UNIVERSITY OF NIŠ
The scientific journal **FACTA UNIVERSITATIS**
Series: **Mechanics, Automatic Control and Robotics** Vol.2, No 9, 1999 pp. 999 – 1004
Editor of series: Katica (Stevanovi}) Hedrih, e–mail: katica@masfak.masfak.ni.ac.yu
Address: Univerzitetski trg 2, 18000 Niš, YU, Tel: +381 18 547–095, Fax: +381 18 547–950
http:// ni.ac.yu/Facta

A PRESENTATION OF SCIENTIFIC CONTENTS OF THE INTERNATIONAL CONFERENCE "NONLINEAR SCIENCES ON THE BORDER OF MILLENIUMS"

dedicated to the 275th Annibersary Of the Russian Academy of Sciences
Saint-Petersburg, June 22–24, 1999

In the period from June 22nd to 24th, at the University of Saint-Petersburg and at the Institute for precise mechanics and optics - Technical University of Saint-Petersburg, an international scientific conference called "Nonlinear sciences on the border of millenniums" was held. It was dedicated to the 275th anniversary of the Russian Academy of Science. The organizers of this conference were The Russian Academy of Science, the Academy of Nonlinear sciences, Saint-Petersburg's state-owned Institute of Precise mechanics and optics - the Technical University.

The scientific and program committee was constituted of well-known scientists from around the world. The participants were also from around the world.

The scientific part of the conference was held plenary and by sections, with a certain number of invited lectures.

In the plenary part of the program lectures had an overview character, and in the sections they were specialized.

The conference had the following sections:

Nonlinear mechanics and applications,
Nonlinear differential equations and analysis,
Nonlinear control systems theory,
Nonlinear methods and models in natural, technical and humanitarian sciences,
Stability and nonlinear oscillations.

Among others there were the following plenary lectures:

V.M. Matrosov: *The development of the stability theory at the Russian Academy of Science*.

A review of papers in the area of the motion stability theory development at the Russian Academy of Science published since the foundation of RAS 275 years ago is given. The classic works of Euler (18th century) on the matter of equilibrium stability of elastic rods and A.M. Ljapunov in the area of setting of method of nonlinear theory of motion stability and its applications to the problems of mechanics (19th century) are described. After that the ideas, generalized and modified function methods of Ljapunov in the 19th century are presented, and the paper also pointed out to the tasks of their further development in the 21st century and that applies both to the basic methods of nonlinear dynamical analysis of different systems, including the logical-dynamical ones, and method of analysis and synthesis of complex systems which allow hybrid defining and also many others.

He considered the basic applications of the Ljapunov's function methods in application to problems of mechanics, technology, physics, economy, in the tasks of stability preservation, controlling and projecting and similar, and especially for aero-kinetic, electromechanical,

energy and other systems.

Important problems of science, techniques of global development, no-spherical control, large-scale systems theories, intellectual support to the accepting of solutions, dynamical theories of games and many others for the research of which, the Ljapunov's function method can be applied, are defined in the conclusion.

K.F. Chernih: *Nonlinear singular theory of stability*.

This lecture pointed to the popular areas of mechanics and physics of deformable bodies through: the brittle fracture mechanics, dislocation and disinclination in crystals and the concentrated forces and moments, through comparation of approaches in linear and nonlinear setting of the problem. It points to the small number of papers in the area of nonlinear approach to this problems group and mainly through physical and geometrical sources of non-linearity. The lecturer pointed to his own results and to the results of his associates in the area of nonlinear singular theory of elasticity.

V.A.Yakibovih: *The square criteria of absolute stability of nonlinear systems.*

M.B. Ignyatev: *Vagueness and the phenomenon of adaptation maximum in complex nonlinear systems.*

The lecture takes into consideration the evolution of the problem of vagueness in science and technology since the appearance of the probability theory, through the Schredinger's vagueness principle and till the latest worked-out systems with vagueness in linguistics, mechanics, biology, chemistry, physics, numerical systems, and in the artificial intelligence systems. The research of nonlinear systems with vagueness are only starting and promise many new discoveries. In the year 1963 the phenomenon of adaptation maximum in systems which develop through degrees of freedom increase was discovered. By using the phenomenon of adaptation maximum we can explain many anti-entropic processes both in nature and in the society. In the process of interaction with a changeable environment, the appearance of random coefficients in the system of equivalent equations allows the system to conduct changes which are of such nature that the more vague coefficients there are the greater are the adaptation possibilities of the system. Considerations about the possibility of controlling such systems - the systems which make possible the keeping of such systems within the area of adaptation maximum in the current of changes through the removal of old boundaries and their integration into a collective system, are presented.

