of cones in the three-dimensional space with the boundary surface coefficients depending only on eigenfrequencies, eigenmodes and system matrices. The obtained relations allow to analyze influence of growing eigenfrequencies and resonance number on resonance domains. Two mechanical problems are considered and solved: Bolotin's problem of dynamic stability of a beam loaded by periodic bending moments, and parametric resonance of a non-uniform column loaded by periodic longitudinal force.

View manuscript

TO THE STABILITY OF NON-CONSERVATIVE SYSTEMS IN ONE DEGENERATE CASE

S.A. Agafonov (*Russia*)

Pages 1061 - 1064

Abstract: We study stability of the mechanical systems subjected to dissipative, gyroscopic, potential and non-conservative positional forces. We start from consideration of non-stationary system under the action of all forces which are listed above in the case when matrix of the gyroscopic forces is constant (degenerate case). By means of the construction of the Lyapunov function we obtain stability conditions. Derived results extend the stability conditions of the stationary system [1]. The stability of non-conservative system in the absence of potential forces is examined and condition of asymptotic stability is obtained. We examine the in uence of the linear dissipative forces on the stability of circulatory system. The estimation of the limit value of these forces for the stable circulatory system to be asymptotically stable is obtained. We also consider circulatory system with two degrees of freedom under the action of non-linear dissipative forces. Original system is transformed to the normal form up to the third order. The internal resonance of the fourth order is considered as well. It is shown that the stable circulatory system becomes asymptotically stable.

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ULTRALOW PARASITIC EIGENVALUES FOR OSCILLATION PROBLEM OF A GUIDED ELASTIC FLYING VEHICLETHAT CONTAINS INTEGRATING SECTION IN A FEEDBACK LOOP

S.V. Arinchev (*Russia*)

Pages 1065 - 1069

Abstract: Integration sections are frequently inserted in feedback loops of flight control systems. They usually help to increase the accuracy of flight control. But at the same time such an engineering solution can change significantly dynamic properties of the guided elastic structure. The oscillation system becomes unconservative. The number of degrees of freedom continues to be the same but the quantity of modes increases. Ultralow parasitic eigenvalues appear. They are named ultralow ones because they tend to zero together with the feedback loop amplification factor. They are named parasitic ones because they interact with the main eigenvalues. The interaction of the ultralow parasitic oscillation mode and the main oscillation mode can cause dynamic instability. It is shown in this issue that violations of the principle oscillation theorems (oscillation properties) take place for the parasitic oscillation modes [1].

View manuscript

NONCONSERVATIVE STABILITY PROBLEMS FOR AXIALLY COMPRESSED RECTANGULAR PLATE

M.V. Belubekyan, V.M. Belubekyan (*Armenia*)

Pages 1070 - 1073

Abstract: For investigation of nonconservative stability problems for beams, in general case, as it is well known, the dynamic approach is necessary [1]. However, there are also some examples of problems for stability of a beam, compressed with a 'follower' force, known, where the static approach suffices [2,3]. Especially interesting are the problems of beam stability, where buckling of both divergent and flutter type is possible. In this case, it is necessary to determine, which of the buckling types arises at minimal critical load. Among the last investigations on this topic, the paper [4] provides also an overview of known contributions on the stability of cantilever beam, loaded at its end.

In the present paper, stability problems for rectangular plates are considered. One of the edges of the plate is under compressive load, and displacements and turns of this edges are not constrained. On the other edges of plate several different boundary conditions are considered. The compressive load may have both 'follower' and 'non-follower' components.

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NON-CONSERVATIVE OSCILLATIONS OF A TOOL FOR DEEP HOLE HONING

A.M. Gouskov, S.A. Voronov (*Russia*), **E.A. Butcher, S.C. Sinha** (*USA*)

Pages 1074 - 1083

Abstract: The dynamics of rotating tool commonly employed in deep hole honing is considered. Mathematical model of a process including the dynamic model of tool and model of workpiece surface and honing sticks interaction is analyzed. It is shown that interaction forces are nonconservative. Honing tool is modeled as a continuous slender beam with a honing mandrel attached at intermediate cross section. Multi-stone tool rotates and has reciprocational motion in axial direction. Honing stones are expanded to the machined surface by special rigid mechanism that provides cutting of workpiece cylindrical surface. Tool shaft vibrates in the transverse and axial directions. The removal of chip causes the variation of expansion pressure and depends on the surface state formed by previous honing stone. Hence the vibrating tool shaft is under action of nonconservative forces depending on its position and including delayed functions. The equations of new surface formation are separated as a specific set of dynamic model. These equations inherently consider the regeneration effect of oscillations during cutting. The expansion pressure is a critical parameter in honing since its influence on process is different. The removal of stock increase linearly with pressure but the lowest expansion pressure and feed rate possible should be used to increase accuracy. The process productivity can be improved by increasing expansion pressure but may in a certain conditions cause a dynamic instability of tool shaft lateral oscillations. Methods of process rational conditions evaluation are considered. The derived partial differential equations of rotating beam motion are reduced to a set of ordinary differential equations by the Galerkin approximation method. The derived differential equations with time periodic functions are numerically analyzed by Floquet method. The system response is studied for different technology and geometric parameters in non-dimensional form. That makes it possible to analyze a set of real processes applying the similarity conditions.

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CONTROL OF MOMENTUM-COMPACTION FACTOR IN SYNCHROTRON WITH "RESONANT" LATTICE (Invited)

Yu. Senichev (*Germany*)

Pages 942 - 952

Abstract: In the construction of different types of synchrotrons we are often restricted in our choice of the momentum compaction factor, which must be kept low enough or negative to satisfy many conditions of beam stability. Some accelerators must have the dispersion-free straight sections desired for RF stations, Siberian Snakes, etc. The dynamic aperture in the presence of chromaticity-correcting sextupoles should be sufficiently large. The theory of momentum compaction factor control is discussed in this article.

View manuscript

CONTROL OF SPACE CHARGE REDISTRIBUTION TO CORRECT ABERRATIONS IN CHARGED PARTICLE BEAMS

Yu.V. Zuev (*Russia*)

Pages 953 - 957

Abstract: The charged particle beam in confining fields tends to an equilibrium configuration. The process, as well known, entails space charge redistribution and nonlinear aberrations. In most cases the beam phase distribution oscillates about equilibrium one due to excess of energy. Appropriate choice of the confining fields allows controlling frequency and amplitude of the oscillation so that beam aberrations remain reversible and exhibit at the exit a required phase, for example, close to the initial phase when the aberrations are small. Beam optics with corrected aberrations may be designed on the principle. An example of the optics for matching beam into a radio-frequency-quadruple accelerator (RFQ) is presented.

View manuscript

ACTUAL PROBLEMS OF BEAM PHYSICS COMPUTING

S.N. Andrianov (*Russia*)

Pages 958 - 963

Abstract: This report is devoted to discussion actual problems of current status in beam physics computing and some solution paths. All present approaches can be divided into two different types: analytical (theoretical) and numerical simulation. The first type is based on theoretical investigations for some approximation models without use numerical simulation actively. The second - on the numerical simulation of some more complete models using computer systems including supercomputers and computational clusters. In the report, some realization paths of this formulated program are discussed. We hope that it gives effective and adequate instruments for further investigation in beam physics.

View manuscript

OPTIMIZATION AND BEAM CONTROL IN LARGE-EMITTANCE ACCELERATORS: NEUTRINO FACTORIES

C.J. Johnstone, M. Berz, D. Errede, K. Makino (*USA*)

Pages 964 - 973

Abstract: Schemes for intense sources of high-energy muons require collection, rf capture, and transport of particle beams with unprecedented emittances, both longitudinally and transversely. These large emittances must be reduced or “cooled” both in size and in energy spread before the muons can be efficiently accelerated. Therefore, formation of muon beams sufficiently intense to drive a Neutrino Factory or Muon Collider requires multi-stage preparation. Further, because of the large beam phase space which must be successfully controlled, accelerated, and transported, the major stages that comprise such a facility: proton driver, production, capture, phase rotation, cooling, acceleration, and storage are complex and strongly interlinked. Each of the stages must be consecutively matched and simultaneously optimized with upstream and downstream systems, meeting challenges not only technically in the optics and component design, but also in the modeling of both new and extended components. One design for transverse cooling, for example, employs meter-diameter solenoids to maintain strong focusing—300-500 mr beam divergences—across ultra-large momentum ranges, $\geq \pm 20\% \ \delta p/p$, defying conventional approximations to the dynamics and field representation. To now, the interplay of the different systems and staging strategies has not been formally addressed. This work discusses two basic, but different approaches to a Neutrino Factory and how the staging strategy depends on beam parameters and method of acceleration.

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MATHEMATICAL CONTROL MODEL FOR BEAM DYNAMICS OPTIMIZATION

D.A. Ovsyannikov, A.D. Ovsyannikov (*Russia*)

Pages 974 - 979

Abstract: A special class of the problems attracting attention of numerous researches is represented by the problems associated with the beam dynamics optimization in accelerators of charged particles.

In this paper problem of beam dynamics optimization is considered as a control theory problem.

Problem statement is considered on the pattern of linear accelerating on traveling wave.

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TRACKING TROJAN ASTEROIDS IN PERIODIC AND QUASI-PERIODIC ORBITS AROUND THE JUPITER LAGRANGE POINTS USING LDV TECHNIQUES

F. Ariaei, E. Jonckheere, S. Bohacek (*USA*)

Pages 101 - 106

Abstract: Linear Dynamically Varying (LDV) control is a technique for getting a natural (nonlinear, possibly chaotic) trajectory and a perturbed trajectory asymptotically synchronized given an initial condition offset. Probably the best illustrative example, which motivates this paper, is tracking the natural (possibly quasi-periodic) motion of a Trojan asteroid near the L4 point of Jupiter with a spacecraft that follows a trajectory perturbed by the non conservative propulsion forces. The tracking error is linearized around the natural dynamics of the Trojan body, leading to an LDV model of the tracking error. This in turn leads to a dynamically varying controller, itself given as the solution to a Partial Differential Riccati Equation, solved via the method of characteristics. It is shown that this technique allows for accurate tracking of the complicated dynamics around the L4 point.

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CONTROLLED WIG FLIGHT - STABILITY AND EFFCIENCY PROBLEMS

A.V. Nebylov (*Russia*)

Pages 107 - 112

Abstract: The statement of the main problems of algorithms and technical means design for motion control at small altitude above the disturbed sea surface is given. The aim of investigation is to improve the functional characteristics of the advanced transport vehicles, particular, wing-in-ground effect craft or ekranoplanes. The physical phenomenon of jump in lift/drag ratio at special wing motion close to supporting surface is the base for WIG-craft construction. Methods of stability providing and other problems solving by means of automatic control are analyzed. The experience and achievements in this field of high technology are described.

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RELIABLE H_2 STATIC OUTPUT-FEEDBACK TRACKING CONTROL AGAINST AIRCRAFT WING/CONTROL SURFACE IMPAIRMENT

F. Liao, J.L. Wang, G.-H. Yang (*Singapore*)

Pages 113 - 118

Abstract: This paper presents a novel reliable tracking control approach for an aircraft system with wing/control surface impairment faults. The approach is based on multiobjective optimization via affine parameter-dependent Lyapunov functions and an iterative Linear Matrix Inequalities (LMIs) algorithm. The solutions of an initial stabilizing controller used by the iterative algorithm are further studied. The application to an aircraft similar to F-16 with control surface impairment in the horizontal stabiliators illustrates the effectiveness of the proposed approach.

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SOME PECULIARITIES OF OPERATIVE “OKEAN-O” CONTROL

V.A. Udaloy, N.M. Ivanov, N.L. Sokolov, V.U. Pazdnikov (*Russia*)

Pages 119 - 121

Absract: During “Okean-O” control Main Operative Group of Control (GOGU) had to support the spacecraft attitude by changing solar array position during communication session. In this paper basic peculiarities of “Okean-O” control in condition of great atmosphere parameters changes and methodic of atmosphere parameters changes calculating are submitted; process of “Okean-O” control during one of the hardest geomagnetic storms on July, 15, 2000 is described.

View manuscript

AN H_∞-TECHNOLOGY FOR THE DETECTION AND DAMPING OF DIVERGENT OSCILLATION IN UPDATABLE INERTIAL SYSTEMS

A.V. Chernodarov, V.N. Kovregin (*Russia*)

Pages 122 - 127

Abstract: This paper discusses the problem of damping of divergent oscillations of the parameters of updatable inertial systems (ISs), in the structure of which an extended Kalman filter (EKF) is included. Such oscillations are set up due to the fact that the models of IS errors do not fit the actual measuring processes adequately. The solution of this problem is dependent on the employment of the properties of EKF residuals (of an innovation sequence) when a disharmony in IS signals is detected. To counteract the disharmony and its related divergent oscillations of IS parameters, we propose to make use of the H_∞ approach to the construction of estimation filters. The proposed implementation of this approach provides for an adaptive robust tuning of the filter gain.

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STRONGLY NONLINEAR DYNAMICS OF A GYROSTAT RESPINUP BY WEAK CONTROL

Ye.I. Somov, G.P. Titov, S.A. Butyrin, V.A. Rayevsky, A.G. Kozlov (*Russia*)

Pages 128 - 133

Abstract: Recently, space science and engineering advanced new problem before theoretical mechanics, physics and motion control theory: a gyrostat directed respinup by the weak restricted control internal forces. The paper presents some results on this problem, which is very actual for energy supply of the communication mini-satellites with plasma thrusters at initial mission modes.

View manuscript

QUANTUM STOCHASTIC WEYL OPERATOR

L. Accardi (*Italy*), **A. Boukas** (*Greece*)

Pages 797 - 803

Abstract: The quantum stochastic differential equation satisfied by the unitary operator $U(t) = e^{iE(t)}$ with $E(t) = \lambda t + zB_t^- + \bar{z}B_t^+ + kM_t$, where B_t^-, B_t^+ and M_t are the square of white noise processes of [15], is obtained in the module form of [9].

View manuscript

KINEMATIC AND GEOMETRIC DESCRIPTION OF THE SOLID MOTION IN THE GRAVITY FIELD

V. Adamyan, G. Zayimtsyan, L. Manandyan (*Armenia*)

Pages 214 - 216

Abstract: It is offered the geometric description of the solid motion in the gravity field; according to it the solid trajectory will be the geometric locus of the epicycles circles centers passing through the empty focus of trajectory and being tangent to the deferent circle. It is introduced the new concept – motion rhomb and algorithm of its construction which by its position, dimension of sides and diagonals determines completely the position of material point and its velocity vector that is required while solving the major task of mechanics.

View manuscript

KINEMATIC TECHNIQUE OF IDEAL GAS THERMODYNAMIC SURFACE FORMING

V. Adamyan, G. Zayimtsyan, V. Adamyan (*Armenia*)

Pages 211 - 213

Abstract: It is offered the kinematic technique of ideal gas thermodynamic surface forming by means of driving the straight isobar or isochor. It is obtained the existing geometric constraint between macroscopic parameters of ideal gas, and the algorithm is derived that allows determining the unknown parameter by two given, and also the value of molar constant by the simple geometrical constructions. The geometric proof of Charles' law is given using only Fales's theorem well-known from geometry. The thermodynamic process is simulated in the form of the curve that the state point circumscribes on the thermodynamic surface during the process.

View manuscript

ON THE STABILITY AND VIBRATIONAL STABILIZATION OF A CLASS OF NONLINEAR SYSTEMS

A.Yu. Aleksandrov, A.V. Platonov (*Russia*)

Pages 410 - 414

Abstract: A certain class of nonlinear oscillatory systems is investigated. The method of construction of Lyapunov's functions is suggested to obtain sufficient conditions of asymptotic stability and instability of the equilibrium position for systems considered. The influence of the nonautonomous perturbations on the asymptotic behavior of solutions is studied. The conditions under which the equilibrium position may be stabilized by means of the periodic variations of system parameters are investigated.

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RESONANCE AND SPEED-GRADIENT DESIGN OF CONTROL ALGORITHMS FOR DISSOCIATION OF DIATOMIC MOLECULE ENSEMBLES

M. Ananjevsky, A. Efimov, A. Fradkov, A. Krivtsov (*Russia*)

Pages 867 - 878

Abstract: Two methods for dissociation of diatomic molecules based on nonperiodic excitation generated by feedback control mechanism are described and analyzed by computer simulation for classical and quantum-mechanical ensembles. The first method of control design uses nonlinear resonance curve of the system to fulfill the resonance conditions at any time of excitation. The second method is based on the speed-gradient principle. Implementation of the proposed methods by pulse laser control is described. Efficiency of the proposed methods is demonstrated by the example of hydrogen fluoride (HF) molecule dissociation. Simulations confirmed that new methods are more efficient then the existing algorithms based on harmonic (monochromatic) and linear chirping excitation both for the model case of single molecule and for an ensembles of molecules. It is shown that the dissociation rate for the quantum-mechanical ensemble is just a few percent slower that the one for the classical ensemble. It justifies using classical models for feedback control design in the dissociation problem.

View manuscript

PHASE RELATIONS IN THE SYNCHRONIZED MOTION OF TWO-PENDULUM SYSTEM

B.R. Andrievsky (*Russia*)

Pages 569 - 576

Abstract: The synchronization phenomenon in nonlinear oscillating system is studied by means of examination of the coupled pendulums. Dependence the of phase shift between pendulum states on system parameters and initial conditions is studied both analytically and numerically. The harmonic linearization (HL) technique is applied for analytical examinations.

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COHERENT CONTROL OF VIBRATIONAL-ROTATIONAL TRANSITIONS IN DIATOMIC MOLECULE UNDER THE ACTION OF BICHROMATIC LASER FIELD

V.A. Astapenko (*Russia*)

Pages 879 - 882

Abstract: The paper is devoted to the theoretical study of the possibility of coherent control of the vibrational-rotational transitions in diatomic molecule under the action of bichromatic laser field. Two possible absorption branches are considered. Dependencies of the control efficiency upon the parameters involved such as gas temperature and electric field amplitudes of the monochromatic components are investigated. Numerical calculations are performed for the case of molecule in Morse approximation. The possibility of the efficient coherent control of the considered process is demonstrated.

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MODELING OF EXCITED STATES OF A CRYSTAL BASING ON THE FREQUENCY-PHASE SYNCHRONIZATION OF VIBRATIONS OF CRYSTAL SITE LATTICE

L.A. Bityutskaya, S.G. Zhitskey (*Russia*)

Pages 933 - 936

Abstract: Model of an excited solid as a system of non-linear oscillators is considered in the work. State of the spatial distribution for the system of oscillators and its limitation were shown to be a condition for transition of a solid into excited state. Mechanism responsible for structural transformations in the range of excitation is frequency-phase synchronization resulting in the formation of dynamically active cluster areas and dissipation of the energy.

View manuscript

ROOT ESTIMATOR OF STATES

Yu.I. Bogdanov (*Russia*)

Pages 808 - 813

Abstract: A fundamental problem of statistical data analysis, distribution density estimation by experimental data, is considered. A new method with optimal asymptotic behavior, the root state estimator, is developed. The method proposed may be applied to its full extent to solve the statistical inverse problem of quantum mechanics, namely, estimating the psi function on the basis of the results of mutually complementing experiments.

View manuscript

MODELING AND IDENTIFICATION OF THE STRUCTURE DEFECTS IN DIELECTRIC DIODES

V.M. Bogomol'nyi (*Russia*)

Pages 920 - 921

Abstract: Theory of the first reversible stage of electrical degradation of metal-dielectric-metal (MDM) structure was formulated on basis of analogy in mathematical description of electron transport in the dielectric layer and hydrodynamical flow. Physical model of nondestructive testing of metal electrode surface roughness proposed, on base of which the micropeak tip curvature can be measured.

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SPEED-GRADIENT CONTROL OF COOLED ATOM DYNAMICS IN POTENTIAL OF STANDING WAVE

S.V. Borisenok, Yu.V. Rozhdestvensky, A.L. Fradkov, B.R. Andrievsky, B.G. Matisov
(*Russia*)

Pages 909 - 912

Abstract: Dynamics of cold atoms in laser standing wave is a subject of a great interest, stimulated by the main problem of nano-lithography with cooled atoms: We can obtain the very narrow width of cooled atoms, much less than wavelength of optical radiation, by focusing in standing wave. We consider the possibility to increase the efficiency which means obtaining the very narrow width of atoms by focusing all atoms of an initial atom beam by controlling of an atom dynamics in periodic potential of standing wave. Such control for cooled atom dynamics achieves by using the additional laser field. There are two additional possibilities of atom focusing to comparing with usual focusing without control function. The first, the control function was chosen so that all atoms fall into potential wells of standing wave. In this case we obtain the increasing of atom number in five times (compare with ordinary focusing). At the same time, the width of atom distribution function inside wells is about л /20. In the second case, the control function was chosen so that all atoms prepare on the hills of the periodical potential. For such unusual focusing we demonstrate that the width of atoms can be done extraordinary narrow 6 nm and an atom number increases in one hundred times.

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SCALE SPLITTING CONTROL FOR AN ATOM WAVE PACKET COHERENT SCATTERING IN MODULATED STANDING WAVE

S.V. Borisenok, Yu.V. Rozhdestvensky, G.G. Udov (*Russia*)

Pages 913 - 916

Abstract: Recently, coherent splitting has been achieved by scattering of an atom wave packet in standing wave with modulated intensity. We demonstrate now as the result of such scattering depends on the initial modulation phase, e.g., the scattering pictures are different for ‘cos’ and ‘sin’ modulation functions and the increasing of coherent components with defined atom momentum occurs for ‘cos’ modulation function only.

As a result, we have reached the conclusion that the shape of the pulse modulation does not influence to the scattering pictures and for any modulation function we can always choose such values of amplitude modulation when only two components will be dominated in the scattering.

View manuscript

CONTROL OF CHAOTIC BEHAVIOR IN HIGH ORDER DYNAMICAL SYSTEMS

A. Boukabou, N. Mansouri (*Algeria*)

Pages 516 - 521

Abstract: In this paper, we present a chaos control algorithm, based on the OGY method, to control chaotic behavior in high order dynamical systems. To begin with, once chaotic behavior identified on the bifurcation diagram, studying the so-called Poincaré sections enable determining fixed points and the effect of small changes in the control parameter on trajectory. Introduction of a stabilizer parameter in the control law, keeps the dynamical properties and maintains them on a cyclic trajectory. The effectiveness of the proposed method is tested by numerical examples on Lorenz and Rössler systems.

