

METHODS OF SOLVING FUZZY SYSTEMS OF LINEAR EQUATIONS. PART 1. COMPLETE SYSTEMS

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Abstract. It is noted that fuzzy systems of linear equations (FSLE) arise when solving fuzzy initial problems, fuzzy partial differential equations of the first order; when processing hybrid data in stochastic systems by the method of least squares or of maximum likelihood estimation; when using the fuzzy Laplace transform to solve fuzzy differential equations of high order; when using the approximate methods of solving fuzzy integral Fredholm-Volterra equations of the 2nd kind; when fuzzy interpolation and fuzzy splines are applied to data processing; when solving fuzzy optimal control problems. The basic methods of solving complete FSLE are considered: inverse matrix, span and ST decomposition, in which fuzzy elements have triangular membership function; cuts, in which membership functions of fuzzy elements are not necessarily triangular; crisp solutions, in which left and right branches of the membership function of fuzzy elements are in the polynomial form. The application of the methods is illustrated by computational examples. Using the least squares method for the model with fuzzy basis functions and the method of fuzzy Gram-Schmidt orthogonalization, the problems are formulated and solved of fuzzy estimation, in which complete FSLE appear. To illustrate the solution of these problems, two fuzzy basic functions are considered: a fuzzy unit and a fuzzy linear dependence.

Keywords: complete fuzzy system of linear equations, fuzzy methods of solving complete fuzzy systems, fuzzy estimation, fuzzy orthogonalization.

PLASMA CONTROL IN TOKAMAKS. Part 3.2. Simulation and Realization of Plasma Control Systems in ITER and Constructions of DEMO

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Abstract. Experimental testing of ITER scenarios on DIII-D (US) and WEST (France) tokamaks, approaches to simulation and realization of plasma control systems in ITER, preparation of ITER plasma control systems for starting and exploitation are presented. The road maps, which are known in Europe, for development and creation of the first fusion power plant DEMO (the next step after ITER) are shown. These maps give two directions of DEMO development: (i) conventional tokamaks with relatively large aspect ratio and (ii) spherical tokamaks of modular type allowing to notably reduce the time of DEMO creation and to get competitive cheap electrical energy. The basic trends in DEMO poloidal systems design are given, and the initial version of DEMO plasma vertical position control system is presented.

Keywords: tokamak, plasma, plasma magnetic control, ITER, DEMO constructions.

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CONTROL SYSTEMS CLASSIFICATION

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Abstract. Control systems classifications are considered to be built on the basis of: type, target and design of control, control object (CO) model, time, CO properties change over time, dimensions of inputs and outputs, disturbances, uncertainty, number of CO, ability to adopt to changes, state of distribution of a single CO, CO structure, number of control systems (CS), CS structure, connections between control and controllable systems, CO autonomy, knowledge use, manifestations of strategic behavior. As additional classification categories, it is suggested to base on: control means, nature and «sectoral» specifics of CO, and functional properties of CO and CS as well.

Keywords: control system, control object model, uncertainty, structure, optimization, strategic behavior.

A MODEL OF MANAGING BUSINESS CONSTRAINTS

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Abstract. A model of hierarchical system of the Center – agent type is considered, in which the Center manages the set of agent's choices. A model of such a system is a hierarchical two-person game with forbidden situations. In this game, the Center selects some subset of the fixed set, while the agent selects his control from this subset. The agent's payoff explicitly depends only on his own choice, while the Center's payoff depends both on the agent's control and on its own choice. The dependence of the Center's payoff on its choice is assumed to be monotonic with respect to relation of inclusion on the set of its strategies. The tasks are set of calculating the maximum guaranteed result of the Center under the assumption of the benevolence of the agent and without such an assumption. A new definition is proposed of the maximum guaranteed result of the Center in the game with a benevolent agent, staying correct also in the case when the maximum of agent's payoff is not reached for some of Center's strategies. The equivalence of this definition to the classical definition of Stackelberg is proved in cases when the latter is correct. In general case, the problems posed assume the calculation of maximin with connected constraints on complex infinite-dimensional spaces. Methods are proposed that significantly simplify these problems. For the case of a finite basic set, algorithms are proposed that allow solving the problem in a polynomial time with respect to the number of elements of this set. For the case of an infinite basic set, the problem is reduced to solving a sequence of ordinary optimization problems. The methods proposed allow to build and explore many meaningful models of such type.