The presentation pointed out that stable development is possible only in the zone of adaptation maximum and that is possible for biological, social-economical, physical-chemical systems and systems of self-sustained reactions. In order to increase the harmlessness of system they must be kept within the area of the adaptation maximum.

On the basis of the system with vagueness a unified nonlinear theory of matter has being built, which explains the behavior of gases, liquids, rigid bodies, plasma and living structures. A unified theory of matter is being created on the basis of analysis of the transfer from one point of rest to another.

Kolesnikov A.A: *A Synergetic approach to nonlinear control systems theory*.

A new synergetic concept in the control theory, based on the fundamental characteristic of self-organization of natural disipative systems is proposed in this lecture. Invariance, self-organization, nonlinearity, optimization and synthesis appear as basic terms of the synergetic control theory developed in the lecture which determine its essence, innovations and contents.

At the basis of the synergetic approach lie two fundamental principles of nature - they are, first- the invariance principle and second - the principle of contraction (shrinking) - expansion of phase volume in dissipate dynamical systems of random nature. Based on the synergetic

concept an essentially new invariant-group approach to the analytical construction of nonlinear multi-measure dynamical objects control systems with complex interconnections, based on the idea of introduction of attracting invariant multiplicities - attractors, on which the natural (energetic, mechanical, heat etc.) properties of object consigned in the best way. Such attractors (synergy) form internal dynamic connections, as a result of what coherent collective motion in the phase space of the system appears. That permits the realization of a purposive (directed) self-organization of the collective state in dynamic systems of different nature.

In a developed synergetic approach the laws of control which take into consideration the internal interactions of concrete physical (chemical, biological) phenomena and processes are synthesized. That approach enabled a breakthrough in solving the fundamental applied problems of setting up physical (chemical, biological, social-economical) theories of control as problems of searching for general objective laws of control processes. The introduced language of invariants, as a primary element of synergetic control theory, permits the attachment of natural-mathematical unity to the theory and the establishment of a direct connection to preservation laws i.e. to basic prepositions of natural properties of objects which correspond to nature.

As the first, the new synergetic approach permits a breakthrough in the area of synthesis of continuos, discrete, selectively-invariant, multi-criterial, terminal and adaptiv nonlinear dynamical objects of different physical nature control systems with complex interconnections. Such approach found a direct application to solving of complex problems of control of nonlinear technical objects (flying machines, turbo-generators, robots, electric power suppliers, technological aggregates etc.), as well as in control tasks in ecology, biotechnology etc.

O.V. Vasiljev and V.A. Srochko*: On numerical methods of optimal control problems solving*.

This lecture considers the types of classes of problems of optimal programmed control in normal dynamical systems. A prehistory of development and advancement of numerical solving methods which are connected to the maximum principle and gradient approximations is given. The lecture also gives an overview of modern approaches to the development of numerical methods which posses the properties of improving through (the use of) effectiveness characteristics.

H. Miyagi (Okinawa): *Application of fuzzy relations to nonlinear uncertain systems*.

Fuzzy relations are well known as the tools for the description, representation and symbolic manipulation of knowledge or system uncertainty. Computational algorithms and systematic methodology of fuzzy relational equations and inequalities are engaged in their practical utilization in nonlinear knowledge-based systems, information retrieval, medical and psychological diagnosis and some business applications.

Solutions of fuzzy relation equations presented by Sanchez have been widely applied to the fuzzy inferences, system identifications, diagnosis problems etc. In company with relation equation, another important formula is relation inequality which is also used in the area of fuzzy reasoning and fuzzy problem diagnostics which is supported by the upper or the lower boundary of normal searching for solutions by the use of fuzzy relation inequality. Whatsoever, such a method depends on the solution algorithm which constitutes of several rules and that complicates everything.