View manuscript

MULTISCALE STOCHASTIC DYNAMICS IN FINANCE

E. Capobianco (*The Netherlands*)

Pages 223 - 228

Abstract: The estimation of volatility processes underlying observed financial returns is stochastically characterized in a semimartingale probabilistic setting through two related measures: realised and integrated volatility. According to the quadratic variation principle the convergence of realised to integrated volatility can be verified both in time and frequency coordinates. We show from an experimental standpoint that consistent estimators for the integrated volatility hold when the scale coordinate is considered and wavelet-based estimators are adopted.

View manuscript

WAVELETS IN THE PROPAGATION OF WAVES IN MATERIALS WITH MICROSTRUCTURE

C. Cattani (*Italy*)

Pages 1084 - 1089

Abstract: The analysis of evolution differential equations (parabolic-hyperbolic), might be considered within the framework of the (harmonic) wavelet theory. In fact, the multiresolution analysis of wavelets seems to be a suitable scheme for the investigation of phenomena which appears at different scales of approximation. Very often, the approximate solution is expressed in terms of functions which are significant only at a given resolution, and, some time, also the exact solution (like e.g. the D'Alembert solution of the wave equation) shows two characteristic features of wavelets: the dilation (multiscale) and the translation properties. However, from physical point of vi ew, the wavelets still have little interpretations, especially concerning the small details expressing small deviations nearby the steady solution, since there are only a few examples of physical propagation of wavelets. In particular, the wavelet solutions of the dispersive (Klein-Gordon) wave equation show that the multiresolution approach is a kind of approximation that at each (scale) step increases the “resolution” of the solution. Thus it seems interesting to investigate this multilevel process that, at each scale (level), adds some more details to the solution. As application, the wavelet solution of the Klein Gordon equations for materials with microstructure, will be defined as follows: the dispersive wave solution of the propagation equation will be interpreted as a superposition of “small” waves on a basic wave. So that the wave propagation will be investigated at each given resolution, by showing that the “minor” details of the solution, neglectable at the initial time, have a significant influence on the solution on a long (time) range.

View manuscript

AN ELECTROMAGNETIC MODEL FOR CHARGED PARTICLE WITH SPIN

A.A. Chernitskii (*Russia*)

Pages 233 - 236

Abstract: An electromagnetic model for charged particle with spin in the framework of Born-Infeld type nonlinear electrodynamics is considered. The field configuration having two dyon singularities with identical electric and opposite magnetic charges is introduced and it is named bidyon. The sum of two dyon solutions when the dyons may have velocities with equal modules and opposite directions on a common line is considered as the initial approximation to the bidyon solution to a nonlinear electrodynamics model. The associated field configuration has a constant full angular momentum which is independent of a distance between the dyons and their speed. The dynamical system with two dyons can have an oscillating regime. The possibility for model representation of leptons with the bidyon solution is discussed.

View manuscript

ON DETECTION OF BELONGING OF TWO POINTS TO ONE TRAJECTORY

A.V. Demin (*Russia*)

Pages 534 - 538

Abstract: The problem of whether two given points belong to one trajectory of given system of nonlinear autonomous differential equations or not is considered. Some variation task with the functional in the form of norm of Hilbert space for set of functions with one parameter is formulated. The solution is given in the form of modified Picard approximations to the solutions of the system of differential equations.

SAFEWAY - SAFETY IMPROVEMENT OF VEHICLE PASSENGERS THROUGH INNOVATIVE ON-ROAD BIO-MECHANICS SAFETY FEATURES

A. Figaredo, L. Cicinatti, J. Papi (*Belgium*)

Abstract: The SAFEWAY project is a research and technological development project funded by the European Union under the GROWTH Programme. Safeway's aim is to develop a prototype barrier that not only conforms to standard requirements, but is also based on knowledge of the traumatological impact of a collision with road safety barriers can have. In addition to the prototype barrier, the project will result in a series of recommendations or guidelines for road barrier design integrating medical as well as engineering aspects into road safety barrier design. SAFEWAY innovation stems from the synergy between engineering and medical expertise.

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PROBLEMS OF REGULAR BEHAVIOUR AND DETERMINED CHAOS IN MATHEMATICAL MODELS OF MENDELIAN LIMITED POPULATIONS

E.Ya. Frisman, E.A. Kolbina, O.L. Zhdanova (*Russia*)

Pages 666 - 669

Abstract: We investigate the fitness differences model with Mendelian one-locus di-allele limited population in cases of linear and exponential rules of selection. It was made the analytical and numerical investigation of the model. The possibility of population number fluctuations with stable genetic structure was showed. Also were found joint fluctuations of genetic structure and population number. This result contradicts to well-known hypothesis of "genetic control". The stable chaotic attractors with non-integer dimensions were found. It was made the generalization of model for polyallele population with some admissions and its analytical investigation was carried out.

View manuscript

NEW MECHANISM OF OSCILLATIONS AND CHAOS IN THE ECOSYSTEM WITH INTENSIVE EXPLOITATION

E.Ya. Frisman, E.V. Sycheva (*Russia*)

Pages 663 - 665

Abstract: This mathematical model generalizes maximum number of trade strategies which take place in the real situation. The number of considered objects was still sufficient for intensive withdrawal. It was shown that the model can have from one up to five roots and,accordingly, from two up to six stationary decisions,including zero. Hence, in addition to described dynamic modes with two attractions, it is possible the mode when there are three unstable stationary points (including zero) and three "areas of attraction", from which the values of number converge to various steady equilibrium or to attractors of other types. Thus, it is clear that trade can change cardinally the population number, transferring it to new difficult dynamic modes.

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OSCILLATIONS OF NATURAL POPULATION’S NUMBER CAUSED BY EXTERNAL CONTROL

E.Ya. Frisman, E.V. Sycheva, E.V. Last (*Russia*)

Pages 617 - 620

Abstract: The new explanation of fluctuating mechanisms in exploitable populations is offered. Is shown that the trade could be the cause of destabilisation; the conditions of loss of stability depend on exploiting parameters but weakly depend on a population structure. In addition, these conditions for a multi-age population and for a uniform population are qualitatively identical. Still age structure uniquely determines the script of cyclic and chaotic dynamic's evolution. The model was adapted for description of four real exploitable populations number changes.

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GLOBAL BIFURCATIONS AND CHAOS IN POLYNOMIAL DYNAMICAL SYSTEMS

V.A. Gaiko (*Belarus*)

Pages 670 - 674

Abstract: Polynomial dynamical systems are considered. First of all, we study global bifurcations of multiple limit cycles in two-dimensional systems developing a new approach to Hilbert's Sixteenth Problem on the maximum number and relative position of limit cycles. The problem has not been solved completely even for the simpliest nonlinear case: for the case of quadratic systems, and we suggest a program solving this problem in the quadratic case. This approach can be applied also to the study of arbitrary polynomial systems and to the global qualitative analysis of higher-dimensional dynamical systems. In particular, we discuss how to apply the obtained results for the construction of a three-dimensional system with a "strange attractor" on the base of a planar quadratic system with two unstable foci and an invariant straight line. This study could give us a chaos birth bifurcation in the polynomial dynamical systems.

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MATHEMATICAL MODELING AND CONTROL OF THE REFRACTION INDEX OF OPTICAL LIGHTGUIDE AT FABRICATION STAGE

A.I. Gavrilov, E.V. Hairjuzova, T.L. Shapochnicova, I.A. Gavrilov (*Russia*)

Pages 928 - 932

Abstract: The reasons of appearance of screw of non-uniformity of obtained layer's thickness in waveguide fabrications are determined in terms of convective deposition model. Non-uniformity leads to deflexion of the refraction index from demanded profile.

Obtained analitic expressions can be used as the basis for managing program, which allows to get determined profiles of refraction index.

View manuscript

DESIGN AND ANALYSIS OF ROBUST CONTROLLERS

V.I. George, C.P. Kurian (*India*)

Pages 1320 - 1325

Abstract: In this paper we address the problem of analyzing and designing robust controller given plants whose dynamic contains significant uncertainty. The proposed work comprises an $H*$ controller design problem for a class of stable/unstable plants and selecting suitable weighting functions W_1 and W_2 such that which satisfies both robust performance and robust stability. We modify the above controller design by making use of the theory of $H*$ parameter space method. And we compare the performance characteristics of the control system.

View manuscript

CHAOTIC MAPS GENERATING WHITE NOISE

A.F. Goloubentsev, V.M. Anikin, Y.A. Barulina (*Russia*)

Pages 452 - 455

Abstract: Some one-dimensional chaotic maps having delta-autocorrelation function are considered. New examples of exact endomophisms generating discrete white noise for a continuous range of a parameter are obtained. They may be treated as generalizations of the Chebyshev polynomial $T_2(x), x \in (-1,1)$ of the first kind. The using such difference equations may be preferable to construct chaotic generators of pseudo-random sequences.

View manuscript

ON SOME CHARACTERISTICS OF COMPUTERS OF NEW GENERATION

O.N. Granitchine, S.S. Sysoev (*Russia*)

Pages 804 - 807

Abstract: The paper deals with the problem of creating of computers of the new generation. Some abstract approach of constructing the hardware is considered and the basic scheme of functioning is proposed. The new generation is supposed to be the generation of computers with artificial intelligence features. In this paper term ”intelligence” is understood as ability of system to adapt to the real world conditions by the effective choosing of the task to solve in current moment.

View manuscript

COMPUTER SEISMIC SYSTEM AND FRACTAL METHOD OF PREDICTION OF EARTHQUAKE CYCLES

A. Gugushvili, V. Sesadze, A. Ediberidze, I. Kutsia, P. Jokhadze (*Georgia*)

Pages 191 - 195

Abstract: A new type of seismic sensor for prediction of earthquakes has been elaborated. The offered seismic sensor sharply differs from standard sensors by its functioning. It is based on optoelectronic principle by means of semi-conductive laser. To determine the earthquake the Hurst statistics is used. The definitions of Hurst index, the magnitude of the deviation of acceleration *R*, the normed deviation of acceleration are introduced.

View manuscript

CONTROL OF SPACIAL STRUCTURES IN A SEMICONDUCTOR-GAS DISCHARGE SYSTEM WITH A SEMI-INSULATING GAAS CATHODE

E. Gurevich (*Russia/Germany*), **Yu. Astrov (Russia), H.-G. Purwins** (*Germany*)

Pages 922 - 927

Abstract: Nonlinear current transport in transversely extended gas discharge system with a semi-insulating GaAs cathode is studied. The emerging spatial patterns appear in the semiconductor electrode, while the application of a thin gas-discharge gap allows to visualize the patterns. Sequences of scenarios in the pattern formation under changing control parameters are presented. It is experimentally shown that the dynamics of the structure is not noticeably influenced by inhomogeneities of the experimental system. Among results obtained, variation of scenarios under changing the temperature of the GaAs electrode are presented.

View manuscript

ADAPTIVE PID CONTROLLER FOR NONLINEAR SYSTEMS WITH H^{∞} TRACKING PERFORMANCE

H.F. Ho, Y.K. Wong, A.B. Rad (*China*)

Pages 1315 - 1319

Abstract: In this paper, we developed a PID control for a certain class of unknown nonlinear dynamic systems. The three parameters of PID controller are obtained based on Lyapunov approach. Moreover, a H^{∞} control technique obtained by a modified Riccati-like equation is constructed to achieve the H^{∞} tracking performance for any prescribed level. The simplicity of the scheme provides a new approach for implementing PID controller for a variety of nonlinear problems. Simulation studies have shown that the proposed controller performs well in tracking performance.

View manuscript

CHAOS IN GERMANIUM OSCILLISTOR

Kh.O. Ibragimov, K.M. Aliev, I.K. Kamilov, N.S. Abakarova (*Russia*)

Pages 680 - 682

Abstract: Dynamic chaos evolution scenarios of the development of a Kadomtsev-Nedospasov instability in the electron-hole plasma in germanium at 77 and 300 K have been studied experimentally in external electric and magnetic fields at high control parameters. The development of a spatio-temporal chaotic state in the system has been analysed using probe measurements along a sample. It is shown that several attractors, with their own dimensions and power characteristics, may exist simultaneously in the same sample. Scenarios have been found leading to chaos through period doubling, quasi-periodicity and intermittency, depending on the parametric space; transitions of the order-chaos-order type have also been observed.

THE CONTROL OF HYSTERESIS LOOPS PARAMETERS OF VANADIUM DIOXIDE FILMS BY SEMICONDUCTOR - METAL PHASE TRANSITION

A. Ilinskii (*Russia*)

Abstract: By spectroscopic and ellipsometric methods hystereses of optical constants of vanadium dioxide films at the semiconductor- metal phase transition are investigated. With the help of an atomic-force microscope the morphology of these films is studied and the correlation between hysteresis loops parameters of optical constants and distribution of films grains on the sizes is detected. Is showed, that the main hysteresis loop consists of elementary loops, distributed on width and position on a temperature scale under the law of the Gauss. The capability of control of width and position of a main hysteresis loop by variation of parameters of these distributions is established. The efficiency of offered methods of parameters verification for applying of vanadium dioxide films in optical limiters and devices of processing of the optical information is showed.

NON-LINEAR DYNAMICAL BEHAVIOR IN A RAILWAY BOGIE MODEL

V.G. Inozemtsev, T.A. Tibilov (*Russia*)

Abstract: This paper presents results of the analytical investigation of the dynamics of a single railway bogie model. The rail vehicle is represented by a two-axes bogie that includes the dynamics of the wheel etc and the truck frame. Flange contact nonlinearities can also have a significant effect on the hunting behavior. Large lateral stiffness of the rail can increase lateral force to vertical force ratio during hunting. Increasing the gauge clearance, however, can have an opposite effect. The effect of various nonlinear and linear parameters, such as gauge clearance, rail lateral stiffness, wheels mass, primary suspension yaw and lateral stiffness, are examined. In each case, the effect of the parameters on the nonlinear speed in examined.

View manuscript

ADAPTIVE NONLINEAR CONTROL OF INDUCTION MOTOR USING NEURALS NETWORKS

N. Kabache, B. Chetate (*Algeria*)

Pages 260 - 265

Abstract: To avoid the various constraints related to the feedback linearisation control (FBLC), in this papers we propose a new control approach for the induction motor control based on artificial neural networks (ANN) trained on-line. The two ANN are used for the on-line reconstitution of the state feedback necessary for the FBLC. The training rules used result from a combination between the ANN properties, the adaptive nonlinear control propriety and the nonlinear adaptation rules. Via these three techniques a training rules were extracted, these last transform the tracking errors into a means to adjust the used ANN behavior so that they adapt with the various operation modes of induction motor.

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ESTIMATION OF TRANSPORT TIMES FOR CHAOTIC DYNAMICAL CONTROL SYSTEMS

S.M. Khryashchev (*Russia*)

Pages 528 - 533

Abstract: Sequences of sets of accessibility and their volumes are studied for dynamical control systems with chaotic behavior of trajectories. Controlled trajectories joining arbitrary initial and final points are constructed. By analysis of sequences of volumes, the transport times, i.e. the times to reach target points, are estimated for some classes of control systems.

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CONSTRUCTION PRINCIPLES AND CONTROL OVER TRANSPORT SYSTEMS ORGANIZATION IN BIOLOGICAL TISSUES

N.N. Kizilova (*Ukraine*)

Pages 303 - 308

Abstract: The main common principles of the long-range transport systems construction in animal and plant tissues are summarized. The results of measurement of conducting system geometry in Cotinus obovatus leaf are analyzed. It is shown that the principles of design of the conducting systems in animals and higher plants are the same and correspond to the model of optimal pipeline. The mathematical model of fluid motion in the conducting system of the leaf as a motion in a branching pipeline with permeable walls is investigated. The cost of a bifurcation of the vessels is analyzed. The hypothesis of the control principle of optimal transport system formation in the growing leaf is discussed. As an example the self-similar conducting system with loops is investigated and compared with some venation systems in plant leaves.

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IDENTIFICATION OF THE LEVEL OF MANAGEMENT BASED ON POWER LAW SCALING

E.V. Kleparskaya (*Russia*)

Pages 220 - 222

Abstract: The power-law-scaling approach developed for hierarchical physical systems was used to identify the integral level of management for the branches of machinery and metallurgy. The obtained results show the transition of the machinery branch to the normal level of management through the chaotic behavior.

INFLUENCE OF THE HARMONIC DISTURBANCE ON CONTROL MOTIONS OF A MECHANICAL SYSTEM

G. Kostin (*Russia*)

Abstract: The disturbed motions of a controlled mechanical system with one degree of freedom under dry friction force are investigated. The feedback control function is time optimal for the undisturbed point-to-point problem. The system is subject to the harmonic disturbing influence. The possible trajectories and limiting cycles are investigated for different values of system and disturbing parameters. The conditions of existence and stability of the simple cycles are analyzed. For disturbed system without friction the synthesis and the program law of time optimal control were derived. It was shown that the optimal control is piecewise constant and has no more than one switch.

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CONTROL DISCRETE SYSTEMS AND THEIR APPLICATIONS TO BEAM DYNAMICS OPTIMIZATION

E.D. Kotina (*Russia*)

Pages 997 - 1002

Abstract: In this paper a mathematical model is considered that allows simultaneous optimization of program motion and that of ensemble of perturbed motions. Analytical expressions for functional variations are suggested that allows constructing various directed methods of optimization. This mathematical apparatus can be effectively used to beam dynamics optimization in the drift-tube linear accelerators.

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PHYSICAL CONTROL AND MONITORING IN MODERN MEDICINE

V.K. Koumykov (*Russia*)

Pages 309 - 313

Abstract: The paper is devoted to the role of fundamental physical achievements in advanced technologies of control and monitoring used in modern medicine. It contains the analysis of diagnostic methods based on physical phenomena: X-ray examination, nuclear medicine, ultrasound test, the method of electronic paramagnetic resonance, nuclear magnetic resonance spectroscopy, X-ray-and positron-emission computer tomography, endoscopy, thermography, luminescent analysis, electrocardiography, biomagnetism etc. Also reviewed are methods of control based on the use of fiber optics, laser mass-spectroscopy and special microscopy.

1/F FLUCTUATIONS UNDER HEAT AND MASS TRANSFER WITH PHASE TRANSITIONS

V. Koverda, V. Skokov (*Russia*)

Abstract: The results of experimental study of critical fluctuations with $1/f$ spectra in heat and mass transfer processes are presented. A phenomenological model describing the initiation of $1/f$ noise at nonequilibrium phase transitions with two interacting order parameters has been suggested. The model predicts the conversion of white noise into two stochastic processes with $1/f$ and $1/f^2$ power spectra in both lumped and space extended systems. It has shown that in the suggested model a noise-induced transition takes place. This transition is connected to an origin of $1/f$ noise.

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KOLMOGOROV COMPLEXITY: HOW A PARADIGM MOTIVATED BY FOUNDATIONS OF PHYSICS CAN BE APPLIED TO ROBUST CONTROL

V. Kreinovich, I.A. Kunin (*USA*)

Pages 89 - 94

Abstract: Born about three decades ago Kolmogorov Complexity Theory (KC) led to important discoveries that, in particular, give a new understanding of the fundamental problem: interrelations between classical continuum mathematics and reality (physics, biology, engineering sciences, ...). Crudely speaking, it enables us to better distinguish between mathematical possible (possible abnormal) and physically possible situations.

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IDENTIFICATION OF NON-MEASURABLE PARAMETERS OF FERROELECTRICS BY OPTIMIZATION METHOD

S.A. Kukushkin, A.V. Osipov, P.Yu. Guzenko (*Russia*)**, V.V. Spirin** (*USA*)

Pages 937 - 941

Abstract: An approach to define certain constants for ferroelectric crystals with respect to analysis of evolution of the switching current is proposed. Algorithms for separate identification of such non-measuarable parameters of ferroelectrics as the surface tension and the kinetic coefficients are given.

View manuscript

INTEGRATION OF SIMULATION METHODS IN CONTROL SYSTEM FOR EB PROCESSING

V.T. Lazurik, V.M. Lazurik, G.F. Popov, Yu.V. Rogov (*Ukraine*)

Pages 1003 - 1008

Abstract: This paper will focus mainly on the integration features of mathematical simulation of electron beam (EB) processing into the control system (CS) of the radiation-technological tine (RTL) incorporating an industrial electron accelerator with a scanner of electron beam and a conveyor. The motivation for this development is the creation of the CS that allow to realize the control of the absorbed dose distribution of EB within the irradiated materials in real-time mode. Because there is no direct express measurement methods for scanning EB of the absorbed dose distribution, which is one of the most important characteristic for all radiation-technological processes.

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MODELING AND CONTROLLING THE HEART CONDUCTIVE SYSTEM

A. Loskutov, S. Rybalko, E. Zhuchkova (*Russia*)

Pages 522 - 527

Abstract: A model of the cardiac tissue as a conductive excitable system with a pacemaker under external stimuli is proposed. At certain conditions this model is reduced to the standard circle map. It is analytically shown that 2--periodic perturbations of the constructed map lead to the stabilization of the prescribed orbits and thus, allow us to realize the control of complex cardiac rhythms and remove the heart behaviour to the required dynamical regime.

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UNCONTROLLABILITY SET FOR MULTI-INPUT DYNAMICAL SYSTEMS DEPENDING ON PARAMETERS

A.A. Mailybaev (*Russia*)

Pages 1102 - 1105

Abstract: Linear multi-input dynamical systems smoothly depending on parameters are considered. The generic (typical) structure of the uncontrollability set, consisting of parameter values corresponding to uncontrollable systems, is described. A constructive perturbation theory for numerical analysis of the uncontrollability set is developed. As an example, the uncontrollability set is found for a mechanical system depending on three parameters.