Keywords: institutional control, games with forbidden situations, decentralization of control.

**STRUCTURE OF RUSSIAN ECONOMIC COMMUNITY AND ITS ATTITUDE TO
RUSSIAN ECONOMIC JOURNALS. Part 2. Analysis of Respondents Patterns**

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Abstract. This article is the second part of the study of the Russian economic community on the basis of an analysis of a survey of the Russian economists and their opinion on Russian scientific journals on economics. Patterns characterizing the representation of structure of the Russian economic community were constructed. It turned out that the views of the majority of respondents about the structure of the Russian economic community correspond to their own distribution of working time between teaching at universities, academic research and expert-analytical work. In addition, this distribution also affects economists' evaluation of scientific journals on economics.

Keywords: economic community, economic journals, pattern analysis.

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APPLICATION OF DETERMINISTIC AND STOCHASTIC MODELS FOR REPLACEMENT OF INDUSTRIAL ENTERPRISES EQUIPMENT

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Abstract. It is noted that solving the problem of rational use and replacement of the equipment is one of the key issues of increasing the work efficiency of the industrial enterprise in modern conditions. Stochastic and deterministic models are described allowing to make decisions on equipment replacement using the language of network modeling and dynamic programming algorithms. The generalizing algorithm is proposed of the equipment replacement and the importance is shown of the accounting for the uncertainty factor while solving the problems of this class. The results obtained can be used to construct an optimal strategy for replacing equipment at industrial enterprise. The algorithms proposed can become an integral part of the mathematical support of information and analytical systems of industrial enterprises.

Keywords: equipment, equipment replacement, investment, investment policy, dynamic programming, strategy, modeling, stochastic modeling, network modeling.

RELAXATION METHODS FOR NAVIGATION SATELLITES SET OPTIMIZATION

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Abstract. Convex relaxation methods are commonly used to solve nonconvex mathematical optimization problems. These methods transform the original nonconvex problem in such a way that effective methods of solving convex optimization problems become applicable. Thus, a convex problem giving the approximate solution of the original task can be solved instead of the original computationally complex problem. Presented is the application of semidefinite relaxation to the task of determining the optimal set of Global navigation satellite systems signals that are selected for processing while solving the positioning problem. The need for signals set optimization is due to large number of navigation satellites accessible for the customers on the ground level. This binary optimization problem is hard to solve in real time. Two approaches are proposed to reduce the initial problem to the convex problem allowing the effective solution.

Keywords: satellite navigation, semidefinite programming, SDP, second-order cone programming, SOCP.

LOOSE COUPLING OF INERTIAL AND SATELLITE NAVIGATION MEASUREMENTS WITH THE AID OF EXTENDED KALMAN FILTER WITH ATTITUDE QUATERNION

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Abstract. It is noted that the observation vector of the proposed coupling filter contains only antenna coordinates, measured by GNSS receiver. The errors of the attitude quaternion are considered as a small rotation vector which is used to construct an a-posteriori attitude error quaternion. The error quaternion is used for multiplicative correction of an a-priori estimate of an attitude quaternion obtained by solving inertial navigation equations. A-priori estimates of the remaining components of the filter's state vector are corrected in an additive way. An experimental testing results of the coupling filter are provided. A numerical observability analysis of the filter's state vector on experimental trajectories has been performed.

Keywords: navigation data coupling, loose coupling, extended Kalman filter.