In this lecture, an effective way of solving fuzzy relation equations and inequalities by introducing fuzzy operators is presented. Operator definitions are made capable of the simpler solving procedures and a method suitable for application is considered. By using the operators we get a whole set of solutions if we solve the new linear matrix equations.

V.A. Pavlov: *The phenomena of catastrophic change of shape of flying objects.*

The development of aviation technology is in connection with constant battle for the increase of speed and the reduction of weight of flying objects, and in connection with it the reduction of relative thickness of wings and the increase in the resistance of material which all led to the appearance of flexible and thin constructions, the elastic movements of which during flight can not be considered small. Taking into account the elastic movements of wings in the process of calculating their load caused the development of linear problems of aero-elasticity. Big movements also demand that the geometric non-linearities of the studied system be taken into consideration. That is especially applicable on compositional constructions such as the wing with wing fans.

As noticed by author, the forces in the hanging supports in the middle area cause the appearance of untouchable types of equilibrium, the crossing to which represents the catastrophic changes of shape of resistance (wings). The catastrophic crossings into streams can result statically or represent an oscillatory process by themselves- the oscillations of catastrophic change of shape.

... The scientific importance of the authors contribution is in the fact, that it brings essential changes in the concept of composed bodies - like rods which are composed jointly in a stream of gas, interaction and it can be formulated in the following way: The phenomenon which was theoretically and experimentally unknown earlier - the catastrophic change oscillations of composed bodies in a stream of gas, consist in the fact that bodies of prolonged shape - the type of plain rods, which have a big discrepancy between maximum and minimum bending rigidities of their transversal cuts, composed jointly by the long sides of the plain of max rigidity and which have small rigidly immobilized in one of the transversal cuts, angles between those plains, when simultaneously bent by the load of a moving stream catastrophically cross into a new equilibrium state in the area of bending movements and curling of rods, which, when the transversal suts attack angles are small, return to starting shape, forming that way an oscillatory process.

S.A. Zagezda, N.G. Filipov M.P. Yushkov: *A combined task of dynamics and nonlinear non-holonom connections of high order.*

By the use of the introduced tangential space in multiplicity's of all the possible positions of a free mechanical system, the equations of Lagrange of the second order are written in the form of vector equation, which has the shape of the Newton's second law. By the use of constraint equations up to the second order the involved tangential spaces fall apart on a direct sum of two subspaces, in one of which the component of the system acceleration vector is completely determined by constraint equations as a function of time, generalized coordinates and generalized velocities.

On the basis of introduced subspaces a definition of ideal connection is given. That definition is also concerned with linear connections of a high order. As such connections we refer to movement program, given in the form of a differential equations system. A system of differential equations is constituted in relation to the required generalized coordinated and the required control forces, which secure the fulfillment of the given program connections (non-holonom connections of high order)

When the program is given in the form of differential equation, nonlinear in relation to higher derivatives, that equation is reduced to a linear form through differentiation in time. In the process the concoction order is increased by one.

Among the section lectures the following were especially interesting:

I.V. Matrosov: *Modeling of global security and stability of world development with*

taking into consideration the bio-mass dynamics, control of BWP distribution, and scientific and technological progress.

In the lecture author described a system he proposed himself for the analysis of global security and stable development. For evaluating global stability the following indicators of the security of world development have been used: the prolongation of life, the spending of nutritional and industrial products, average social spending per capita in the world, pollution level and the bio-mass of plant inhabited part of land which remained at the end of the 21st century as a natural resource. If the higher values (in the case of pollution lower) are the border of permissibility, then the global system of world developments in the state of security, but if one of the inequalities is disturbed we talk about the disturbance of the security conditions.

System is set up on the basis of the model of D.Medous World 3.91 written in program language C++.