View manuscript

MODELING OF NEGATIVE RESISTANCE FOR RESISTIVE TRANSDUCERS LINEARISATION

Kh. Mamikonyan (*Armenia*)

Pages 217 - 219

Abstract: The aim of the research is to develop the precision measuring converter for resistive transducers having nonlinear characteristic of conversion. It is reviewed the example of measuring converter creation for narrow-limited (about 20*K*) thermometers with application of standard platinum resistance thermal converter (RTC) in the capacity of the transducer when the linearization problem of conversion characteristic arises. In this work the linearization is realized by means of negative resistance modeling by positive feedback introduction. The questions of stability are reviewed; it is made the estimation of initial and residual nonlinearities with the purpose of determining the achievable precision of temperature narrow limits measurement in working conditions.

View manuscript

STABILITY OF THE DISCRETE POPULATION MODEL WITH TWO DELAYS

R.M. Nigmatulin, M.M. Kipnis (*Russia*)

Pages 314 - 316

Abstract: Stability of the population dynamics model $y(n) = \alpha y(n-m)/(1+\beta y(n-m)+\gamma y(n-k))$ is concidered. Here $y(n)$ is the size of the population at time n; k and m are delays ($k,m \in N$), $\alpha > 1$, $\beta > 0$, $\gamma > 0$. It appears that if $\beta = 0$ then the necessary condition for stability of stationary solution is divisibility of k by m. Inequality $1 > \beta > 1/2$ is sufficient for asymptotic stability of stationary trajectory of model for every delays k,m. If k,m is mutually prime, $k > m$ and m is even then the condition $\beta > 1/2$ is nesessary too.

FOKKER-PLANCK EQUATION FOR CHARGED PARTICLE BEAMS

Z. Parsa, V. Zadorozhny, V. Yavorskij, S. Rudenko (*Ukraine*)

Abstract: Originally a six-dimentional (6D) in phase space kinetic equation for charged particle beams is reduced at least to a four-dimensional (4D) or even to a three-dimensional (3D) Fokker-Planck type kinetic equation by using the beam symmetry and also the averaging over the periodic or quasi-periodic motion of beam particles. The explicit expressions for the transport coefficients of the reduced Fokker-Planck kinetic equation for the case of linear and toroidal beams are obtained. Resonant and non-adiabatic effects for beam particle motion in periodic external fields are considered.

View manuscript

COMPLEX SYSTEMS CONTROL TAKING INTO ACCOUNT THE INTERNAL HOMOGENIOUS STRUCTURES

V.N. Pilishkin (*Russia*)**, I. Tollet** (*Finland*)

Pages 95 - 100

Abstract: The new approach of homogeneous robust control systems synthesis, both linear, and nonlinear and non-stationary is offered. The control is carried out, providing the given phase constrains varied in acceptable limits, in view of constrains on its value and incompleteness of the information about functioning disturbances. The approach is based on introduction of auxiliary integral surfaces, on which the initial moving is projected. As a result the reduced equivalent moving is forming, described by the scalar equation which in many important cases can be integrated directly. On the basis of the obtained equation solving of a synthesis task is carried out and can be reduced to algebraic or integral inequalities. The final relations defined for linear equivalent moving are presented.

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MECHANISM OF IMPULSE FLOWS SYNCHRONIZATION IN NEURONAL NETWORK OF VISUAL SYSTEM

N.P. Podvigin, T.V. Bagaeva, J.M. Markova, D.N. Podvigina (*Russia*), E. Poeppel (*Germany*)

Pages 299 - 302

Abstract: The mechanism of control of the level of impulse flows' synchronicity in brain neural networks is an important part of the processes of cooperative functioning of entire brain structures. For example it takes part in control of signal transfer coefficient and of the velocity of signal spreading in neuronal networks; it participates in spatial-temporal segmentation of excited areas, in "bahnung effect" procedure etc. It's believed nowadays [Singer W., Gray C., 1995 et al.] that the highest degree of synchronicity of impulses of the couple of adjoined neurons may be attained only during their testing by the stimuli which parameters correspond optimally to functional properties of the neurons. In other words the authors suppose that the factor of synchronization is the corresponding to neurons properties of test stimuli. In search of biologically more universal mechanism of control of synchronicity of impulse flows generated by visual system neurons we've conducted the series of experiments where neuronal pools were tested by the number of different visual test stimuli. It turned out that [Podvigin et al. 1997] the level of synchronicity of impulse flows (according to crosscorrelation analysis) of neuronal couples correlates with (coefficient 0,716+/-0,217) the level of excitation of neuronal pools being analyzed by the stimuli. It's showed that neuronal assemblies analyzed have an ability for self-synchronization of impulse flows generated by them. We analyzed visual system using visual stimuli specific for it. Is this synchronization principle correct for the other brain systems? To answer this question we used nonspecific excitatory effect to excite neuronal pools during the experiments on visual system - microinjections of glutamic acid into neuronal pools. The data obtained have proved that glutamic acid excitatory influence upon neuronal pools analyzed also results in the increase in synchronism of impulse reactions to test visual stimulus generated by neurons in neuronal pools. Thus the excitation of neuronal structures or their loci caused by both specific for visual system and nonspecific influences is accompanied by the increase in synchronism of impulse flows generated by neurons being excited. Such universal principle of self-synchronization may control the synchronism of impulse flows within the whole possible diapason - from their absolute asynchronicity to the highest possible synchronism (for example, from sleep to activity). Thus neuronal structures can control the synchronicity of impulse signals produced by these structures by regulating the level of their own excitation. Hence, the principle of self-synchronization is proper to brain neuronal systems, as well as to dynamic technical systems (for example to mechanical vibroexciters [Blekhman 1971]).

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QUANTUM SYSTEM IDENTIFICATION

M. Raginski (*USA*)

Pages 792 - 796

Abstract: We formulate and study, in general terms, the problem of quantum system identification, i.e., the determination (or estimation) of unknown quantum channels through their action on suitably chosen input density operators. We also present a quantitative analysis of the worst-case performance of these schemes.

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SIMULATION MODELS TO OBTAIN X-RAY SPECTRA USING THE COMPTON SCATTERING TECHNIQUE

J. Ródenas, S. Gallardo, M.C. Burgos (*Spain*)

Pages 229 - 232

Abstract: Quality control of X-ray tubes for medical radiodiagnostic services is very important. Therefore, it is convenient to develop new procedures to characterise the X-ray primary beam, obtaining an accurate assessment of the actual photon spectrum. The Compton scattering technique is very useful to determine X-ray spectra, avoiding the pile-up effect in the detector, as usually a large room is not available to apply other techniques. The Compton scattering procedure has been simulated using the Monte Carlo method. Several simplified models have been developed for the scattering assembly, considering the X-ray focus as a point source.

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THIN FILMS INDUCED BY NANOMETRIC POWDERS FLOTATION

I. Sandu, I. Morjan, I. Voicu, R. Alexandrescu, F. Dumitrache, I. Soare, I. Ploscaru, M. Fleaca, E. Popovici (*Romania*)

Pages 917 - 919

Abstract: Different kind of nanometric powders: carbon, iron, titanium oxide or composites like: Fe/Ti, C/Fe, were obtained by laser pyrolysis of some specific precursors. All of these powders have the ability to float on water. In a good analogy with Langmuir-Blodgett deposition technique, thin film of pyrolytic nanoparticles were realized. Special properties and future applications of them were exhibit.

OSCILLATORY SELF-ORGANIZATION PROCESSES AT ENANTIOTROPIC TRANSFORMATIONS OF IRON SULFATE BASED DEPOSITS

N. Sergeeva, V. Korsakov, Y. Nakanishi, S. Mjakin, V. Gnatyuk (*Russia*)

Abstract: Oxidizing-hydrolytic deposition of Fe (III) ions (oxidized from Fe(II) state) proceeds with decreasing pH via an oscillatory mechanism. Ultra dispersed goethite and glockerite deposited from the initial solutions with higher pH (~2) pass through non-equilibrated states with increasing acidity eventually undergoing recrystallization into basic iron sulfates at pH (~1). According to XRD data the precipitation is featured with reversible enantiotropic transformations of goethite into hydroxonium-jarozite depending of the ion concentration, pH, pressure and temperature. These parameters comprise a multi-dimensional thermodynamic surface behaving as the attractor for this process. The adjustment of the system deviation degree from the equilibrium state affords the control over the direction and conversion of oscillatory self-organization processes and affords obtaining deposits with a certain structure (goethite, hydroxonic-jarozite, sodium-jarozite) and dispersity (the particle size can be varied from nanometers up to the several tens of micrometers. This technique can provide a simultaneous approach to the environment protection from pollution and production of various dispersed iron-based materials (e.g. magnetite for the production of electric batteries/accumulators).

NONLINEAR MODELING AND PREDICTIVE CONTROL OF MOLTEN CARBONATE FUEL CELLS STACK

Shen Cheng, Yu Li-yun, Cao Guang-yi (*China*)

Abstract: Performance and availability of Molten Carbonate Fuel Cells (MCFC) stack are greatly dependent on its operating temperature. Control of the operating temperature within a specified range and reducing its temperature fluctuation are highly desirable. The models of MCFC stack obtained are too complicated to be suitable for design of a controller because its lack of clear input-output relations. In this paper, according to demands of control design, a quantitative relations model Control-oriented of MCFC between the temperatures of the stack and flowrates of the input gases is developed, based on conservation laws. It is an affine nonlinear model with multi-input and multi-output (MIMO). The nonlinear plant is linearized with a input-output feedback linearization of multi-variables system. Then a model predictive control (MPC) algorithm is designed to control the temperatures of the stack, with the linearized model as the predictive model. The algorithm and structure of the control system is given. The simulation results reveal the model developed is valid and the MPC system can adjust MCFC stack temperature effectively.

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COMPARATIVE STUDY OF INTERFERENCE ELIMINATION IN HEAVY METALS CONTROL BY ANODIC STRIPPING VOLTAMMETRY METHOD

E.A. Sosnin, V.N. Batalova, E.Yu. Buyanova, V.F. Tarasenko (*Russia*)

Pages 350 - 352

Abstract: The conditions for elimination of interference of surface-active organic substances (for e.g., natrium laurilsulfate) or humic acid on anodic peaks of Zn, Cd, Pb and Cu were investigated. Interference of these substances is related to their adsorption on working electrode and formation of strong ion-metal complexes. Both of them are obstacles to reduction of metal ions on the working electrode. Aiming at interfering substances destruction in solutions, the effect of ozone and UV irradiation from mercury quartz lamp (λ~254 nm) and KrCl-excilamp (λ~222 nm) was studied. It is presented that KrCl-excilamp is mostly efficient for surface-active organic substances destruction. Effect of Hg-lamp under TiO_2 additions in solution is less efficient. And ozone treatment of the sample is not in the least efficient here, except for Cu. All three ways can be used for Metal + humic acid complexes destruction.

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PARAMETRICALLY INDUCED STOCHASTIC SYNCHRONIZATION

O.V. Sosnovtseva, V.V. Astakhov, A.V. Shabunin, P.A. Stalmakhov (*Russia*)

Pages 577 - 581

Abstract: We find that a periodic parametric perturbations of coupling coefficient can induce the transition to the synchronized regime in bistable systems. This effect is demonstrated via numerical simulation using Duffing oscillator. Generic aspects of obtained results are argued.

INTELLIGENT CONTROL SYSTEM FOR IMPROVED SYSTEM PERFORMANCE FOR PUMPS OPERATING IN PARALLEL IN PROCESS INDUSTRIES

A. Sundaram (*Singapore*)

Abstract: In Process industries such as Petrochemical and Semiconductor industries, there is often a need to operate several pumps of same capacity in parallel to cater the changing requirements of the loads. The desired performance attributes for such a Pump systems include, but not limited to 1) Low energy consumption at High loads 2) Low energy consumption at Low loads 3) Ease of Maintainability 4) Quick response to disturbances such as Pressure fluctuation and Power glitches. 5) Expandability. This paper discusses the Logic behind the various Control systems (with Programmable Logic Controllers) available currently in the market and in addition proposes a novel method to start and stop additional pumps to improve Energy optimization of the pumps that operate in parallel.

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EQUATIONS WITH PARTIAL DERIVATIVES AND DIFFERENTIAL EQUATIONS USED FOR SIMULATING ACAUSAL PULSES

C. Toma (*Romania*)

Pages 1178 - 1183

Abstract: Some phenomena in physics (photonic echo) appears for an external observer as non-causal pulses suddenly emerging from an active medium (prepared by some other optical pulses) being hard to be simulated. It is shown that such functions can be put in correspondence with acausal pulses in physics (generated by the wave-equation considered on the length interval (0, 1) (an open set), starting at the initial moment of time from null initial conditions). Consequences for a possible control of such phenomena are also presented.

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STABILITY OF THE DELAY LOGISTIC EQUATION OF POPULATION DYNAMICS

M.Yu. Vagina (*Russia*)

Pages 317 - 319

Abstract: The nonlinear logistic equation $dy/dt = \varepsilon y(t)\left(1 - \Sigma_{k=0}^{n} b_k y(t - \tau_k)\right)$, $\varepsilon > 0$, $b_k, \tau \in [0;\infty)$, $(0 \le k \le n)$ is discussed. The local stability of the nonzero stationary solution of this equation depends on the stability of linear equation $dx/dt = -\Sigma_{k=1}^{n} a_k x(t - \tau_k)$, where $a_k = \varepsilon b_k \big/ \Sigma_{j=0}^{n} b_j$ $(0 \le k \le n)$. It is shown that the condition $\Sigma_{k=1}^{n} a_k \tau_k < \pi/2$ is sufficient for zero solution stability of linear equation. We prove, that there is no restriction above on the value $\Sigma_{k=1}^{n} a_k \tau_k$ which is necessary for the stability of linear equation. It disproves one of the propositions of K. Gopalsamy. It is shown that, if all the delays τ_k are multiples of one of them: $\tau_k = k\tau(\tau > 0, k = 0,1,\ldots,n)$, then the stationary solution $y \equiv 1 \big/ \Sigma_{k=0}^{n} b_k$ of logistic equation is stable with respect to small perturbations when the sequence b_k is nonnegative and convex.

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ON TWO CLASSES OF PARTIAL STABILITY PROBLEMS

V.I. Vorotnikov (*Russia*)

Pages 1141 - 1146

Abstract: For nonlinear nonautonomous systems of ordinary differential equations, we consider two basic classes of partial stability problems: (i) problems of stability with respect to part variables of the zero equilibrium position (Lyapunov - Rumyantsev partial stability problems) and (ii) problems of stability of partial equilibrium positions. The corresponding definitions of stability are unified so that the solvability conditions for these two classes of problems are identical in the context of the Lyapunov function method. We present a number of such common stability conditions. Also we consider problem of stability with respect to part variables of partial equilibrium positions. The results are illustrated by examples.

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MECHANISMS OF NON-FEEDBACK CONTROLLING CHAOS AND SUPPRESSION OF CHAOTIC MOTION (Invited)

A. Loskutov, S. Rybalko (*Russia*)

Pages 378 - 389

Abstract: We describe a rigorous approach to the investigation of qualitative changes in the behaviour of chaotic dynamical systems under external periodic perturbations and propose an analytical key to find such perturbations. It is proven that through a simple periodic perturbation one can stabilize the chosen periodic orbits of any unimodal maps. As an example the quadratic family maps is investigated. Also, it is proven that for piecewise linear family maps and for a two-dimensional map having a hyperbolic attractor there are feedback-free perturbations which lead to suppression of chaos and stabilization of certain periodic orbits.

View manuscript

A NOVEL POLYNOMIAL METHOD FOR TAMING CHAOS IN A WIDE CLASS OF NONLINEAR OSCILLATORS

V.M. Preciado, R. Chacon (*Spain*)

Pages 390 - 395

Abstract: A novel polynomial method is presented concerning the inhibition of homoclinic chaos in a wide class of nonlinear systems by means of an additional weak perturbation. From Melnikov analysis, we theoretically find paramete-space regions, associated with the chaos-suppressing perturbation, where chaotic states can be suppressed by transforming the problem in a polynomial form. Using this novel focus, an adapted concept of controllability in a Melnikov sense is defined and analyzed by applying the well-known root locus technique from classical control theory.

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MULTISTABILITY IN A DRIVEN NONLINEAR SYSTEM CONTROLLED BY WEAK SUBHARMONIC PERTURBATIONS

V.N. Chizhevsky (*Italy/Belarus*), **R. Corbalan** (*Spain*)

Pages 396 - 402

Abstract: It is shown that weak resonant perturbations at subharmonic frequencies can induce and control multistability in a wide class of nonlinear systems, which display the period doubling route into chaos or possess isolated subharmonic branches. The number of attractors induced depends on the subharmonic frequency, amplitude and phase of periodic perturbations as well as an initial dynamical state of nonlinear systems. Besides, phase scaling relations for the onsets of both saddle-node bifurcations and boundary crises induced by resonant periodic perturbations at subharmonic frequencies are found from the numerical simulation. These phase dependences determine the domains of existence of induced attractors in bifurcation parameter, perturbation phase) parameter space. The overlapping of these domains leads to the formation of zones with different number of coexisting attractors. Experimental and numerical evidences are given on the basis of a loss-modulated CO_2 laser.

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HOMOCLINICAL CHAOS SUPPRESSION

A. Loskutov, A. Janoev (*Russia*)

Pages 403 - 409

Abstract: Basing on the Melnikov method that gives a sufficient criterion of chaoticity in the separatrix neighborhood, analysis of the chaos suppression phenomenon is carried out. As a result, an explicit form of external perturbations leading to the stabilization of chaotic dynamics is analytically found. This fact gives us a method for the chaos suppression by an additive excitation of the system with the homoclinical structure.

COMBINATORIAL PHOTONICS, CONTROLLING CHEMISTRY WITH TAILORED STRONG FIELD LASER PULSES (Invited)

R.J. Levis (*USA*)

Abstract: Control of chemical photoionization, dissociation, and rearrangement will be discussed using tailored intense (10^{13} W cm^{-2}) laser pulses. The laser pulses are created using an evolutionary learning algorithm with the chemical product distribution guiding the phase and amplitude tailoring of the laser pulses. Control has been demonstrated for many reactions to date, including the production of the acetone parent ion ((CH_3)(2)CO+), the competition of the products CH_3CO vs. CH_3 during CH_3COCF_3 laser induced dissociation, and the rearrangement acetophenone ($C_6H_5COCH_3$) to produce $C_6H_5CH_3$ vs. C_6H_5 + CH_3CO. The reasons for the generic nature of the technique will be discussed and the fundamental underlying principles of such strong-field control experiments will be considered. Finally, a new control mechanism based on the formation of a quasicontinuum within the molecule in the presence of the strong laser field will be discussed.

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OPEN AND CLOSED LOOP CONTROL OF COMPLEX MOLECULES WITH SHAPED FS PULSES (Invited)

M. Motzkus (*Germany*)

Page 746

Abstract: Quantum control of photo induced reactions exploits molecular interferences by adjusting the phases of multiple quantum pathways to different product channels via adapted excitation light. The approach features general applicability but an accurate theoretical prediction of the optimal laserfield to drive a specific chemical reaction is possible only for very basic systems. Moreover, the experimental realization of such a predicted complex field at the site of the interaction volume is extremely difficult or even impossible. If the molecular system under study comprises more than two atoms, a closed loop experiment may bypass such complications since it identifies the optimal pulse shapes in a trial and error fashion, without any specific a priori knowledge. Such a loop is established by a tunable modulator to shape the fs pulses at will, and a learning algorithm which reads and interprets a relevant response signal to compute a corrective input and return it to the shaper. Many successful demonstrations of this approach on a multitude of atomic and molecular systems have been presented in the last few years. However, in spite of these demonstrations, it was still uncertain whether this approach can be applied to highly complex systems, or even biological samples.

In our studies of the recent past we gradually advanced from atoms [2] and dimers [3] to small polyatomic molecules and polymers [4] and very recently to ultracomplex systems. Here we proved that coherent control can indeed be exercised even on biological samples, as demonstrated in the control of the energy flow in the LH2 antenna complex in the primary step in photosynthesis.[5] These results confirm that the closed loop approach opens a new access for spectroscopic studies that will provide insight into how nature designs biological systems for optimal performance.

Once an optimization has been successfully performed the optimal field can be approximated by analytic functions which allow to study the impact of specific parameters on the solution.[3] In essence, this presents a return to open loop experiments but can be a more efficient way to identify the control mechanism.

In the case of LH2 the optimization initially acted upon 64 parameters which could eventually be reduced to three of relevance by applying this concept of parametrization. A systematic study allowed us to identify an additional electronic state and to obtain a better understanding of the underlying control mechanism.

In a further experiment, we studied the control of dissociation processes of metalcarbonyls using shaped fs pulses in the mid-infrared to directly excite a chemical bond. A systematic open loop study of the role of chirp suggested a vibrational ladder climbing mechanism as the relevant control process [6]. Follow-up studies based on the closed loop concept will try to identify still other, non-intuitive control schemes and probably more efficient excitation pathways.

These demonstrations illustrate that coherent control effected by a combination of open and closed loop experiments is well suited to uncover the structure and dynamics of complex molecules.

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NUMERICAL ALGORITHMS FOR NONLINEAR OBSERVER-BASED CONTROL

S.B. Tkachev, S.G. Alexeenkov (*Russia*)

Pages 1278 - 1283

Abstract: We develop a numerical observer design method for an affine system. We present an example of the state estimation of a chemical reactor using the numerical algorithm. If an observer for a nonlinear system is designed then we consider it as a dynamical system with inputs. We show that it is possible to design a stabilizing feedback for the observer instead of the original system and this feedback also stabilizes the original system. Example of an observer-based stabilization of a desired state for a chemical reactor is considered.

View manuscript

ON UNCONTROLLABLE NON-LINEAR DYNAMIC SYSTEMS: ANALYTIC SOLUTIONS FOR INTEGRAL MANIFOLDS

J.D. Stefanovski (*Macedonia*), **G.M. Dimirovski** (*Turkey*)

Pages 1284 - 1289

Abstract: In this paper three solutions for invariant submanifolds of nonlinear control systems are presented. The first and the second are based on functional expansion, which can be obtained by differentiation of functions only. The third one presents a singular solution and os based on linear-algebraic operations and finite differentiation of functions only. Examples for all derived results are presented.

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DESIGN PROCEDURE OF MINIMUM PHASE AFFINE SYSTEMS

A.P. Krishchenko (*Russia*)

Pages 1290 - 1295

Abstract: Conceptions of relative degree and minimum phase are connected to many control problems. To apply its one needs to know an output which renders an affine system minimum phase. We present necessary and sufficient conditions of the existence of such outputs and discuss its relations with backstepping method of stabilization. In the case of relative degree more then one the obtained conditions result in new setting of the stabilization problem.

View manuscript

CONTROL OF DELAYED MEASURED SYSTEMS AND IMPULSE LENGTH LIMITATIONS IN DIFFERENCE CONTROL

J.C. Claussen (*Germany*)

Pages 1296 - 1302

Abstract: When stabilization of unstable periodic orbits or fixed points by the method given by Ott, Grebogi and Yorke (OGY) has to be based on a measurement delayed by τ orbit lengths, unmodified OGY method fails beyond a maximal Ljapunov number of $\lambda_{max} = 1 + 1/\tau$. Therefore the question arises how the control of delayed measured chaotic systems can be improved. Apart from rhythmic control, OGY and difference control can be improved for this case by the memory methods discussed here, linear predictive logging control (LPLC) and memory difference control (MDC).These allow to overcome the measurement delay completely within the linear approximation around the orbit.Furthermore a new stability analysis of the two elementary Poincaré-based chaos control schemes, OGY and difference control, is given by means of Floquet theory. This approach allows to calculate exactly the stability restrictions occuring for small measurement delays and for an impulse length shorter than the length of the orbit. As an unexpected result, while for OGY control the influence of the impulse length is marginal, difference control is shown to fail when the impulse length is taken longer than one half of the orbit length.

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MODEL ORDER REDUCTION AND PARAMETRIZATION OF NONLINEAR NUMERICAL MODELS

H. Müller, S. Götz, M. Bestehorn (*Germany*)

Pages 1303 - 1308

Abstract: We describe techniques of model order reduction (MOR) for weakly nonlinear finite difference and finite element (FE) models. In our approach we combine on the one hand parameter identification based on linearized systems for a behavioral description of weakly nonlinear effects by means of a Taylor series expansion. On the other hand we use projection based MOR-methods (on the base of Krylov subspace and singular perturbation approaches for the linear case), to get manageable nonlinear behavioral models. We therefore take advantage of using the linearized model description in nonlinear MOR without the necessity of having an explicit formulation of the nonlinearities —such providing, for example, nonlinear MOR techniques to simulations with commercial FE software. We demonstrate the applicability of the methods on a time depending example of heat transfer including material and thermal radiation nonlinearities.

View manuscript

A METHOD OF CONSTRUCTING PROGRAMMED MOTION FOR NONLINEAR AND NONSTATIONARY SYSTEMS BY INDIRECT CONTROLLER

A.N. Kwitko (*Russia*)

Pages 1309 - 1314

Abstract: The algorithm for transferring nonlinear system of differential equations from one initial state to fixed final state is suggested.

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HOW DO SMALL VELOCITY-DEPENDENT FORCES (DE)STABILIZE A NON-CONSERVATIVE SYSTEM?

O.N. Kirillov (*Russia*)

Pages 1090 - 1095

Abstract: The influence of small velocity-dependent forces on the stability of a linear autonomous non-conservative system of general type is studied. The problem is investigated by anapproach based on the analysis of multiple roots of the characteristic polynomial whose coefficients are expressed through the invariants of the matrices of a non-conservative system. For systems with two degrees of freedom approximations of the domain of asymptotic stability are constructed and the structure of the matrix of velocity-dependent forces stabilizing a circulatory system is found. As mechanical examples the Bolotin problem and the Herrman-Jong pendulum are considered in detail.

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METELITSYN'S INEQUALITY AND STABILITY CRITERIA FOR MECHANICAL SYSTEMS

A. Seyranian (*Russia*), **W. Kliem** (*Denmark*)

Pages 1096 - 1101

Abstract: Asymptotic stability criteria for general linear mechanical systems are studied. It is shown that the inequality first derived by Metelitsyn (1952) is a sufficient but not a necessary condition for asymptotic stability. We argue that this inequality is of little use in applications. The theorems of Metelitsyn based on his inequality as well as critical comments in the literature on these theorems are analyzed. Practical sufficient stability criteria are obtained in terms of extreme eigenvalues of the system matrices. This analysis is of special value for rotor systems in a complex setting which is demonstrated by three examples.

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POTENTIAL WEAKLY DAMPED AUTONOMOUS SYSTEMS EXHIBITING PERIODIC ATTRACTORS

A.N. Kounadis (*Greece*)

Abstract is not available

View manuscript

STABILITY AND RESPONSE BOUNDS OF NON-CONSERVATIVE LINEAR SYSTEMS

C. Pommer (*Denmark*)

Pages 1106 - 1109

Abstract: For a linear system of second order differential equations the stability is studied by Lyapunov's direct method. The Lyapunov matrix equation is solved and a sufficient condition for stability is expressed by the system matrices. For a system which satisfies the condition for stability the Lyapunov function is used to derive amplitude bounds of displacement and velocity in the homogeneous as well as in the inhomogeneous case. The developed results are illustrated by examples.

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ON EQUATIONS WITH PARTIAL DERIVATIVES WHICH CORRESPOND TO INVARIANT MANIFOLDS OF MECHANICAL SYSTEMS

V.D. Irtegov (*Russia*)

Pages 1110 - 1114

Abstract: The paper discusses the relationships between the equations of disturbed motion in the neighbourhood of invariant manifolds of conservative systems and the systems of equations with partial derivatives which have one and the same main part. The properties, which are common for the considered systems, are indicated. Some examples of application of such a relationship to the case of equations of rigid body dynamics are given.

STABILITY OF FREE ELASTIC STRUCTURES AT NONCONSERVATIVE LOADING

A. Sharanyuk (*Russia*)

Abstract: The problem of the analysis of parameters of dynamic stability of the free elastic struc-tures subjected to the action of follower loading is considered. The equations describing dynamic behavior of free elastic structures derived from the general variational principles of mechanics are received. It is supposed, that the elastic behavior of a structure is considered in the moving non-inertial local sys-tem of coordinates, and spatial movement of a structure is considered in global inertial system of coordinates. Position of the elastic structure is characterized by a spatial coordinates of the origin of the local frame and its angular orientation concerning axes of global frame. Different moving systems of coordinates are considered. As an example, the problem of the analysis of dynamic stability of a free elastic bar under tangential end force is considered. Eigenvalue problem allowing to investigate the dynamic stability of the bar for different moving systems of coordinates connected to the bar is analyzed. Dependence of solutions of eigenvalue problem on a choice of a connected system of coordinates is shown.

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VALIDATION OF TRANSFER MAPS USING TAYLOR MODELS (Invited)

M. Berz, K. Makino (*USA*)

Page 980

Abstract: High-order transfer maps of particle systems play an important role in the design and optimization of particle optical systems, both for satisfying the basic design needs as well as for the correction of aberrations and non-linear effects. The differential algebraic method has proved useful for this problem, allowing the computation of maps of arbitrary order of systems described by arbitrary electromagnetic fields.

Since the high-order maps represent an approximation of the motion, in particular in strongly nonlinear cases in which convergence of the maps may be slow, it is important to know the quality of the approximation. Recent work has shown that it is in principle possible to not only propagate the conventional differential algebraic high-order objects, but also adjoint remainder terms that rigorously account for any errors made both by the integrator scheme and any possibly inaccuracy of the description of the system.

In this paper we describe various recent enhancements of the original method of maps with remainder bounds. First we address a variable doubling scheme that allows the treatment of the remainder effect themselves in terms of a transfer map-like relationship instead of a mere box. Using suitable extensions of the DA and Taylor model operators used in the Schauder fixed point theorem formulation of the problem, this approach is in practice nearly as transparent as the original method and leads to a significant enhancement of sharpness. Under the presence of a scheme for effective treatment of sparsity in the DA vectors, such as the method available in the code COSY INFINITY, the additional resources necessary for this algorithm are very modest.

Next we describe a method for the treatment of the one-step approximation errors of the integration scheme called shrink wrapping. It allows the reabsorption of these approximation errors that are initially merely given by an n-dimensional box into the remainder terms described by the variable doubling. Using the combination of these effects, the already rather tight bounds for the approximation errors of transfer maps can be further significantly reduced, and it is even possible to estimate bounds on the overestimation of those error inclusions themselves.

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NONLINEAR TRANSFER MAP TREATMENT OF BEAMS THROUGH SYSTEMS WITH ABSORBING MATERIAL

K. Makino, M. Berz, D. Errede, C. Johnstone (*USA*)

Page 981

Abstract: Particle optical systems are usually comprised of electric and magnetic bending elements, focusing elements, and high-order multipoles for correction of aberrations. However, various modern systems for the transport and manipulation of large acceptance beams of rare and short-lived particles require the detailed treatment of more advanced optical elements. In particular, in recent years the reduction of the emittance of such beams has become of prime importance. The systems performing such reduction of emittance usually consist of combinations of absorbers that uniformly reduce the components of the momenta of the particles, as well as cavities that increase predominately the longitudinal components, which overall leads to a reduction of transversal emittance. For purposes of optimal focusing, frequently both cavities and absorbers are placed inside the body or at least the fringe fields of quadrupole or solenoidal focusing elements, which leads to the requirement of treating the nonlinear optics of acceleration, absorption, and focusing in a combined approach.

The treatment of such systems in ray-tracing scenarios based on integration through fields and matter is very laborious and time consuming, and does not lend itself well to optimization and correction of undesirable nonlinear effects. We describe a differential algebraic method for the treatment of such nonlinear dynamics, based on the spatial and temporal form of the accelerating fields, any superimposed focusing magnetic fields, and the geometry and physical properties of the absorbing material and its possible vessel. Described by a Bethe-Bloch-Vavilov formalism, the bulk of the effects are described in terms of a high order nonlinear transfer maps. The also occurring scattering and straggling, which are inherently non-deterministic and hence not representable in the map formalism, are described in terms of a set of stochastic kicks in the transversal and longitudinal dynamics. The stochastics is propagated to the center of the occurring absorbers and thus allows a combined treatment of the tracking of both deterministic and random effects in an efficient way. The method is implemented in the high-order code COSY INFINTIY. Examples for the application and performance of the method are given.

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CONTROL AND OPTIMIZATION IN SAFE NUCLEAR ENERGETICS PROBLEM

Yu.A. Svistunov, M.F. Vorogushin (*Russia*)

Pages 982 - 985

Abstract: There are considered interaction of accelerator-subcritical reactor in energy producing and nuclear waste transmutation problem. Review of some papers connected with this topic is given.

Separate tasks which are related to this problem are control of nuclear reactor with accelerator, optimal choice of accelerator and reactor types, beam dynamics optimization and structure of active reactor zone optimization. Possible construction of compact energy-producing nuclear station is proposed.

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BRAKING RADIATION IN PROBLEM OF IDENTIFICATION AND MANAGEMENT OF RADIOACTIVE WASTE

N.P. Dikiy, A.N. Dovbnya, V.L. Uvarov (*Ukraine*)

Pages 986 - 990

Abstract: Growth of atomic energetics and nuclear technologies is accompanied by increase of radioactive waste including long-lived ones. The wastes inside the wrecked Chernobyl 4-th unit is of particular importance because their amount is estimated as much as 20MCi. Under the circumstances a problem of operative identification of the waste and their long-term disposal is urgent. The report presents an overview of the waste identification high-duty method elaborated in NSC KIPT and based on γ-activation analysis with use bremsstrahlung of the high-current electron accelerator.

On the other hand disposal of the radioactive waste faces a problem of confinement materials (including geological structures). Such materials have to keep their protection properties with respect to radionuclide transport under absorbed dose value up to ~10^8 Gy during thousand years or so. The elaborated methods for production of radionuclide–tracers and operative determination of their diffusion coefficients into barriers under different doses of the braking photons and corrosion conditions are described.

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CONTROL THEORY TO ACCELERATOR RESEARCH AND SELF-FOCUSED BUNCHED BEAM

Z. Parsa (*USA*), **V. Zadorozhny, A. Rudenko** (*Ukraine*)

Pages 991 - 996

Abstract: A new approach to a nonlinear bunched beam dynamics based on the self-consistent Vlasov equation is presented. The main emphasis is given on the direct Lyapunov method in case of a vector field (on a compact manifold with a singular point) to finding a solution to Vlasov - Poisson equation (VPE). The VPE is transformed into a Fredholm equation in an attraction region. These properties are linked to the self-focusing and acceleration of a bunched beam.

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ELASTICITY OF THE LONG-LENGTH SHAFTS OF ROTATION TRANSMISSION MECHANICAL SYSTEMS AS A SOURCE OF INFORMATION IN THE TASKS OF CONTROL AND PREVENTING OF EXTREME EMERGENCY

V.Yu. Rutkovsky, V.M. Sukhanov (*Russia*)

Pages 134 - 139

Abstract: On the example of the elastic transmission of turboprop aircraft engine with differential gearbox and two co-axial propellers the task for obtaining of information in real-time concerned with torsion angle of the shaft is considered. The shaft transmits rotation (turbine's torque) to prop-fan. It is suggested to use this information for the turbine's torque identification in an effort to control and as a signal in system for leading cut-out of the engine in the case a dangerous situation preceding of the shaft's destroying. The influence of the two types of the noises (measurements' noises and vibrational noises of the elastic shaft) on the accuracy of the shaft torsion angle estimation was investigated.

View manuscript

ADAPTIVE APPROACH TO MONITORING OF GAS-TURBINE’S TRANSMISSION SHAFTS

S.D. Zemlyakov, V.M. Glumov (*Russia*)

Pages 140 - 145

Abstract: An attempt of approach to gas-turbine’s transmission shafts monitoring during its operation is done. It is shown that a measurement of a current torsion shaft angle could be used for estimation of free turbine’s current torque. The method of a torsion shaft angle measurement on the base of model reference adaptive system is proposed. The results of simulation confirmed the efficiency of proposed adaptive system under condition closed to real one are represented.

View manuscript

ELECTROMAGNETIC SUSPENSION OF VERTICAL TURBOMACHINE FOR NUCLEAR POWER PLANT

F.M. Mitenkov, N.G. Kodochigov, V.V. Drumov, S.E. Belov, V.S. Vostokov, I.V. Drumov, O.B. Klochkov, A.V. Khodykin (*Russia*)

Pages 146 - 151

Abstract: The application of magnetic bearing (EMB) in the suspension of nuclear power plant (NPP) turbomachine rotor is considered in the report. The main indices and turbomachine (TM) arrangement are given. The unique nature of turbomachine rotor characteristics is shown. The investigation problems for the project provision as for electromagnetic suspension are determined. The main results of investigations, performed at turbomachine rotor model and obtained at calculational investigations are considered. The purposes of the following investigations were determined.

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NONLINEAR DYNAMICS AND CONTROL OF A WIND-MILLING GYROPLANE ROTOR

Ye.I. Somov, O.Ye. Polyntsev (*Russia*)

Pages 152 - 157

Abstract: Mathematical models of auto-rotation and flapping the wind-milling rotor have been carried out. Their approximate analytical solutions have been obtained. Software allowing one to simulate and study a rotor dynamics have been created. Major physical features on the forced flexible oscillations of the wind-milling rotor in the flapping plane have been investigated. Results obtained have successfully been applied to designing the Irkutsk A-002 gyroplane main rotor.

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ROBUST H_2 VIBRATION CONTROL OF BEAMS WITH PIEZOELECTRIC SENSORS AND ACTUATORS

G. Foutsitzi (*Greece*), **D. Marinova** (*Bulgaria*), **E. Hadjigeorgiou** (*Greece*), **G. Stavroulakis** (*Greece/Germany*)

Pages 158 - 163

Abstract: This paper studies vibration control of a beam with bonded piezoelectric sensors and actuators. Basic equations for piezoelectric sensors and actuators are presented. The equation of motion for the beam structure is derived by using the Hamilton's principle. A robust H_2 controller is designed. The numerical simulation shows that the vibration can be significantly suppressed by the proposed controller.

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AN IMPROVED TACTILE MATRIX MICROSENSOR PACKAGE

V.D. Todorova, M.T. Mladenov (*Bulgaria*)

Pages 164 - 167

Abstract: It is a fact that the most perspective tendency of the contemporary electronics is the development of intelligent systems of type, known as “artificial intellect”. In line with the digital computing devices, very high importance has the information obtaining devices – sensors. The complex applying of many physical, chemical and even biological principles in the contemporary microsystem technologies makes the sensor systems near to the possibilities of the real biological receptors. The object of this paper is a specific tactile sensor type with matrix structure. In some papers [1 - 8], we considered the possibilities, the peculiarities and operating principle of the tactile matrix /TM/. In this paper is represented a suggestion for package construction corresponding to the exploitation requirements for this sensor class. The package is especially for a completely automated sensor system, which allows:

- ♦ an automatic identification of the tactile matrix;
- ♦ self-tuning to the changed sensor parameters (time degradation, outer influences and other);
- ♦ a possibility for using a neural network for signal processing in high resolution TM.

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ON THE MODIFIED MAROTTO THEOREM

C.P. Li (*China*)

Pages 415 - 419

Abstract: This paper provides some notes on the modified Marotto Theorem recently by Li and Chen (called “Marotto-Li-Chen Theorem” here for convenience and distinction). And a rigorous chaotification theorem is constructed for multi-dimensional discrete dynamical systems.

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SWITCHING CONTROL FOR MULTI-SCROLL CHAOS GENERATION: AN OVERVIEW

J.-H. Lü (*China*)**, X. Yu** (*Australia*)**, G. Chen** (*China*)

Pages 420 - 428

Abstract: This paper reviews and meanwhile introduces several new switching piecewise-linear controllers, which can generate multi-scroll chaotic attractors from some simple two-dimensional (2D) or three-dimensional (3D) linear autonomous systems. The mechanism for generating multi-scroll chaotic attractors via switching control is discussed.

View manuscript

FUZZY CHAOS GENERATORS FOR NONLINEAR DYNAMICAL SYSTEMS

Z. Li (*Germany*)

Pages 429 - 433

Abstract: A fuzzy chaos generator is proposed for nonlinear dynamical systems via fuzzy modeling. A discrete-time or continuous-time nonlinear system can first be formulated as a Takagi-Sugeno fuzzy system, and then a fuzzy anti-controller can be designed to make this system chaotic. The generation of chaos is mathematically rigorous in the sense of Li and Yorke. An example is included to visualize the effect of the chaos generation method.

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SUSTAINED CHAOS AND CONTROL BY MEANS OF WEAK PERIODIC EXCITATIONS: APPLICATION TO A CLASS OF NONLINEAR ELECTRONIC CIRCUITS

V.M. Preciado, R. Chacon (*Spain*)**, V. Tereshko** (*UK*)

Pages 434 - 439

Abstract: The problem of homoclinic chaos enhancement by means of weak periodic perturbations is studied for a broad class of dissipative nonautonomous systems subjected to two harmonic excitations (one of them chaos inducing). Theoretical results are derived from the basis of Melnikov's analysis. Analytical expressions for optimal values of initial phase differences between excitations in order to obtain an optimal chaos-inducing situation are derived. Robustness to noise is experimentally proved by the application of this technique in the induction of chaos in a nonlinear electronic circuit.

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MODEL BASED ANTICONTROL OF CHAOS

Ö. Morgül (*Turkey*)

Pages 440 - 445

Abstract: We will consider model based anticontrol of chaotic systems. We consider both continuous and discrete time cases. We first assume that the systems to be controlled are linear and time invariant. Under controllability assumption, we transform these systems into some canonical forms. We assume the existence of chaotic systems which has similar forms. Then by using appropriate inputs, we match the dynamics of the systems to be controlled and the model chaotic systems.

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DIFFERENCE SCHEME WITH INSTANT TRANSITION "FROM ORDER TO CHAOS"

A.F. Goloubentsev, V.M. Anikin, Y.A. Barulina (*Russia*)

Pages 446 - 451

Abstract: The one-dimensional nonlinear difference equation of the first order depending on a parameter is constructed on the infinite interval. Its exact solutions have semi-group properties and demonstrate regular or chaotic behavior for various regions of parameter changing. There is a parameter value that "provides" an instant transition "from order to chaos". The chaotic regime is characterized by having the invariant density in the form of the Cauchy distribution and the positive Lyapunov exponent ln2. The eigenfunction and eigenvalues of the Perron-Frobenius operator for constructed map are found.

QUANTUM FILTERING AND OPTIMAL FEEDBACK CONTROL (Invited)

V. Belavkin (*UK*)

Abstract: A multi-stage version of the optimal entanglement theory applied to the optimal control problem in a Markovian dynamical system with quantum-mechanical output is developed. Quantum noncommutative analogies of Stratonovich non-stationary discrete filtering and Bellman quantum dynamical programming are obtained. It is shown that optimal feedback in Gaussian case of linearly controlled system with a quantum linear communication channel and mean square criteria consists of a of the dual linear quantum nondemolition filter and quantum linear optimal decision rule.

View manuscript

ON THE DUALITY OF QUANTUM FILTERING AND OPTIMAL FEEDBACK CONTROL IN QUANTUM OPEN LINEAR DYNAMICAL DYSTEMS

S.C. Edwards, V.P. Belavkin (*UK*)

Pages 768 - 772

Abstract: The multi-dimensional quantum open linear dynamical system with observation and feedback along a quantum linear transmission line is studied in discrete time. The linear least squares filtering and optimal control strategies are obtained as quantum analogies of the Kalman filter and Bellman dynamical programming. The duality of quantum filtering and optimal feedback control is observed for this particular case.

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MULTI-AGENT STOCHASTIC CONTROL: MODELS INSPIRED FROM QUANTUM PHYSICS

J.S. Baras (*USA*)

Pages 747 - 758

Abstract: In this paper we consider multi-agent stochastic optimization and control problems, with partial information. The agent can operate in a distributed and asynchronous fashion. We investigate new problems that arise out of the interaction between observations and control actions by the agent. We show that new non-classical and non-commutative probability models are needed in order to properly formulate such problems. The models we develop here are inspired by models developed for dynamical physics problems. We establish a series of fundamental results for the trade-off between information and control patterns in distributed stochastic control, detection and estimation.