Additionally the following things are taken into consideration in the system:

- The control of the total world bruto product - time constants which take into consideration the time of making certain branches are introduced into control equations.
- Dynamics of change of the plant inhabited land bio-mass dependent on the pollution level.
- In the economic specter the science progress equation is introduced (by using the results of S.V. Dubrovski).
- The artificial cleaning of air
- The conquest of new types and the regeneration of non-regenerative resources.
- The political tension in the world in dependence on the remaining non-regenerative resources, quantity of nutritional products per capita, pollution and population density.
- Model contains around 300 mathematical dependence (differential equations and algebra relations) some from the published literature, and some worked out by workers

By the use of the worked out system a number of scenarios of global development has been studied including both the known (depleted resource crises, ecological and demographically) and the qualitatively new. Author has been specially noticed that the scenario of Meduzov D. "A stable society" can lead to a global collapse, if the listed additional factors are included.

Within the boundaries of the proposed models a scenario called "A stable development" was found, and that scenarios property is that it is not destroyed when small disturbances of the system parameters appear. The basic thing in that scenario is the use (20 to 40%) of the bruto world product for control. The work was carried out on a Pentium II computer, with C++ Builder.

Harold SZU (University of George Washington: *Non-surveying learning sensors in nonlinear sciences*.

Starting from biological systems and the basis of sensory learning, the author makes conclusions which he uses to make artificial systems which learn by using sensor and on the basis of informational data and introduces Ljapunov's function for the study of such systems. The lecture caused a very vivid discussion and many doubts about the reexamination of the statements and introduced prepositions of the presented theory.

Al.A. Kolesnikov*: Directed self-organization and controlling of objects with chaotic attractors*.

V.V. Baranov: *The equilibrium method in problems of dynamic solution accepting in vagueness.*

C.N. Vasiljev: *From classic problems of regulation to intelligent control.*

P.E. Tovstik and V.Ju. Anisimov: *On one model of crack growth.*

V.A. Shamina: *On asymptotic method of setting up nonlinear models of continual environments mechanics.*

A.O. Bochkarev: *MGE of Geometrically Nonlinear Problems of Fracture Mechanics*.

A.V. Bushmanov: *The Analysis of Tension-deformational State of Biomechanical Systems.*

A.A. Tikhonov: *On Nonlinear Oscillations of Gravity-oriented Rigid Bodies*.

F. Wegmann and F. Pfeiffer (Germany): *The Textile Threads Dynamics*.

Katica (Stevanović) Hedrih (Yugoslavia): *Differential Equations of Two Material Particles Dynamics Constrained with a Hereditary Element*
and a 20 minute long, improvised speech *On Some Research Directions and the Integration of Scientific Knowledge in the are of Nonlinear dynamical Systems.*

At the opening, while presenting the list of countries the participants come from, and among them Japan, France, USA and others, academician Meljnikov said "The Heroic Yugoslavia". With one keyword he expressed the feelings of organizers towards Yugoslavia and her people, as well as the reputation Yugoslavia and her people got by the magnificent and proud resistance to NATO aggression.

In the concluding part of the closing session of this international scientific conference a scientific discussion developed on perspectives of development of sciences that deal with nonlinear dynamical processes, a especially connected to nonlinear processes and stability in social systems, in the course of which the perspective of civilization on Earth as a nonlinear system was analyzed - "noosphere" with all the properties of intellect and other resources of that systems dynamics. On that occasion the support was given to "The Heroic Yugoslavia and Her People" in resistance which is a contribution to ways of better and more humane system of values of civilization on Earth. I was given the floor and in my speech I pointed to the dangers of monopoly control and the system of deciding "by the power of wealth" and about the need for the limitation of those powers by the "force of the power of conciseness, moral and ethics", as well as that we by our heroic resistance gave the UN again the chance to make decisions, which must not be missed by the more powerful in numbers and militarily stronger. All these speeches at the closing ceremony were held in the frames of scientific discussions and elements of nonlinear dynamical systems, bat there were also present open sympathies for the Yugoslav people and its proud behavior and resistance.

The president of the scientific committee academician Matrosov held a scientific speech on perspectives scientific research on global level in the area of nonlinear sciences from the aspect of modeling of social processes, Earth's resources, and global nonlinear dynamical, intelligent system on Earth - "noosphere", and which will also be in the content of his speech at the, at that time -future, World Conference on Science in the Third Millennium, held in Budapest one week after the end of our conference (from June 29th to July 2nd 1999), and in the work of which he participated as a scientist - a member of the Russian state delegation.

Katica (Stevanović) Hedrih