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THE SCIENTIFIC LANGUAGE SPOKEN BY OPTICAL INSTRUMENTS

Y.S. Kim (*USA*)

Pages 785 - 791

Abstract: Most common optical instruments include filters, polarizers, interferometers, lenses, lasers and multi-layers. It requires two-by-two matrices to study optical beams going through these optical components. It is therefore possible to study these matrices in terms of the two-by-two representation of the six-parameter Lorentz group. Furthermore, using the correspondence between the two-by-two and four-by-four representations, it is possible to study many of the formulas in optics in terms of the kinematics of Lorentz transformations. Conversely, the optical instruments can serve as analogue computers for events in special relativity.

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UNCERTAINTY RELATIONS FOR GENERALIZED QUANTUM MEASUREMENTS AND COMPLETELY POSITIVE MAPS

M. Ozawa (*Japan*)

Pages 773 - 784

Abstract: The Heisenberg uncertainty relation for measurement noise and disturbance states that any position measurement with noise brings the momentum disturbance not less than $\hbar/2\varepsilon$. However, this relation holds only for restricted class of measurements. Here, a generalized uncertainty relation for measurement noise and disturbance is formalized and proven, which holds for all the possible quantum measurements. For this purpose, all the possible quantum measurements are characterized by naturally acceptable axioms. The measurement noise and disturbance are defined rigorously for any such general quantum measurements.

View manuscript

DYNAMIC STABILITY OF FREE-FREE BEAM SUBJECTED TO END ROCKET THRUST AND CARRYING A HEAVY PAYLOAD AT ITS NOSE

T. Ohshima, Y. Sugiyama (*Japan*)

Pages 1115 - 1120

Abstract: The present paper deals with the dynamic stability of a flexible flight body accommodated with a heavy payload at its nose and subjected to end rocket thrust. The thrust acts on the flexible flight body as a follower load, thus the flight body may lose its stability by body-divergence or body-flutter. The intended aim of the paper is to reveal the effect of a heavy payload on dynamic stability of slender flight bodies under rocket thrust. It is assumed that a payload is a rigid body, but not a mass point. The slender flight body is simplified into a uniform free-free beam having a spherical rigid body at its nose. A large rigid body at the nose of the beam applies a lumped inertia force on the nose, in addition to a distributed inertia force along the axis of the beam. Extended Hamilton's principle is applied to the considered beam for driving the equations of motion. Application of finite element method yields a standard eigen-value problem. Stability of the beam is determined by the sign of the real part of complex eigen-values. It is shown that a large rigid body at the tip lowers the flutter bound considerably. As extreme cases, the free-free beam having no payload can be simplified into Feodosiev's beam, while the beam having an infinitely large rigid sphere leads to Beck's column. Thus the proposed beam can be the missing link between Feodosiev's beam and Beck's column.

View manuscript

INFLUENCE OF FORCE STRUCTURE ON THE STABILITY

V.A. Goncharenko, V.I. Goncharenko (*Ukraine*)

Pages 1121 - 1123

Abstract: A problem related to the influence of force structure on the stability of motion is formulated. The hystorical development of the problem is presented briefly. Catalyst role of the Metelitsyn paper is emphasized. The selected pathes of the problem development are considered.

View manuscript

COMPUTATIONAL APPROACH TO DAMPED BECK'S COLUMN

Y. Sugiyama, S.-U. Ryu, M. Hamatani, T. Iwama (*Japan*)

Pages 1124 - 1129

Abstract: The paper discusses on the basis of computational energy approach the effect of damping on stability of damped Beck's column. By making the present computational approach to the damped Beck's problem, it has been demonstrated that though the internal damping dissipates energy, the damping at the same time help the non-conservative force to do more work on the column. This paper aims at explaining the mechanism of the effect of damping on stability of non-conservative systems.

View manuscript

OPTIMAL EXCITATION OF OSCILLATIONS BY A LIMITED CONTROL FORCE

A.O. Belyakov (*Russia*)

Pages 1130 - 1133

Abstract: A linear oscillator with limited excitation force (control function) is under consideration. The optimal control, which brings oscillatory system to a certain energy level from any initial conditions at the minimal time, is found. The synthesis of control is done. Multi-dimensional case is also studied. The problem has mechanical application to inertia moments measuring by oscillations of a rigid body in elastic support with several degrees of freedom.

View manuscript

REGULARIZING GENERALIZED LINEAR SYSTEMS BY MEANS OF DERIVATIVE FEEDBACK

M.I. Garcia-Planas (*Spain*)

Pages 1134 - 1140

Abstract: We consider generalized linear time invariant systems in the form $E\dot{x}(t)=Ax(t)+Bu(t)$ with $E,A\in M_n(C)$, $B\in M_{n\times m}(C)$, arising naturally in a variety of circumstances for example they are used in modelling of mechanical multibody system.

Obviously, the regularity condition $det\,E\neq 0$ guarantees the existence and uniqueness of solutions. In this work we study necessary and sufficient conditions in order that the matrix E can be regularized by means of a derivative feedback, that is to say conditions that ensure the existence of a control $u(t)=-V\dot{x}(t)+w(t)$ with $V\in M_{m\times n}(C)$ such that the matrix $E+BV$ in the closed loop system $(E+BV)\dot{x}(t)=Ax(t)+Bw(t)$ is regular and consequently the close loop system is uniquely solvable. We also study conditions for controllability of the close loop system ensuring the existence of a feedback $w(t)=Ux(t)+w(t)$ with $V\in M_{m\times n}(C)$, such that the system $(E+BV)\dot{x}(t)=(A+BU)x(t)+Bw(t)$ has a stable solution.

Finally, a stratification of the space of orbits of the systems that can be regularized is presented.

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SPATIAL PROBLEMS OF NONLINEAR DYNAMICS: MOTIVATION AND ANALYSIS

I.V. Miroshnik, E. Olkhovskaya (*Russia*)

Pages 582 - 588

Abstract: The paper represents a comparative study of the main problems of spatial motion of nonlinear systems and properties of invariance and attractivity of smooth multidimensional sets. Their connection with concepts of synergetics, coordinated control and synchronization is demonstrated. Problems of energy stabilization and synchronization of coupled pendulums, as well as local behaviour of Lorenz system, are considered as special cases and prove an analogy of the concepts.

View manuscript

ELEMENTS OF PHYSICAL OSCILLATION AND CONTROL THEORY

S.L. Chechurin, L.S. Chechurin (*Russia*)

Pages 589 - 594

Abstract: Parametric oscillation conditions for periodically time-variant system and stability failure of periodic motion of nonlinear dynamic system are derived within the mono-frequency approximation. Graphical illustration and physically based explanation for oscillation conditions are given. Conditions for two-frequency combined oscillation of sum and difference resonance phenomenon and high frequency synchronization are obtained. A problem of nonlinear system robust control avoiding one-frequency parametric resonances is set up.

View manuscript

LOCALIZATION/NONEXISTENCE CONDITION OF PERIODIC ORBITS OF POLYNOMIAL SYSTEMS AND ITS APPLICATIONS

K.E. Starkov (*Mexico*)

Pages 595 - 600

Abstract: This paper contains localization/ nonexistence conditions for periodic orbits of multidimensional polynomial systems. Our approach is based upon high order extremum conditions, high order tangency conditions of a nonsingular solution with an algebraic set in the state space and some ideas related to algebraic dependent polynomials. A few examples are examined including the Rössler system, the mathematical model of the chemical reaction with autocatalyptic step and the May-Leonard system.

View manuscript

DRIFT BIFURCATION OF DISSIPATIVE SOLITONS: DESTABILISATION DUE TO A CHANGE OF SHAPE

S.V. Gurevich, H.U. Bödeker, A.S. Moskalenko, A.W. Liehr, H.-G. Purwins (*Germany*)

Pages 601 - 606

Abstract: In this paper we report on the drift bifurcation of single dissipative soliton in a three-component reaction diffusion system due to a change of its shape. We derive analytical expression for the velocity of the dissipative soliton as a function of an appropriate control parameters. To prove the correctness of the calculations, numerical simulations are carried out showing good agreement with the analytical predictions.

View manuscript

FREQUENCY-DOMAIN CONDITIONS FOR CYCLE-SLIPPING IN DISCRETE SYSTEMS WITH PERIODIC NONLINEARITY

V.B. Smirnova, N.V. Utina, A.I. Shepeljavyi (*Russia*)

Pages 607 - 610

Abstract: The property that the phase-error $\sigma(t)$ increases at least by $k\Delta$, where k is an integer and Δ is the period of the nonlinearity, when t tends to infinity, is called in communication systems ”cycle-slipping” [1]. For the case of continuous synchronization systems this property is considered in [2]-[8]. In this paper we extend the analysis to discrete synchronization systems.

View manuscript

PHASE MULTISTABILITY OF SELF-MODULATED OSCILLATIONS

A.M. Nekrasov (*Russia*)**, O.V. Sosnovtseva** (*Russia/Denmark*)

Pages 611 - 616

Abstract: The paper examines the type of multistability that can arise in the coupling of two oscillators when the systems individually display a selfmodulation being the typical waveform when fast dynamics modulated by a slow dynamics. The investigation is based on a phase reduction method and on the calculation of phase maps for vanishing and finite coupling strengths, respectively. Various phase-locked patterns are observed. In the presence of a frequency mismatch, the two-parameter bifurcation analysis reveals a set of synchronization regions inserted one into the other. Numerical examples using a generator with inertial nonlinearity and a biologically motivated model of nephron autoregulation are given.

View manuscript

MODEL OF OPTOELECTRONIC MEASURING INTELLIGENT SYSTEM

I.V. Denisov, Yu.N. Kulchin, O.V. Kirichenko, V.A. Sedov, R.S. Drozdov, E.V. Denisova
(*Russia*)

Pages 173 - 176

Abstract: The model of optoelectronic measuring intelligent system on the basis of fiber-optical measuring network is offered. This system breadboard can fulfill the reconstruction of coordinate and value of single actions of deformation of physical field on the analysis of surface areas with dimension 5×5 of the measuring lines. This system is the base element for creation of the new class of adaptive optoelectronic control and measuring devices allowing to reconstruct a spatial allocations structure of physical fields in real time for guarding and diagnostics of the condition of some technical or technological objects.

View manuscript

NONLINEAR PI CONTROL OF ECCENTRICITY COMPENSATION PROBLEM

B. Behar, F. Lamnabhi Lagarrigue, T. Ahmed-Ali (*France*)

Pages 177 - 182

Abstract: This paper deals with the eccentricity compensation which is a problem of rejecting oscillatory position-dependant disturbances with unknown frequency and unknown amplitude. We present an original solution based on Nonlinear PI (Proportional Integrator) approach which ensures global asymptotic stability. We consider here that disturbances are produced by eccentricity in mechanical systems and drives. We also assume that the oscillatory disturbance is position time dependant. Also a comparative study with an adaptive controller which uses a velocity-dependant internal model of the eccentricity is presented.

View manuscript

ON A ROBUST CONTROL OF PARABOLIC OBSTACLE PROBLEM

M. Blizorukova, V. Maksimov (Russia)

Pages 183 - 186

Abstract: The robust control of parabolic obstacle problem [1] is considered. The approach based on the method of control with a model [2-4] is discussed. This approach is characterized by the following two features: first by, directedness to the work with nonlinear dynamical systems and, second by, orientation to constructing solving algorithms, which are stable with respect to informational noises and computational errors. Solving algorithms for other problems of feedback control of distributed systems based on the method [2-4] can be found in [5, 6].

View manuscript

STABILITY OF VISCOELASTIC ELEMENTS OF CONSTRUCTIONS UNDER HYDRODYNAMIC ACTION

P.A. Velmisov, Yu.A. Reshetnikov, A.A. Molgachev (*Russia*)

Pages 187 - 190

Abstract: Dynamic stability of a lattice viscoelastic plates interacting with a flow of ideal incompressible fluid is investigated. Stability of oscillations of viscoelastic elements of channel walls is investigated too. For the deflection function of the plates an oscillation equations are derived and sufficient stability conditions of its solutions are obtained. These conditions have the form of restrictions on the kernals of relaxation on the uniform flow velocity and other parameters of the considered mechanics system.

View manuscript

SPINNING MASS AS AN INFORMATION SENSOR FOR ASTROPHYSICS RESEARCH

B.Yu. Bogdanovich, I.S. Shchedrin, N.V. Egorov, V.N. Smirnov (*Russia*)

Pages 168 - 172

Abstract: In spite of a very long history of investigation, the physical understanding of all of the processes accompanying rapid spinning of solids is far from being perfect. A custom design experimental set-up based on the periodically retarded spinning wheel is build. This device made possible registration of some celestial processes like Moon and Sun eclipse, new Moon moments, Sun rise and sun sets, stars screening by Moon, etc. It appears that the device - Space Time geometrizer - is sensitive to some kind of space radiation, presumably, gravitational waves.

INTRODUCING CLIMAX: A NOVEL STRATEGY TO A TRI-WHEEL SPIRAL ROBOT

A.H. Javadi, P. Mojabi (*Iran*)

Abstract: This paper describes a prototype and analytical studies of a tri-wheel spiral mobile robot. The robot can reach any desired point with a sequence of rotational movements. The robot has a simple actuation mechanism, consisted of three wheels mounted on a platform with axes fixed in 120° and a motor connected to each. Our approach introduces several new features such as simple repeated sequence of commands for steering, and spiral motion, versus direct movement to target. The mathematical model of the robot is discussed, and a steering method is developed to achieve full motion capabilities. For a number of missions, it is shown experimentally that the proposed motion planning agrees well with the results.

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IMPROVING PLASMA STABILIZATION SYSTEM IN ITER BY EXCLUDING NON-EFFICIENT POLOIDAL COILS

D.A. Ovsyannikov, A.D. Ovsyannikov, A.P. Zhabko, E.I. Veremey, B.A. Misenov, V.A. Belyakov, A.A. Kavin (*Russia*)

Pages 1009 - 1018

Abstract: In the paper the problem of plasma control in the toroidal magnetic chamber of ITER tokamak is investigated. Extreme physical conditions in tokamaks lead to very high requirement to control accuracy for electromagnetic capture system while positioning plasma within given gaps from the walls of chamber. On the other hand, real conditions restrict some characteristics, such as control power. Mathematical methods of stabilizing control design based on modern optimization theory are proposed. These methods were designed to increase control efficiency by redistributing its power between tasks.

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DERIVATION OF THE LINEAR MODELS FOR THE ANALYSIS OF THE PLASMA CURRENT, POSITION AND SHAPE CONTROL SYSTEM IN TOKAMAK DEVICES

V.A. Belyakov, A.A. Kavin (*Russia*)

Pages 1019 - 1024

Abstract: The plasma current, position and shape control subsystem in Tokamaks (especially in tokamak-reactor) is one of the key part in the overall control system of the devices. Therefore to synthesize such subsystem it is necessary to derive the simplified (linear) model of the control object. In this paper one of the modern approach to derivation of the linear models for the analysis of the plasma current, position and shape control system is considered. The problems of the adaptability of the linear models and comparison with other models are discussed as well.

View manuscript

ANALYSIS OF INITIAL STAGE OF PLASMA DISCHARGE IN TOKAMAKS: MATHEMATICAL MODEL FORMULATION, SIMULATION RESULTS, COMPARISON WITH EXPERIMENTS

V.A. Belyakov, V.I. Vasiliev, K.M. Lobanov, L.P. Makarova, A.B. Mineev (*Russia*)

Pages 1025 - 1034

Abstract: Stage of plasma initiation is marked out from remaining plasma discharge scenario in tokamak. Plasma as object for control is appear during this stage.

Mathematical model of SCENPLINT code for the physical processes description on the stage of plasma initiation is done.

Results of comparison between simulations and experimental data on the Russian tokamak T-10 are presented.

View manuscript

DESIGN OF NON-STATIC CONTROLLERS FOR PLASMA STABILIZATION

E.I. Veremey, M.V. Korovkin (*Russia*)

Pages 1035 - 1042

Abstract: This paper examines the problem of control synthesis which takes into account constraints of current in the coils of poloidal system. The necessary condition for control synthesis consists of astaticism providing on controllable states, because reaching of constraints of current may be treated as new constant disturbance in mathematical model. According to this demand different ways of astaticism providing are examined. Some theorems are proved, giving basis for these methods.

New structure of generalized astaticism providing controller is proposed. It uses observer of special type. It is shown that unlike traditional method, which uses integrals of controlled states, proposed methods do not worse the plasma stabilization performance objectives.

View manuscript

ABSOLUTE MINIMUM OF MEAN-SQUARE FUNCTIONAL IN PLASMA OPTIMAL STABILIZATION

S.V. Pogojev (*Russia*)

Pages 1043 - 1049

Abstract: The central problem to be investigated in this paper is plasma optimal stabilization in tokamaks. Mathematical methods of stabilizing control design based on modern optimization theory are applied. Easy-to-find estimation of linear mean-square functional without need of direct solving the optimization problem is obtained. Particular problem of synthesis in the case of harmonic determinate disturbances is investigated.

View manuscript

ROBUST STABILITY OF THE LINEAR TIME-DELAY SYSTEMS WITH INDEFINITE DELAY

A.P. Zhabko, D.V. Zaretsky (*Russia*)

Pages 1050 - 1051

Abstract: Usually physical control systems such as that of stabilization of the current in tokamaks, or that of stabilization of the form of the plasma in tokamaks should operate adequately in presence of various of uncertain factors. These factors include both the uncertainty in the mathematical description of the processes and some external perturbations of the system under consideration.

This note is devoted to the qualitative analysis of control dynamical systems subjected to the parametrical type of uncertainty. The main goal of the note is to obtain some new bounds on system delay within which the system preserves such qualitative characteristics as, for example, given stability margin, or (and) given oscillation margin.

Results presented in the note may have direct application in analysis and synthesis of robust regulators described by differential-difference equations.

View manuscript

TIME-DELAYED FEEDBACK CONTROL METHOD AND UNSTABLE CONTROLLERS

(Invited)

K. Pyragas (*Lithuania*)

Pages 456 - 467

Abstract: Time delayed-feedback control is an efficient method for stabilizing unstable periodic orbits of chaotic systems. The method is based on applying feedback proportional to the deviation of the current state of the system from its state one period in the past so that the control signal vanishes when the stabilization of the desired orbit is attained. A brief review of experimental implementations, applications for theoretical models, most important modifications as well as recent advancements in the theory of the method is presented. An idea of using unstable degrees of freedom in a feedback loop to avoid a well known topological limitation of the method is described in details. This idea is extended for the problem of adaptive stabilization of unknown steady states of dynamical systems.

View manuscript

CHAOTIFICATION VIA FEEDBACK CONTROL: THEORIES, METHODS, AND APPLICATIONS (Invited)

G. Chen (*China*)

Pages 468 - 474

Abstract: This article introduces the notion of chaotification (or, anticontrol of chaos), which means to make an originally non-chaotic dynamical system chaotic, or to enhance the existing chaos of a chaotic system, via feedback control techniques. The discrete case is discussed in somewhat detail, while the continuous case is outlined briefly. Basic theories and methods are described, and potential applications are mentioned as motivation of the research.

View manuscript

PRINCIPLES OF DIRECT CHAOTIC COMMUNICATIONS (Invited)

A.S. Dmitriev, A.I. Panas, K.V. Zakharchenko (*Russia*)

Pages 475 - 483

Abstract: Basics of the theory of direct chaotic communications is presented. We introduce the notion of chaotic radio pulse and consider signal structures and modulation methods applicable in direct chaotic schemes. Signal processing in noncoherent and coherent receivers is discussed. The efficiency of direct chaotic communications is investigated by means of numerical simulation. Potential application areas are analyzed, including multiple access systems.

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NON-LINEAR PROCESSES AND CONTROL OF CHAOS IN CHEMICAL TECHNOLOGY
(Invited)

E.M. Koltsova, M.V. Cherenkov, E.Yu. Korchagin (*Russia*)

Pages 484 - 490

Abstract: Two methods of controlling chaotic oscillations are considered: with feedback and without feedback (destochastization). The process of continuous mass crystallization of dibasic lead phosphite (at the expense of chemical reaction) is considered. The mathematical model of such a process forecasts as periodic so and chaotic oscillations. The feedback algorithm of Ott-Grebogi-Yorke (OGY) was modified for stabilization of period-2 cycle. It was shown that the main equations of the mathematical model could be resulted in the logistic type equations. The correlation was found between the bifurcation parameter of the mathematical model (flow rate) and the bifurcation parameter of the logistic equation. The periodic perturbation was built for the bifurcation parameter (flow rate), which regulate the chaotic oscillations to the period-6 cycle (destochastization algorithm).

View manuscript

DYNAMICAL CONTROL OF DECAY AND DECOHERENCE IN COMPLEX QUANTUM SYSTEMS (Invited)

G. Kurizki, A.G. Kofman (*Israel*)**, T. Arecchi, G. Mantica** (*Italy*)

Pages 759 - 767

Abstract: A unified theory is given of dynamically modified decay and decoherence in driven quantum systems that are coupled to arbitrary finite-temperature reservoirs and undergo random phase fluctuations. Criteria for the optimization of the suppression and the limitations of this approach are obtained. Decay acceleration by frequent measurements (interruptions of the coupling), known as the anti-Zeno effect (AZE) is argued to be much more ubiquitous than its inhibition in one- or two-level systems coupled to reservoirs (continua). In multilevel systems, frequent measurements cause accelerated decay by destroying the multilevel interference, which tends to inhibit decay in the absence of measurements.

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ADAPTIVE CONTROL OF QUANTUM COMPUTING SYSTEMS (Invited)

R.L. Kosut, H. Rabitz (*USA*)

Pages 824 - 828

Abstract: In this paper we promote the use of adaptive control for deducing the external control fields required to make a quantum computer behave as desired in an uncertain environment.

View manuscript

GEOMETRIC QUANTUM CONTROL (Invited)

J.W. Clark, T.J. Tarn, D.J. Lucarelli (*USA*)

Pages 814 - 823

Abstract: The property of controllability of quantum systems is explored, and conditions for controllability based on Lie-algebraic properties are enunciated. Due consideration is given to the unbounded character of some of the operators that arise and to the generally noncompact nature of the operator algebras associated with the system. Results for both Ïnite and inÏnite-dimensional systems are provided; in the latter case the results are not limited to cases having purely discrete spectra. The applicability of the results to systems with both bound and scattering states is demonstrated through examples, namely the Pöschl-Teller potential and the repulsive radial oscillator, which reveal some of the subtleties of the controllability issue. Attention is also directed to transitivity of the pertinent Lie algebra of a system without drift as a necessary and su±cient condition for its controllability.

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UNIVERSAL SINGLE-QUBIT QUANTUM INTERFACES: QUANTUM CONTROLLERS AND QUANTUM OBSERVERS IN ONE

S. Lloyd, A. Landahl, J.-J.E. Slotine (*USA*)

Pages 829 - 833

Abstract: A feedback loop consists of three dynamical systems: an observer, a controller, and the system to be manipulated. Because of back-action in quantum systems, quantum controllers can act as quantum observers and vice-versa. We demonstrate that under very general conditions, a single quantum bit can serve as both a full controller and full observer of a quantum system for a feedback loop. By similar techniques, we show that a qubit can be harnessed to serve as a quantum communication channel between two systems, and that multiple systems can be connected together to create an efficient universal quantum computer. We propose experimental realizations of our approach, and explore the implications for controllability, observability, and quantum information processing.

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SHORT-TIME ISOTOPE SEPARATION BY QUANTUM CONTROL OF INTRAMOLECULAR DYNAMICS OF POLYATOMIC MOLECULES. NO_2 NONADIABATIC ELECTRONIC DYNAMICS

O.M. Sarkisov, S.Ya. Umanskii, A.S. Vetchinkin, Yu.A. Zotov (*Russia*)

Abstract is not available.

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MODELING AND SIMULATION OF NON-SMOOTH MECHANICAL SYSTEMS (Invited)

J. Awrejcewicz, G. Kudra, P. Olejnik (*Poland*)

Pages 1147 - 1158

Abstract: An advanced modeling of two real physical non-smooth objects is carried out. The non-linear ordinary differential and algebraic inequalities are derived and then numerically simulated. Various aspects of non-linear dynamics are addressed, illustrated and discussed. In the first case, the triple physical pendulum with barriers is used to model a piston – connecting rod – crankshaft system of a mono-cylinder combustion engine. Among other results, a peculiar motion of the piston – connecting rod – crankshaft model is reported, i.e. six sliding stages of the piston along the cylinder per one engine cycle are illustrated. In the second case, the two-degrees-of-freedom mechanical self-excited system with friction modeling the girling duo-servo brake is studied.

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COMPLEXITY AND CHAOS IN PIECEWISE-SMOOTH DYNAMICAL SYSTEMS

Zh.T. Zhusubaliyev, E.A. Soukhoterin (*Russia*)**, E. Mosekilde** (*Denmark*)

Pages 1159 - 1164

Abstract: The paper describes the main bifurcations and routes to chaos exhibited by piecewise-smooth dynamical systems. Emphasis is given to the study of complex behavior in multidimensional piecewise-smooth systems with border-collision bifurcations. The considered phenomena include usual period-doubling and quasiperiodic routes to chaos as well as sequences of different kinds of border-collision bifurcations.

We also present a family of three-dimensional piecewise-smooth maps that can be used for analyzing typical nonlinear phenomena in nonsmooth systems.

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DYNAMICS OF CURRENT REGULATOR WITH HYSTERESIS CONTROL AND CLOCKED COMMUTATION IN APPLICATION TO POWER ELECTRONIC SYSTEMS

Yu.V. Kolokolov, S.L. Koschinsky (*Russia*)**, C. Hatziadoniu, G. Galanos** (*USA*)

Pages 1165 - 1169

Abstract: The results of dynamics analysis of current regulator with hysteresis control and clocked commutation are given in application to electric drive systems. Some new bifurcation phenomena were studied.

IMPACTING OSCILLATORS - THE SENSITIVITY OF MOTION TO EXTERNAL DISTURBANCES

K. Czolczynski (*Poland*)

Abstract: The objects of the investigations presented in this paper are two dynamical systems. The first one is a linear oscillator that can hit the immovable base; the second one consists of two linear oscillators that can impact on each other. For selected sets of parameters, various kinds of motion of these systems are possible: a motion without impacts (periodic or quasi-periodic) and a motion with impacts (periodic or chaotic). The kind of motion depends on initial conditions. The question arises then: what is the sensitivity of motion to external disturbances? The answer can be found by means of making the maps of basins of attraction of all existing attractors. Two examples of such maps and the differences between them caused by a various number of degrees of freedom of the systems under consideration are presented in this paper.

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A GENERALIZED MAXWELL-SLIP FRICTION MODEL APPROPRIATE FOR CONTROL PURPOSES

V. Lampaert, F. Al-Bender, J. Swevers (*Belgium*)

Pages 1170 - 1177

Abstract: During the last decades, under the increasing demand for more accurate high-performance motion systems, various friction models appropriate for control purpose of mechanical systems have been proposed. Most of these friction models formulate a heuristic dynamical model based on a few observed typical friction properties (e.g. a Stribeck curve for constant velocities and a hysteresis behaviour in presliding regime). This paper presents a novel friction model, called the generalized Maxwell-Slip (GMS) model, appropriate for control purpose, based on a physically motivated friction model, i.e. a generic friction model which simulates the contact physics at asperity level. This paper compares the GMS model with some well-known existing models and shows that the novel model is capable of predicting accurately not only the presliding regime and Stribeck effect, but also frictional lag, transition behavior, break-away force and the non-drifting (’stiction’) property.

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AN IDENTIFICATION OF PULSE SYSTEM DYNAMICS ON THE BASIS OF FRACTAL REGULARITY USE

Yu.V. Kolokolov, A.V. Monovskaya (*Russia*)**, K.H. Adjallah** (*France*)

Pages 1184 - 1188

Abstract: This paper analyzes the on-line identification problem of the pulse energy conversion system dynamics. One of possible approaches to the problem solution on the dynamics fractal regularity use basis is proposed. The approach is applied to a buck voltage converter with pulse-width modulation of the second kind.

View manuscript

MODELLING PHYSICAL HYSTERESIS AND CONTROL OF A FINE PIEZO-DRIVE

Ye.I. Somov (*Russia*)

Pages 1189 - 1194

Abstract: New universal and constructible approach for mathematical description of physical hysteresis is presented. This approach is based on using set-valued differential equation with discontinuous right-side and on a shape parametrization of a hysteresis relation. Developed approach is efficiently applied for nonlinear dynamic research of the fine piezo-ceramic micro-drive for an image motion stabilization at a space Earth' observing telescope.

View manuscript

"STRANGE NONCHAOTIC ATTRACTOR" IN 3D AUTONOMOUS DIFFERENTIAL SYSTEM

M.V. Loginova, V.S. Anishchenko (*Russia*)

Pages 621 - 625

Abstract: Dynamic regimes of an autonomous chaotic system (oscillator with inertial nonlinearity) have been investigated. The new type of attractor was found, its characteristics (autocorrelation function, power spectra, Lyapunov exponents) were calculated. And it was found that they are close to thats for strange nonchaotic attractor.

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APPLICATIONS OF A NEW ULTIMATE BOUND ON THE TRAJECTORIES OF THE LORENZ SYSTEM TO SYNCHRONIZATION AND ESTIMATION OF THE HAUSDORFF DIMENSION

A. Pogromsky (*The Netherlands*), **G. Santoboni** (*Italy*), **H. Nijmeijer** (*The Netherlands*)

Pages 626 - 631

Abstract: In this paper a new bound on the trajectories of the Lorenz system is derived. This result is useful to show that the transverse stability of the origin in two Lorenz systems coupled in a drive-response manner is a necessary and sufficient condition for global asymptotic synchrony of the two systems. It also enables to simplify the derivation of an upper bound of the Hausdorff dimension of the Lorenz attractor.

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NUMERICAL ESTIMATES OF LOCAL AND GLOBAL MOTIONS OF THE LORENZ ATTRACTOR

B.G. Kukharenko (Russia)

Pages 632 - 637

Abstract: The Lorenz equations are studied numerically. It is shown that the Lorenz strange attractor can comprise attraction domains, or real-time attractors in the vicinity of a stable fixed point, and transient sets or conductors, which are related to jumps between the fixed points. It has been found that long sequences of nearly periodic stable local orbits near each stable fixed point of the Lorenz equations are real-time attractors for the Lorenz attractor. The laws of motion are revealed for these sequences of local orbits. The backbone curves are found for three universal transient processes, which represent all long sequences of local orbits of the Lorenz attractor. It has been found that the conductors of the Lorenz attractor are represented by nearly subharmonic transient process for 3 time-variables defined by the Lorenz equations.

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THE DETERMINED CHAOS IN DISTURBED BY TEMPERATURE DYNAMIC SYSTEMS WITH GYROS

V.E. Dzhashitov, V.M. Pankratov (*Russia*)

Pages 638 - 643

Abstract: The new approach in theory of dynamic systems with gyros - research of a capability and conditions of originating in output signals of these systems of a phenomenon of the determined chaos is realized. On the basis of the general provisions of the theory of the determined chaos the procedure of learning of this phenomenon in non-linear gyroscopic systems disturbed by temperature is designed. This procedure is applied to concrete dynamic systems with gyros. Namely, are reviewed a capability and conditions of originating of the determined chaos in an output signal fiber optic gyro disturbed by temperature and at temperature control of damping in a float gyroscopic damper of oscillations of autonomous space flying vehicles. Qualitative and quantitative assessments of output parameters of gyros, space flight vehicles and thermal control systems are obtained. The areas of the determined chaos as functions of parameters of gyroscopic systems and disturbances are constructed.

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IMPACTING OSCILLATORS – THE PROBLEM OF VISUALIZATION OF BASINS OF ATTRACTION

T. Kapitaniak, K. Czolczynski (*Poland*)

Pages 657 - 662

Abstract: The objects of the investigations presented in this paper are two dynamical systems. The first one is a linear oscillator that can hit the immovable base; the second one consists of two linear oscillators that can impact on each other.

For selected sets of parameters, various kinds of motion of these systems are possible: a motion without impacts (periodic or quasi-periodic) and a motion with impacts (periodic or chaotic). The kind of motion depends on initial conditions. The question arises then: what is the sensitivity of motion to external disturbances?

The answer can be found by means of making the maps of basins of attraction of all existing attractors.

Two examples of such maps and the differences between them caused by a various number of degrees of freedom of the systems under consideration are presented in this paper.

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COMPLEX DYNAMICS OF DOUBLE-LOOP TRACKING SYSTEM

V.P. Ponomarenko (*Russia*)

Pages 644 - 648

Abstract: This paper deals with the problem of nonlinear dynamics of a system of coupled phase-locked loop and delay-lock loop interacting through crossed feedback. Stability of regime of synchronization and the behaviour of the system at the boundaries of stability region are studied. Possible scenarios of the evolution of nonsynchronous regimes as a function of system parameters are found. Strong dependence of nonsynchronous regimes on control circuits parameters is found. Index Terms-Double-loop tracking system, chaos, nonlinear dynamics, stability, synchronization.

View manuscript

STOCHASTIC DYNAMICS OF FITZHUGH-NAGUMO MODEL NEAR THE CANARD EXPLOSION

A. Shishkin, D. Postnov (*Russia*)

Pages 649 - 653

Abstract: The subject of our study is FutzHugh-Hagumo model driven by additive noise in the region of transition from excitable regime to continuous spiking. We show how canard explosion influences characteristics of stochastic oscillations. In particular, there are two effects with varying noise intensity: (i) frequency stabilization of noise-induced spikes and (ii) partial suppression of spike generation.

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BAKER TRANSFORMATION AS AUTOREGRESSION SYSTEM

A.F. Goloubentsev, V.M. Anikin, S.A. Noyanova, Y.A. Barulina (*Russia*)

Pages 654 - 656

Abstract: We study the baker transformation in the context of an autoregression model (digital filter) of the first order. An initial condition x_0 is supposed to be a random value having the uniform distribution on the interval (0,1). Being unbiased, binary digits of x_0, 0 and 1, have the occurrence probability equal to $1/2$. The y-component of the baker transformation is represented as a linear autoregression equation of the first order where binary digits of x_0 play the role of an excitation (input signal). It is shown that the digital filter corresponding to the baker transformation is causal, stable and reversible one. The asymptotic regime of baker transform dynamics does not depend on the distribution of the initial value y_0.

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IDEAL TURBULENCE: DEFINITION AND MODELS (Invited)

A. Sharkovsky, E. Romanenko, S. Berezovsky (*Ukraine*)

Pages 23 - 30

Abstract: Ideal turbulence is a mathematical phenomenon which occurs in certain infinite-dimensional deterministic dynamical systems, and implies that the attractor of a system lies off the phase space and among the attractor points there are fractal or even random functions.

Ideal turbulence is observed in various idealized models of real distributed systems, addressed by electrodynamics, acoustics, radiophysics, etc. Unlike real systems, in ideal systems (without internal resistance), cascade processes are capable of giving birth to structures of arbitrarily small scale and even causing stochastization of the systems. Just these phenomena are readily described in the contest of ideal turbulence, and allows to understand the mathematical scenarios for many features of real turbulence.

A mathematically rigorous definition of ideal turbulence is based on standard notions of dynamical systems theory and chaos theory.

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CONTROL OF TURBULENCE IN JETS BY ACOUSTIC MEANS (Invited)

P.S. Landa, A.S. Ginevsky (*Russia*)

Pages 31 - 40

Abstract: Suppression and intensification of turbulence in submerged subsonic jets under acoustic forcing are considered. The profound parallels between these processes and the control of noise-induced oscillations of a pendulum with a randomly vibrated suspension axis is analyzed.

View manuscript

PHYSICS, CONTROL, AND KOLMOGOROV COMPLEXITY (Invited)

I.A. Kunin (*USA*)

Pages 41 - 51

Abstract: The paper addresses a new possible approach to interrelations between physics, control, and mathematics. The approach is based on a principally new mathematical theory: Kolmogorov complexity that rejects infinite precision in numbers and algorithms. In the paper this principle is taken as a necessary condition for physically meaningful interrelations between indicated above sciences. To satisfy this condition the paper starts with (physical) definitions of K-numbers and K-observables. On this basis the corresponding notions of Kontrol, Kaos, K-systems, and K-gauge are introduced. This permits to establish a bridge between control and dynamical systems that traditionally are considered as different objects. One of results of this approach: K-equivalence of optimal control and optimal gauge (interrelation: control – gauge). Algorithmic efficiency of the approach is demonstrated by examples.

View manuscript

GRANULAR MATTER: TRANSITION TO EQUILIBRIUM UNDER GRAVITY

N.B. Loguinova (*Russia*)

Pages 52 - 57

Abstract: The relaxation processes in a granular matter confined in a closed container in space under gravity is investigated numerically by means of the ED-algorithm. To simulate the system behavior a model of identical hard elastically interacting spheres is used. The system transition to thermodynamic equilibrium is considered in detail. Oscillatory nature of the relaxation processes is established and explained. The conditions of the oscillations absence are ascertained.

View manuscript

PROPERTY OF ISODYNAMISM AS A PRINCIPLE OF GUARANTEEING / ELIMINATION OF GIVEN SYSTEM EVOLUTION

I.V. Izmailov, B.N. Poizner (*Russia*)

Pages 58 - 63

Abstract: The concept of an *isodynamism* of parameters values various groups influence on evolution of a dynamic system is entered. Method of detection of this the isodynamism is developed *in abstracto* and is applied to case of nonlinear ring interferometer. The paths of application of properties of the isodynamism to solution of control problems are planned if last are reducible to tasks of identification and compensating or imitation of some parameter influence on evolution of system.

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NONLINEAR MATHEMATICAL MODELING OF AIRCRAFT WING FLUTTER IN TRANSONIC RANGE

H. Matsushita, T. Miyata, M. Kawai (*Japan*)**, E. Mosekilde** (*Denmark*)

Pages 196 - 200

Abstract: Two-degrees-of-freedom, finite dimensional, nonlinear mathematical model, which models the nonlinear features of aircraft wing flutter in transonic speed is discussed. The model enables to explain every feature of the transonic flutter data of the wind tunnel tests conducted at National Aerospace Laboratory in Japan for a high aspect ratio wing. It explains the nonlinear features of the transonic flutter such as the subcritical Hopf bifurcation of a limit cycle oscillation (LCO), a saddle - node bifurcation, and an unstable limit cycle as well as a normal (linear) flutter condition with its linear part. At a final procedure of improving a quantitative matching with the test data, the continuation method for analyzing the bifurcation is extensively used.

View manuscript

MODELING OF MANUFACTURING SYSTEMS USING NEURAL NETWORKS

A. Shtay, T. El-Fauly, G.M. Aly (*Egypt*)

Pages 201 - 206

Abstract: The paper investigates the use of artificial neural networks in modeling and control of manufacturing systems. It’s approach by the form of neural networks, for the various elements of a manufacturing system. The modeling approximates discrete systems by continuous models. The suggested model is applied to the approximation of the manufacturing system, and trained to control the machines to achieve the desired targets.

View manuscript

FREQUENCY SPECTRUM CONTROL IN A DIELECTRIC WAKEFIELD ACCELERATING WAVEGUIDE

A. Altmark, E. Sheinman (*Russia*)**, A. Kanareykin** (*USA*)

Pages 207 - 210

Abstract: We present a method to vary the resonant frequency of a dielectric loaded structure (driven either by the wakefield of a beam or an external rf source). It consists of a thin layer of a ferroelectric material backing a layer of conventional ceramic. An external electric field is used to vary the permittivity of the ferroelectric layer and thus tune the overall frequency of the accelerating structure. In this paper, a detailed model is given for this. This scheme employing would compensate for frequency shifts in the accelerating structure caused by ceramic waveguide machining tolerances and dielectric constant heterogeneity. We have identified a suitable material for this application: a BST ferroelectric-oxides compound with a dielectric constant of 300-500. A tuning range of (2-4)% could be achieved for a (11-13) GHz dielectric accelerating structure.

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ADAPTIVE CONTROL OF VIBRATION FOR SYSTEMS WITH NON-STOCHASTIC UNCERTAINTY MEASURE AND BOUNDED DISTURBANCES

N.M. Filatov (*Russia*)

Pages 237 - 242

Abstract: The application of feedback control with adaptive approach in vibration systems is considered. This research field is considered now as significant and not investigated. The elaborated method allows designing of controllers which provide adaptive control of oscillations with improved performance for the systems with complex behavior and unknown parameters. A direct adaptive pole-placement controller (APPC) is designed based on the bicriterial optimization and ellipsoid bounded estimation of the controller parameters. In contrast to the well-known direct APPC, based on the certainty equivalence (CE) assumption, the accuracy of the controller parameter estimation, the size of the ellipsoid for bounded estimation, and necessity of an optimal excitation signal are taken into account in the presented controller design. The new adaptive control algorithm is simple and allows improving the performance of the adaptive pole-placement control especially at the beginning of the adaptation. The elaborated method can be suggested for software development and applications to laboratory and industrial equipment. Increased precision of the control, improved practical acceptance of the systems as well as extension of their application field are expected as advantages of the suggested adaptive systems for vibration control.

View manuscript

EFFECTIVE NEURAL NETWORK APPROACH TO IMAGE RECOGNITION AND CONTROL

G. Ososkov (*Russia*)

Pages 243 - 247

Abstract: A new approach to structuring and training of feedforward artificial neural networks (ANN) is proposed. That leads to overcome many shortcomings of multilayer perceptrons and ANNs with radial basis functions (RBF-nets). A dynamical training algorithm is developed in order to keep the optimal number of neurons in the hidden layers and to guarantee the finiteness of the training procedure due to individual training of each neuron. Results of applying of the proposed neural network to recognizing frontal images of human faces look very promising and give rise to propose a non-expensive security system.

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INVERSE LEARNING CONTROL USING NEURO-FUZZY APPROACH FOR A PROCESS MINI-PLANT

Y.Y. Nazaruddin, J. Waluyo, S. Hadisupadmo (*Indonesia*)

Pages 248 - 253

Abstract: This paper is concerned with a development of an inverse learning control method designed using adaptive neuro-fuzzy controller and its real-time implementation for controlling a process mini-plant. The adaptive neuro-fuzzy approach is implemented to model the dynamic inverse of the plant where, during the learning phase, an off-line and on-line technique will be performed, while in the design of the neuro-fuzzy controller, an adaptive network will be employed as a building block. A hybrid learning rule is also used to minimize the difference between the actual and a given desired trajectory. Experimental results of real-time control of a laboratory-scaled process mini-plant show that the designed on-line inverse learning control technique performs well to the changing dynamics of the plant and tracks the given desired set-points. Performance comparison was also made between the designed and PI controller.

View manuscript

PHYSICAL DIAGNOSTICS AND FAULT RELEVANT FEEDBACK CONTROL

A.V. Timofeev (*Russia*)

Pages 254 - 259

Abstract: The methods of feedback control and physical diagnostics of dynamical systems on the base of their direct and inverse (on subspace) dynamics models are suggested. Absolute and relative criteria of correct (or fault) functioning have been formulated and classification physical models of initial, parametrical, external and measurable faults have been described. The methods for synthesis of fault relevant (tolerant) control of programmed motion have been suggested and the evaluations of allowed physical bounds (tolerances) of classes of possible faults have been obtained. Using of suggested methods provides high indexes of motion control quality of dynamical systems (mechanical systems, robots, mechatronic systems etc.) in a broad class of physical faults uncertainty of dynamical systems.

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SYNCHRONIZATION DOMAINS IN ARRAYS OF CHAOTIC HOMOCLINIC SYSTEMS
(Invited)

F.T. Arecchi, E. Allaria (*Italy*), **I. Leyva** (*Italy/Spain*), **S. Boccaletti** (*Italy*)

Pages 539 - 547

Abstract: With reference to experiments on a CO_2 laser with feedback, we summarize the main features of chaotic orbits homoclinic to a saddle focus, and then face the problem of an array of coupled identical systems of this kind. We first investigate the dynamics of a closed chain of unidirectionally coupled oscillators in a regime of homoclinic chaos. The emerging synchronization regimes show analogies with the experimental behavior of a single chaotic laser self synchronized by a delayed feedback. Then we explore the response of an open chain of bidirectionally coupled chaotic homoclinic systems to external periodic stimuli. When one end of the chain is driven by a periodic signal, the system propagates a phase synchronization state in a certain range of coupling strengths and external frequencies. When two simultaneous forcings are applied at different points of the array, a rich phenomenology of stable competitive states is observed, including temporal alternation and spatial coexistence synchronization domains.

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PROGRAMMABLE PHASE LOCKED LOOPS FOR DIGITAL SIGNAL PROCESSORS

G.A. Leonov, S.M. Seledzhi (*Russia*)

Pages 548 - 554

Abstract: In systems of digital signal processors (array processors) the synchronization problems arise. In these systems the clock skew may be significant and may lead to the incorrect work of parallel algorithms. A clock skew can be eliminated by globally stable phase locked loops. Locally and globally stability of continuous and discrete phase locked loops for digital signal processors are considered. The parameters of period doubling bifurcations for discrete phase locked loop are obtained.

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ON THE CHOICE OF COUPLING IN A SYSTEM OF COUPLED MAPS: STRUCTURE IMPLIES FEATURES

I. Tyukin, C. van Leeuwen (*Japan*)

Pages 555 - 562

Abstract: The conditions of stable synchrony for asymmetrically coupled maps (CM) were analyzed. Utilizing Adamar's lemma we derived sufficient conditions for partial pair-wise synchronization. These results allow us to derive the conditions for cluster-to-node and cluster-to-cluster synchronization. We distinguish four particular types of synchronization patterns and analyze their properties. These properties are sensitivity to disturbances and ability of the system to act as either associative memory or classiÏer. We identify the restrictions on the coupling parameters that determine in which of these models the system operates.

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SYNCHRONIZATION OF CHAOTIC OSCILLATORS WITH TYPE-I INTERMITTENCY

M.V. Ivanchenko, G.V. Osipov, V.D. Shalfeev (*Russia*)

Pages 563 - 568

Abstract: We study phase synchronization effects of chaotic oscillators with type-I intermittency behavior. The external and mutual locking of the average length of the laminar stage for coupled discrete and continuous in time systems is shown. The mechanism of synchronization is explained. It is demonstrated that the considered synchronization can be described using results of the parametric resonance theory and that this correspondence enables one to predict and derive all zones of synchronization.

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QUANTUM ERROR CORRECTION FOR CONTINUOUSLY DETECTED ERRORS

C. Ahn (*USA*), **H.M. Wiseman, G.J. Milburn** (*Australia*)

Pages 834 - 839

Abstract: We show that quantum feedback control can be used as a quantum error correction process for errors induced by weak continuous measurement. In particular, when the error model is restricted to one, perfectly measured, error channel per physical qubit, quantum feedback can act to perfectly protect a stabilizer codespace. Using the stabilizer formalism we derive an explicit scheme, involving feedback and an additional constant Hamiltonian, to protect an (n -1)-qubit logical state encoded in n physical qubits. This works for both Poisson (jump) and white-noise (diffusion) measurement processes. As an example, we show that detected-spontaneous emission error correction with a driving Hamiltonian can greatly reduce the amount of redundancy required to protect a state from that which has been previously postulated. This work is a condensation of results in [1].

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QUANTUM STATE PROTECTION WITH QUANTUM FEEDBACK SCHEMES

D. Vitali, S. Zippilli, P. Tombesi (*Italy*), **J.-M. Raimond** (*France*)

Pages 840 - 845

Abstract: We present a scheme able to protect the quantum states of a cavity mode against the decohering effects of photon loss. The scheme preserves quantum states with a definite parity and it is implemented by sending single atoms, one by one, through the cavity. By solving numerically the exact master equation of the system, we show that the protection of simple quantum states could be experimentally demonstrated using presently available experimental apparatus.

View manuscript

LASER CONTROL OF QUANTUM DYNAMICS

P.A. Golovinski, P.V. Ryasnoy, V.M. Nazarov (*Russia*)

Pages 846 - 850

Abstract: The concept of ultrafast optimal control based on Schrödinger equation is developed for quantum systems. General properties of optimal dynamics are illustrated by computer simulation for two-level system and Morse potential. A number of maximums for transition probability are realized for different contributions of laser pulse parameters.

View manuscript

ON PREPARATION OF THE ATOMIC W-STATES

V.N. Gorbachev, A.A. Rodichkina, A.I. Trubilko, A.I. Zhiliba (*Russia*)

Pages 851 - 854

Abstract: We analyse possibilities for quantum state engineering offered by the resonance Raman type interaction of light with ensembles of two-level atoms taking account relaxation to prepare and control of entangled states. It is found that atomic entanglement of the W-class can be obtained during evolution of atoms interacted with a single mode squeezed light. Two schemes, involving projection measurements that result in multipartite W-like states, are introduced.

View manuscript

SPIN SYSTEMS AND MINIMAL SWITCHING DECOMPOSITIONS

J. Clemente-Gallardo, F. Silva-Leite (*Portugal*)

Pages 855 - 860

Abstract: The control of spin chains represents a very interesting problem from the point of view of quantum computation. The problem consists in defining a procedure to obtain any possible evolution operator of the spin chain by means of an external magnetic field. The set of possible evolution operators of the system corresponds to the unitary group $SU\left(2^N\right)$ (where N is the number of atoms in the chain) and the interactions involved can be set to correspond to elements in the corresponding Lie algebra. As a consequence, the whole problem can be formulated in Lie algebraic terms, and the design issues be reduced to a suitable decomposition of the group elements. The goal of this paper is to introduce a Cartan decomposition for the unitary group based on a minimal switching decomposition of the special orthogonal group. We analyze its implications from the point of view of time optimality in the construction of a program as a sequence of quantum gates.

View manuscript

QUANTUM PROCESSORS AND CONTROLLERS

A.Yu. Vlasov (*Russia*)

Pages 861 - 866

Abstract: In this paper is presented an abstract theory of quantum processors and controllers, special kind of quantum computational network defined on a composite quantum system with two parts: the controlling and controlled subsystems. Such approach formally differs from consideration of quantum control as some external influence on a system using some set of Hamiltonians or quantum gates. The model of programmed quantum controllers discussed in present paper is based on theory of universal deterministic quantum processors (programmable gate arrays). Such quantum devices may simulate arbitrary evolution of quantum system and so demonstrate an example of universal quantum control.

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CONTROL SCIENCE FOR INJURY PREVENTION (Invited)

D.V. Balandin, N.N. Bolotnik (*Russia*), **W.D. Pilkey** (*USA*)

Pages 1195 - 1200

Abstract: A review of recent research on the limiting performance analysis of impact isolation systems for injury prevention is presented. A limiting performance analysis establishes the absolute optimum for a performance index measuring the quality of an isolation system by solving an optimal control problem. Problems related to the optimal design of a crashworthy helicopter seat, automobile set belts, and sporting helmets are discussed.

View manuscript

H_∞ OPTIMAL CONTROL OF A PARAMETRICALLY DISTURBED PENDULUM

D.V. Balandin, M.M. Kogan, A.A. Fedukov (*Russia*)

Pages 1201 - 1205

Abstract: Based on H_∞-control technique, a control law for a parametrically disturbed pendulum is derived, under which a level of attenuating oscillations is close to the minimally possible one. Results of numerical modeling are presented.

View manuscript

OPTIMAL PROTECTION OF TWO-DEGREE-OF-FREEDOM SYSTEM FROM SHOCK AND VIBRATION

S.V. Purtsezov (*Russia*)

Pages 1206 - 1208

Abstract: Problem of shock and vibration isolation for rectilinearly moving isolation system with two masses and passive isolators consisted of damper and stiffness elements with linear characteristics is investigated. As performance criteria peak forces transmitted to the mass being isolated for shock and vibration external disturbances and maximums of relative displacements of the masses are used. Calculation of parameters of isolation system for parabolic type of external shock disturbance is fulfilled.

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TIME SUBSTITUTION METHOD IN A SHOCK PROTECTION PROBLEM FOR NONLINEAR HAMILTONIAN SYSTEMS

V.A. Proursin (*Russia*)

Pages 1214 - 1215

Abstract: A control problem for a system of finite number of masses connected by means of nonlinear spring elements is considered. This problem is reduced to control problems for independent one-degree-of-freedom linear oscillators. The optimal shock isolation problem for nonlinear system with two degrees of freedom is investigated.

View manuscript

MAXIMUM ROBUSTNESS CONTROL FOR ISOLATION OF MECHANICAL DISTURBANCES

V.V. Koulaguin (*Russia*)

Pages 1209 - 1213

Abstract: Some new criterion for decision making under uncertainty and its control application are set forth. The criterion is based on known property of robustness of each admissible decision. Namely, a decision goal is realized by this admissible decision in spite of fact that an uncertainty parameter value is changed within some range of it.

A few basic goals for decision making and basic types of control design problem are considered.

Application to protection devices from shock and vibration is investigated.

View manuscript

SOME NEW ADVANCES IN THE THEORY OF DYNAMIC MATERIALS (Invited)

K. Lurie, S. Weekes (*USA*)

Pages 1326 - 1335

Abstract: In this paper, we present some recent advances in the theory of dynamic materials or spatio-temporal composites. We discuss the technique used to determine the set of invariant characteristics of material mixtures in one spatial dimension and time, in the context of electrodynamics of moving dielectrics, versus the relevant results in traditional electrostatics. Energy transformation in spatio-temporal laminates is discussed. We also present some results on dynamic materials with a rectangular microstructure. Some special features of dynamic materials demonstrated through material disgn are given as well. Among them, we mention the possibility to eliminate the cut-off frequency in the waveguides with activated dielectric filling.

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SWITCHED CHATTERING CONTROL OF ELECTRICAL SERVO-MOTORS AND BACKLASH/FRICTION ATTENUATION

Y. Orlov, L. Aguilar (*USA*), **J.C. Cadiou** (*France*)

Pages 1336 - 1341

Abstract: A switched control algorithm is developed to globally stabilize an electrical servo-motor operating under uncertainty conditions in the presence of complex nonlinear phenomena such as backlash, stick-slip motion, etc. Particularly, the chattering controller ensures robustness against external disturbances with the a priori known norm bounds, thus rejecting the influence of undesired backlash/friction effects on the motor. Stability analysis, given within the Lyapunov functions framework extended to discontinuous dynamic systems, additionally reveals a finite time convergence of the system trajectories to the equilibrium point. Performance issues of the controller are illustrated in a simulation study.

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DESIGN OF FINITE CONTROLLERS FOR A CLASS OF INFINITE SYSTEMS FOR THE H^{∞}-CONTROL PROBLEM

V.A. Brusin, A.V. Bovyrin (*Russia*)

Pages 1342 - 1345

Abstract: The considered problem consists in finite controller design for the H^{∞}- criteria fulfilment, when a object may be represented by hyperbolic type equations in partial derivatives. Presented method of finite controller design based on results from [1]. The controllers class is given. Theorems solving this problem are stated. Application to mechanical system is given.

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NAVIER-STOKES EQUATION CONTROLLED BY DEGENERATE FORCING: CONTROLLABILITY OF FINITE-DIMENSIONAL APPROXIMATIONS

A. Agrachev, A. Sarychev (*Italy/Russia*)

Pages 1346 - 1351

Abstract: The aim of this work is studying controllability of finite-dimensional Galerkin approximations of 2D and 3D Navier-Stokes equations, controlled by degenerate (applied in few low modes) forcing. Methods of geometric/Lie-algebraic nonlinear control theory are used to establish sufficient criteria of global controllability.

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MINIMAL DISSIPATION PROCESSES AND ESTIMATES OF LIMITING POSSIBILITIES OF IRREVERSIBLE THERMODYNAMIC SYSTEMS (Invited)

A.M. Tsirlin (*Russia*), **V. Kazakov** (*Australia*)

Pages 71-76

Abstract: Irreversible work of separation and irreversible maximal productivity of heat driven separation are derived in this paper.

View manuscript

THE BOOLEAN AVERAGING PROCEDURE, COMMON TO THREE SYSTEMS IN STATISTICAL MECHANICS, CONTROL AND SIGNAL PROCESSING

M.M. Kipnis (*Russia*)

Pages 77 - 80

Abstract: We investigate the Boolean averaging procedure (BAP) $u(n) = sgn\left(\psi - \sum_{i=1}^{\infty} \gamma_i u(n-i)\right)$, where $\psi \in \Re$, (γ_i) is a weight function $(i \in N)$, $(u(n))$ is a two-sided sequence $(n \in Z)$. It describes three systems: 1) the Hubbard model in statistical mechanics, 2) sampled-data control system, 3) analog-to-digital converter with sigma-delta modulation and leaky integration. The periodic modes in the BAP generate so-called Hubbard configurations, in which $(+1)-s$ is evenly distributed between $(-1)-s$(the phenomenon of even 2-colouring). Our new results shows that the trajectories $(u(n))$ become periodic for almost all ψ if the sequence (γ_n) is convex.

View manuscript

CONTROL AND PARAMETERIZATION OF DYNAMICAL NONLINEAR PROCESSES DURING FIRST-ORDER PHASE TRANSITION

L.A. Bityutskaya, E.S. Mashkina (*Russia*)

Pages 81 - 85

Abstract: Thermodynamical conditions of beginning dynamical nonlinear processes near the melting point of crystal matters with different type of chemical bond were indentificated by the technique of digital differential-thermal analysis (DTA). Cooperative pre- and post-melting effects are nonequelibrium phase transitions and can be characterized by the system of thermodynamical parameters *J*. Introdused system of the parameters characterise of formation specific structure state in a material - mesophase pre- and post-melting. Parameterization of the transient processes during first-order phase transition gives opportunity to investigate influence of diffeternt factors, such as initial conditions, heating rate, mass of sample, internal magnetic fields, on mesophase formation.

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SUB-RIEMANNIAN FORMULATION FOR NON INTERACTING, NON RELATIVISTIC PARTICLES IN HOMOGENEOUS MAGNETIC FIELDS

F. Monroy Pérez, A. Anzaldo-Meneses (*Mexico*)

Pages 64 - 70

Abstract: We propose a formulation for charged non relativistic particles in homogeneous magnetic field within the framework of Sub-Riemannian geometry. Our approach takes advantage of the underlying Lie algebraic structure to uncover a set of Casimir elements. Second order conditions for the corresponding variational problem are touched upon.

View manuscript

TYPE THEORY, COMPUTER ALGEBRA & DYNAMICAL SYSTEMS

A.V. Flegontov (*Russia*), **S.V. Soloviev** (*France*)

Pages 86 - 88

Abstract: Type theory is one of most active directions in modern mathematical logic. It supports constructive formalization of mathematical computations, including analytical ones. Type theory is used as basis in most of so called proof assistants (software supporting interactive proof-check and development). One of important problems is the problem of efficient combined use of proof assistants and computer algebra systems. Here this problem is considered in the context of complex multiparametric nonlinear dynamical systems represented by differential equations of some types.

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ENERGY LYAPUNOV FUNCTION FOR GENERALIZED REPLICATOR EQUATIONS

Yu.A. Pykh (*Russia*)

Pages 271 - 276

Abstract: Replicator dynamics is an evolutionary strategy well established in different disciplines of biological sciences. It describes the evolution of self-reproducing entities called replicators in various independent models of, e.g., genetics, ecology, prebiotic evolution, and sociobiology. Besides this, replicator selection has been applied to problem solving in combinatorial optimization and to learning in neural networks and also in fluid mechanics, game and laser theory. So, the replicator systems arising in an extraordinary variety of modeling situations. In this report I'll introduce the new class of generalized replicator equations with nonlinear response functions and construct Energy Lyapunov function for this system. Tsallis entropy is considered as an example.

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NONLINEAR SWITCHING DYNAMICS IN SURFACE ELECTROMYOGRAPHY OF THE SPINE

P. Lohsoonthorn, E. Jonckheere (*USA*)

Pages 277 - 282

Abstract: This paper develops a switching dynamics model of the surface Electromyographic (sEMG) signal generated during a condition in which the mechanical attachment of the spinal dura to the cervical vertebra creates an unstable nonlinear feedback coupling between the biomechanics of the spine and the central nervous system (CNS). The sEMG signal recorded on the paraspinal muscles during this condition reveals "bursts" of accrued sEMG activity interrupting an otherwise quiet "background" signal. Statistical analysis of the autocorrelation and partial correlation functions of the burst and background parts of the signal reveals that the overall signal indeed switches between two modes. Both the burst and the background modes are dynamically modeled by ARIMA and ACE, and a switching logic, driven by the autocorrelation and the partial correlation, is designed, resulting in a switching model that matches the experimental sEMG signal fairly well.

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BIMODAL DYNAMICS OF NEPHRON AUTOREGULATION

O.V. Sosnovtseva, A.N. Pavlov (*Russia*), **E. Mosekilde, N.-H. Holstein-Rathlou** (*Denmark*)

Pages 283 - 288

Abstract: The individual functional unit of the kidney (the nephron) displays oscillations in its pressure and flow regulation at two different time scales: fast oscillations associated with a myogenic dynamics of the afferent arteriole, and slower oscillations arising from a delay in the tubuloglomerular feedback. We investigate the intra- and inter-nephron entrainment of the two time-scales. Besides full synchronization, both wavelet analyses of experimental data and numerical simulations reveal a partial entrainment in which neighboring nephrons attain a state of chaotic synchronization with respect to their slow dynamics, but the fast dynamics remain desynchronized.

View manuscript

COMPLEX PHASE DYNAMICS IN COUPLED BURSTERS

D.E. Postnov, S.Y. Malova (*Russia*)

Pages 289 - 294

Abstract: Focusing on the mechanisms underlying the appearance of phase multistability, the paper examines a variety of phase-locked patterns in the bursting behavior of a model of coupled pancreatic cells. In particular we show how the number of spikes per train and the proximity of a neighboring equilibrium point can influence the formation of coexisting regimes.

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CHAOTIC BEHAVIOR BY THE AIR FLOW OF THE BREATH OF HUMAN BEING

G. Lukyanov, V. Usachev (*Russia*)

Pages 295 - 298

Abstract: This paper presents an investigation of the relations between the regimes of the air flow within the men's nose and his breath diseases. The regimes of the air flow has investigated on the basic of analysis of chaotic behavior, also with the methods of deterministic chaos analysis. The results of study indicated that the chaotic invariants (for example correlation dimension) can be used for the medical diagnostic of the men's breath diseares.

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OPTIMAL TRANSPORT FOR VISUAL TRACKING AND REGISTRATION

S. Haker, A. Tannenbaum, A. Goldstein (*USA*)

Pages 266 - 270

Abstract: In this note, we consider a new method for an important aspect of the visual tracking problem. Tracking in the presence of a disturbance is a classical control issue, but because of the highly uncertain nature of the disturbance, this type of problem is very difficult. A key issue in many visual tracking tasks is that of registration. Image registration is the process of establishing a common geometric reference frame among several data sets taken at different times. We propose a method of registration based on the Monge-Kantorovich problem of optimal mass transport. We argue that such an approach can also be very useful for several problems in controlled active vision.

View manuscript

STABILITY OF DELAYED FEEDBACK CONTROLLERS FOR DISCRETE TIME SYSTEMS

Ö. Morgül (*Turkey*)

Pages 491 - 496

Abstract: We consider the delayed feedback control (DFC) scheme for one dimensional discrete time systems. To analyze the stability, we construct a map whose fixed points correspond to the periodic orbits of the system to be controlled. Then the stability of the DFC is equivalent to the stability of the corresponding equilibrium point of the constructed map.

TIME DELAYED FEEDBACK CONTROL OF CHAOS BY SPATIO-TEMPORAL FILTERING

A. Amann, E. Schöll, N. Baba, W. Just (*Germany*)

Abstract: Time delayed feedback control is employed to stabilise time periodic patterns in a reaction-diffusion model with global coupling. The control performance is increased by several orders of magnitude by suitable filters and couplings which are based on the Floquet eigenmodes of the unstable orbit. The essential mechanism for the improvement of the control performance is attributed to a phase synchronisation mechanism between the target state and the control loop.

View manuscript

MUSIC AND CONTROL OF CHAOS IN THE BRAIN

V.E. Bondarenko (*USA*), **I. Yevin** (*Russia*)

Pages 497 - 500

Abstract: Recent researches revealed that music tends to reduce the degree of chaos in brain waves. For some epilepsy patients music triggers their seizures. Loskutov, Hubler, and others carried out a series of studies concerning control of deterministic chaotic systems. It turned out, that carefully chosen tiny perturbation could stabilize any of unstable periodic orbits making up a strange attractor. Computer experiments have shown a possibility to control a chaotic behavior in neural network by external periodic pulsed force or sinusoidal force. One may propose that the aim of this control is to establish coherent behavior in the brain, because many cognitive functions of the brain are related to a temporal coherence.

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ENERGY-OPTIMAL STEERING OF TRANSITIONS THROUGH A FRACTAL BASIN BOUNDARY

A.N. Silchenko, S. Beri, D.G. Luchinsky, P.V.E. McClintock (*UK*)

Pages 501 - 506

Abstract: We study fluctuational transitions in a discrete dynamical system having two co-existing attractors in phase space, separated by a fractal basin boundary. It is shown that transitions occur via a unique accessible point on the boundary. The complicated structure of the paths inside a fractal boundary is determined by a hierarchy of homoclinic original saddles. By exploiting an analogy between the control problem and the concept of the optimal fluctuational path, we find an optimal deterministic control function that is equivalent to the optimal fluctuational force obtained from a numerical analysis of the fluctuational transitions between two states.

View manuscript

APPLICATION OF IDEA OF CHAOS CONTROL TO STABILIZATION OF STATIONARY GENERATION IN BACKWARD-WAVE OSCILLATOR

A.M. Dolov, S.P. Kuznetsov (*Russia*)

Pages 507 - 509

Abstract: The method of suppression of self-modulation in a backward wave tube is offered. For this, the additional circuit of a delayed feedback is introduced in such way that the level of amplitude of output signal influences magnitude of a current of electron beam at the input of the interaction space. Results of numerical simulation demonstrate a possibility to increase working current twice, keeping a single-frequency regime of generation.

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ROBUST CONTROL OF TIME-DELAY CHAOTIC SYSTEMS

C. Hua, X. Guan (*China*)

Pages 510 - 515

Abstract: Robust control problem of nonlinear time delay chaotic systems is investigated. For such uncertain systems, we propose adaptive feedback controller and novel nonlinear feedback controller. They are both independent of the time delay and can render the corresponding closed-loop systems globally uniformly ultimately bounded stable. The simulations on controlling logistic system are made and the results show the controllers are feasible.

View manuscript

SEMICONDUCTOR-GAS DISCHARGE ELECTRONIC DEVICES: STABILITY, PATTERNS AND CONTROL (Invited)

Yu.A. Astrov (*Russia*)

Pages 883 - 894

Abstract: Recent results of studying the transport properties of planar semiconductor - gas discharge devices are reviewed. The device can operate in the stable mode or in regimes where self-organization of spatial and temporal patterns occurs. In the range of stability, it can be applied as a high speed converter of infrared images. Simple non-linear models of operation in both modes are presented. The equations corresponding to the converter regime are used to implement a control scheme that can essentially optimize the process of switching on of the state of discharge with increased current. Different scenarios of pattern formation are described and examples both of global and local control of patterns are presented. Some experimental data are accompanied by results of numerical study of the corresponding two-dimensional reaction-diffusion model.

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OPEN-LOOP-CONTROL OF PORE FORMATION IN SEMICONDUCTOR ETCHING

J.C. Claussen, J. Carstensen (*Germany*), **M. Christophersen** (*Germany/USA*), **S. Langa, H. Full** (*Germany*)

Pages 895 - 900

Abstract: Electrochemical etching of semiconductors gives rise to a wide variety of self-organized structures including fractal structures, regular and branching pores. The Current-Burst Model and the Aging Concept are considered to describe the dynamical behavior governing the structure formation. Here the suppression of side-branching during pore growth is demonstrated by an open-loop-control method, resulting in pores with oscillating diameter.

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SYNCHRONIZATION OF CHAOS AND SMALL SIGNAL AMPLIFICATION IN ELECTRON-HOLE PLASMAS OF GERMANIUM

K.M. Aliev, I.K. Kamilov, Kh.O. Ibragimov, N.S. Abakarova (*Russia*)

Pages 675 - 679

Abstract: The effect of an external harmonic signal on the screw instability of the current in the electron-hole plasma has been studied experimentally in Ge at 77 K and 300 K. The influence exerted by external signals with various amplitudes and frequencies, applied to a sample both additively and multiplicatively, on the synchronization, amplification and stability of the system in absolute and convective modes of instability excitation has been investigated at points of bifurcation in a wide region of the parametric space.

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COHERENT ATOMIC BEAM SPLITTER CONTROL FOR NANO-SCALE ATOM WAVE PACKET LITHOGRAPHY

S.V. Borisenok, Yu.V. Rozhdestvensky (*Russia*)

Pages 906 - 908

Abstract: Atomic beam splitter needs for the practical realization of nano-scale lithography by coherent scattering of the atoms. We consider the different types of atomic beam splitters, which could be used for the creation of the space structures with nano-scale period. We concentrate to a few main schemes of an interaction between an atom beam and optical radiation, which can produce a large angle splitting of atom beam into only two main momentum components: multi Bragg scattering an atom wave packet in standing wave; coherent splitting by scattering of an atom wave packet in standing wave with modulated intensity, when the intensity of the standing wave changes harmonically.

We discuss also the experimental possibility of an atom selection in internal states for obtaining of space periodical structure with high clearance.

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APPLICATION OF CONTROL ALGORITHM IN A SLIDING MODE IN SPECRTRUM MEASUREMENT SYSTEMS AND GROWING OF CRYSTALS

A. Khachaturova (*Armenia*), **V. Mkrttchian** (*Australia*)

Pages 901 - 905

Abstract: The algorithm in a Sliding Mode that can be used for adaptive temperature control of a heating system for spectrum measurement systems and growing of crystals is presented. This paper is aimed not only at stating and developing the results obtained in the sphere of discontinuous system design, but also at presenting these results in close correlation with the basic concepts, problems and methods of theoretical aspects of present-day control theory. Implementation of this approach implies the knowledge of the conditions of the occurrence of sliding mode, for which purpose a sliding mode indicator has been developed. The Sliding Mode controller by means the Lab View graphical programming language under Windows 1998 environment is proposed. The controller program consist of the following separate blocks: the block for acquiring of data from the thermal point block; the programmer block (set points), which ensures the desired temp erature profile and provides the linear-dependent voltage (or temperature) of a few desired slot time of different duration; the block responsible for the knowledge of conditions of the occurrence of SM, the so-called indicator; the observer block, which identifications the state vector of the system; block of anticipatory compensation; block of PID regulator.

View manuscript

CONSTRAINED VARIATIONAL APPROACH TO NONHOLONOMIC CONTROL SYSTEMS

T. Kai, H. Kimura (*Japan*)

Pages 1216 - 1221

Abstract: In this paper, we deal with nonholonomic dynamical systems based on the Lagrangian formulation. In modeling nonholonomic control systems, we especially focus on vakonomic mechanics which is one of the constrained variational methods to derive the equations of motion of constrained systems. Using vakonomic mechanics, we introduce the vakonomic affine system (VAS) and analyze it theoretically in the context of nonlinear control theory. Then we consider control problems of the VAS and show simulation results to demonstrate the effectiveness of our theory.

View manuscript

DECOMPOSITION OF LAGRANGIAN SYSTEMS ON THE BASE OF THE TECHNICAL CONTROLLABILITY CONCEPT

V.Yu. Rutkovsky, S.D. Zemlyakov (*Russia*)

Pages 1242 - 1247

Abstract: Consideration is given to control of the plant obeying Lagrange equations under bounded control actions. The notion of autonomous technical controllability of the plant is established and uses to prove that the mathematical model of plant motion can be decomposed into individual subsystems.

View manuscript

SLOW LOCOMOTION OF THE THREE-LINK SYSTEMS ALONG A HORIZONTAL PLANE

T.Yu. Figurina (*Russia*)

Pages 1222 - 1225

Abstract: We continue to investigate the possibility of slow (quasi-static) locomotion of multi-link systems along a horizontal plane owing to changing their configurations. It has been shown in [1] that the quasi-static motion of a two-link system, occuring when the angle between its links varies, is uncontrollable and that the trajectories of the system's vertices are uniquely defined by the initial position of the system. It has been shown in [2] and [3] that, in contrast, both two-link and three-link systems are controllable (i.e. they can be driven to a prescribed position on the plane), when using both fast and slow motions. We state here quasi-static controllability. We state here quasi-static controllability of three-link systems, both star-like and with links connected in series. We investigate a symmetrical star-like three-link system. We show that there exist much enough possibilities for the quasi-static motion of the system. One can arrange a motion with the central vertex of the system moving along a prescribed broken line on the plane. As an example, we consider two gaits of the three-link system allowing it to move along a slraight line and to rotate on a spot. We also consider a star-like three-link system which conlacts the plane only at the three end vertices. This system is an important special case of the star-like three-link system, since it can move along surfaces. We consider its motion only along a horizontal plane and construct a statically stable gait allowing driving the linkage to a desired position on the plane. At the end, we consider a three-link system with links connected in series and prove it quasi-static controllability.

View manuscript

CONTINUOUS FEEDBACK CONTROL FOR SCLERONOMOUS MECHANICAL SYSTEMS

I.M. Ananievski (*Russia*)

Pages 1226 - 1230

Abstract: A problem of designing a feedback control for a Lagrangian scleronomous mechanical system is considered. The control forces are assumed to be bounded and the system undergoes uncontrolled disturbances. The continuous feedback control is constructed which drives the system to a prescribed terminal state in a finite time. The proposed algorithm employs a linear feedback control with the gains which are functions of the phase variables. The gains increase and tend to in .nity as the phase variables tend to zero; nevertheless, the control forces are bounded and meet the imposed constraint. The approach developed is based on Lyapunov's direct method.

View manuscript

HYBRID CONTROL OF A CART-PENDULUM SYSTEM WITH RESTRICTIONS ON THE TRAVEL

D. Gromov, J. Raisch (*Germany*)

Pages 1231 - 1235

Abstract: A globally stabilizing controller for a cart-pendulum system is developed. It is shown that the use of hybrid methods can significantly simplify the procedure of control synthesis in the presence of restrictions on the control signal and on the length of travel. A special feature of the proposed approach is that restrictions are embedded into the control algorithm.

View manuscript

SINGULAR FUNCTIONS OF A NONLINEAR PENDULUM ON FINITE TIME INTERVALS

X.Y. Petrova, L.A. Mironovsky (*Russia*)

Pages 1236 - 1241

Abstract: Concept of singular functions of linear systems introduced in the previous works of the authors is extended to the nonlinear case. Singular functions of the nonlinear pendulum are studied. Three approaches to finding singular functions are considered: the classical variational approach, combined approach of variational calculus and flip-method, and genetic algorithm.

View manuscript

FEEDBACK CONTROL FOR A HEAT EQUATION UNDER A WHITE NOISE EXCITATION

A.S. Bratus, A.P. Ivanova (*Russia*)

Pages 1352 - 1356

Abstract: An optimal feedback control problem for a heat conduction equation under white-noise random excitation is considered. The problem is to minimize expected response for integral value of squared difference among current and preassigned temperature during by a given time instant *T*. The control forces are concentrated in the fixed points (heat actuators). The magnitude of control forces are restricted by positive values. Using Dynamic Programming method this problem can be reduced to the Cauchy problem for Hamilton-Jacobi-Bellman (HJB) partial nonlinear differential equation for a Bellman function *H* in unbounded domain. Specifically, an exact analitical solution has been obtained within a certain unbounded "outer" domain on the phase plane, which provides necessary boundary conditions for numerical solution within a bounded (finite) "inner" domain, thereby alleviating problem of numerical analysis for an unbounded domain. The size of "outer" domain can be chosen such way that the values of Bellman function *H* and its corresponding derivatives will coincide in the boundary of "outer" and "inner" domains. As an example the case of control problem for one heat actuator in the rod is considered.

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CONTROL AND STABILIZATION OF A ROTATING PLANAR BODY WITH FLEXIBLE ATTACHMENTS

A.L. Zuyev (*Ukraine*)

Pages 1357 - 1362

Abstract: A control system describing rotation of a rigid body with an arbitrary number of elastic beams is considered. We characterize the approximate controllability property in terms of the eigenvalues of the associated homogeneous beam equation. It is proved that boundary controllability of the whole infinite dimensional dynamics is possible if there is no resonance in the system. Under this assumption we construct a feedback law that strongly stabilizes the equilibrium.

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TREATMENT OF THE INTERFACE BETWEEN FINE ELASTIC STRUCTURES AND FLUIDS

N.D. Botkin, K.-H. Hoffmann, V.N. Starovoitov, V.L. Turova (*Germany*)

Pages 1367 - 1372

Abstract: The interaction of fine pin or bristle structures with fluids is studied. Such problems arise when modeling biomolecular layers moving in liquids or when simulating epithelium surfaces of blood vessels. We propose a homogenized model where the interaction between the bristles and the uid is accounted through an averaged material whose properties are derived using the passage to the limit in the model based on the uid-solid interface conditions as the number of the bristles goes to infinity whereas their thickness goes to zero. The model of such an averaged material is used for the study of a Love wave biosensor.

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EXACT CONTROLLABILITY IN NEUTRAL DELAY EQUATIONS

D.V. Yakubovich (*Spain*), **S.M. Verduyn Lunel** (*The Netherlands*)

Pages 1373 - 1376

Abstract: A necessary condition for the exact controllability in neutral delay equations of general form is given in terms of uniform lower estimates for the minors of an “extended” transfer function. Some upper and lower estimates of the time of exact controllability in terms of the maximal delay and the dimensions of the state and the control vectors are also obtained.

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ROBUST FAULT-TOLERANT CONTROL FOR A CLASS OF NONLINEAR SINGULAR SYSTEMS WITH UNCERTAINTY

G. Hu, J. Ren, C. Liu (*China*)

Pages 1378 - 1382

Abstract: A design method of robust fault-tolerant feedback controller is put forward for a class of nonlinear singular systems with uncertainty. It is shown that the proposed state feedback systems are of integrity and robustness in the presence of all admissible parameter perturbations against the sensor or actuator failures. The controller can be obtained by solving LMI, which is tractable. Numerical examples are given illustrating the effectiveness of the proposed approach.

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NOVEL ELECTROCHEMICAL FERROXALATE ACTINOMETER FOR EXCILAMP INTENSITY MEASUREMENT

E.A. Sosnin, V.N. Batalova, E.A. Zacharova, V.F. Tarasenko (*Russia*)

Pages 320 - 323

Abstract: In this paper we report on use of electrochemical ferroxalate actinometer for measuring of intensity of KrCl-, XeCl-, and XeBr-excilamps for which traditionally physical photodetectors were applied. Advantages of the suggested method are discussed in comparison with colorimetry method to define radiation intensity using ferroxalate actinometer. It is shown that the novel version of chemical actinometer can serve as alternative method to measure intensity and to calibrate physical photodetectors in UV range.

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ADAPTIVE CONTROL OF THE TOP BLOWN OXYGEN CONVERTER PROCESS CONSIDERING TEMPERATURE AND UNKNOWN EXTERNAL DISTURBANCES

B.M. Sokolov, A.I. Shepeljavyi (*Russia*), **A. Medvedev** (*Sweden*)

Pages 324 - 328

Abstract: The paper considers the control of the top blown oxygen converter process by exploiting the equations of the process in order to compensate for unknown disturbances. These disturbances are caused by additives dissolving in the converter. Necessity to take into account temperature of reaction has resulted in increase of number of the equations in the mathematical model of process. Thus the speed of reaction now depends on the metal temperature. The dissipation region of the controller is evaluated. A nonlinear observer is developed for estimating the metal analysis in real time. It is shown that the observer is asymptotically stable and a region of attraction, where the estimation error converges, is derived. Adaptive control of this process is constructed.

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DISCRETE-TIME CONTROL SYSTEM DESIGN FOR A REACTIVE ION ETCHING (RIE) SYSTEM

N. Tudoroiu, V. Yurkevich, K. Khorasani (*Canada*)

Pages 329 - 334

Abstract: The problem of designing a robust controller to solve a tracking control problem for improving plasma characteristics in Reactive Ion Etching process is studied. The presented design methodology is based on the construction of a two-time scale motions of the closed-loop system. It has been shown that under discussed conditions the proposed dynamical controller induces a two time-scale separation of the fast and slow modes in the closed-loop system. Stability conditions imposed on the fast and slow motions can ensure that the full-order closed-loop system achieves the desired properties so that the output transient performances are insensitive to parameter variations and external disturbances. Simulation results on a multivariable Auto Regressive Moving Average model of a RIE process are presented to demonstrate the utility of the proposed algorithm.

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MODEL PREDICTIVE CONTROL ALGORITHM FOR NONLINEAR CHEMICAL PROCESSES

A.A. Tiagounov, S. Weiland (*The Netherlands*)

Pages 335 - 340

Abstract: This paper considers MPC algorithm for nonlinear plants using successive linearization. The prediction equation was computed via nonlinear integration. Local linear approximation of the state equation was used to develop an optimal prediction equation for the future states. The output prediction was made linear with respect to the undecided control input moves, which allowed to reduce the MPC optimization problem to a quadratic programming problem. The effectiveness of the proposed MPC algorithm is demonstrated on two nonlinear industrial examples.

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MODEL PREDICTIVE CONTROL OF AN INFRARED-DRYER

H. Abukhalifeh, R. Dhib, M. Fayed (*Canada*)

Pages 341 - 345

Abstract: For product quality purposes, the drying of some delicate materials is not easily realizable and requires a tight well-designed control scheme. This study presents control results for the drying of a thin fiber sheet moving through an electric infrared dryer. The drying process dynamics is described by a minimum realization linear model that is used to develop a model predictive controller (MPC) and test its performance. The results obtained indicate that the MPC multivariable controller is able to handle process interactions and produced good results for setpoint tracking of the humidity and temperature of the material exiting the dryer and for disturbance rejection of measured and unmeasured disturbances.

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DIFFERENTIAL GEOMETRY CONTROL OF A POLYMER REACTOR

N. Felorzabihi, N. Ghadi, R. Dhib (*Canada*)

Pages 346 - 349

Abstract: Free radical polymerization of styrene in a continuous stirred tank reactor (CSTR) exhibits highly nonlinear behaviour and requires a good nonlinear control. The linear control theory (optimal control, pole placement, H_∞–methods and popular DMC) has limited performance for nonlinear processes like polymerization reactors. Therefore, the development of a nonlinear controller is highly desirable. Using the global external linearization scheme (differential geometric approach) based on Lie-Algebra, a nonlinear controller was developed to control the polymer reactor temperature for setpoint tracking and disturbance rejections and it was demonstrated to outperform P and PI classical controllers.

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LOGISTIC MAPPING AS THE MEANS OF THE DESCRIPTION OF THE SPEECH RHYTHM IN THE VICINITY OF THE CRITICAL POINT

O.P. Skljarov (*Russia*)

Pages 683 - 688

Abstract: The concept of the speech rhythm as a sequence of duration of the segments in the acoustic signal is introduced. These segments are obtained in accordance with a principle" is a voice - is not a voice" (principle "Voice/Unvoice"). By an evaluation of Kolmogorov entropy for the empirically obtained rhythms is shown that the rhythm of normal speech is exhibiting irregular chaotic dynamics and the rhythm of samples consisting only of violations of smoothness in stutterer's speech is exhibiting regular dynamic process with a zero entropy. Thus the rhythm of speech is exhibiting dynamics of a system near to critical point. The direct evaluation of indexes of a critical behavior shows, that for exposition of dynamics of speech rhythm it is possible to use Feigenbaum scenario of route to chaos for logistics mapping with control parameter. Hopfield discrete neural net is offered to be use as neurodynamics model of a complex system with critical behavior. The total modification of the "synaptic weights" in such net during "learning" is featured by the same Feigenbaum scenario of route to chaos for logistics mapping in which parameter of "learning" in net is used as control parameter. The requirement is fixed at which both the segments of the rhythm accepted by such model and segments of the rhythm generated by this net are identical to total modification of the "synaptic weights" on the each step of the net's evolution during learning. The outcomes are used in practice of correction of stuttering in Saint Petersburg Research Institute of Ear, Throat, Nose and Speech.

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THE CONTROL OF DYNAMIC REGIMES OF THE RHYTHM WITHIN FEIGENBAUM SCENARIO OF ROUTE TO CHAOS

O.P. Skljarov, T.N. Bortnik (*Russia*)

Pages 689 - 692

Abstract: Dynamics of rate and rhythm traced in speech during correction of a stuttering is submitted in this paper. The various strategy of correction of a stuttering in dependence of behavior of rate and rhythm are detected. This trajectory has conforming to a modification of rate and a rhythm during correction. Two basic strategy are a method of "pulled speech" and the method "tunnel passage". Combination of these strategy has allowed to increase efficacy of correction of a stuttering. The outcomes are interpreted in the terms response-contingent feed-back reacting in Hopfield network. Both strategy take the explanation within the framework of the theory of control of dynamic regimes of a rhythm within Feigenbaum scenario of route to chaos.

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ROBUST RHYTHM AS A CONSEQUENCE OF THE UNIVERSAL DESCRIPTION OF COMPLEX SYSTEM DYNAMICS IN THE VICINITY OF CRITICAL POINT

O.P. Skljarov, T.N. Skljarova (*Russia*)

Pages 693 - 698

Abstract: In work the fundamental robustness property (universality) of description of a rhythm under the attitude to all variety of styles of the various speakers articulated in various conditions is considered. This universality is a corollary of critical behavior of rhythm production system. On model of an artificial neuron network of perception the equivalence of description of a rhythm both at a level of perception of speech, and at a level of speech production is established. In this paper the analogies between the mechanism ensuring universal behavior of a rhythm in range of a criticality from the point of view of theoretical physics and the mechanism ensuring constancy of speech perception from the psychology point of view on ontogenesis of child's babble toward normal speech were established.

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CALCULATION OF LOGISTICS EQUATION PARAMETER ON EXPERIMENTAL DATA WITH THE MISS

D.I. Yakushev (*Russia*)

Pages 699 - 702

Abstract: The iterative method of calculation of a logistic equation parameter on experimental data with the miss is described.

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AN INTERNET SYSTEM OF PARTNER-LEARNING SPECIAL TYPE

A.N. Poroshin, O.P. Skljarov (*Russia*)

Pages 703 - 706

Abstract: An Internet system for stuttering, correction based upon so-called partner principles is offered. In the system as a trainee as a learning models are Feigenbaum scenario of route to chaos for dynamical regimes of trainee's speech rhythm as result of both learning and/or an external feedback of various type. In the paper dynamics of speech rate and rhythm is traced during its self-correction by trainee in accordance with various methods are being developed in the system. It estimates the efficacy of various strategy of self-correction in dependence of deviation of trainee's rate and rhythm from norm.

View manuscript

SYNERGIC INTERACTION OF COMPONENTS OF RAREFIED COMB FILTRATION OF THE SPEECH SIGNAL

S.M. Petrov, A.V. Borshchev (*Russia*)

Pages 707 - 709

Abstract: At complete deleting of a part of high or low speech frequencies 100% intelligibility of speech is saved. Research of speech perception with mosaic deleting of frequency bands is more interesting. It gives possibility to estimate redundancy of a speech from the point of view of the spectral contents. We divided speech spectrum on the frequency bands with separate summation of with even and odd bands. 1 - width of even and odd bands was identical. 2 - we simulated speech percepted by the cochlear implanted patients. 3 - at a constant odd bands width we increased width of even bands so long as the speech intelligibility did not decrease from 100%. 4 - research is conducted in relation of comfortable loudness of speech with different parameters of comb filter. We found that redundancy of speech achieves 95%. Comfortable loudness of comb filtered speech depends on test bands width and period of the filter. Problem of speech perception of cochlear implanted patients and in noise background is discussed.

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