REVIEW OF THE WORLD MARKET OF AGRICULTURE ROBOTICS. Part 1. Unmanned Vehicles for Agriculture

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Abstract. The overview is presented of the global market of unmanned agricultural vehicles and robotic devices and complexes used in various areas of agriculture. The main lines in application of agricultural robots and the feasibility of their introduction into agriculture along with traditional methods or in exchange of them are highlighted. The data on the concepts and developments of unmanned tractors and their equipment are given. The main market players are considered and promising technologies are described for unmanned agricultural vehicles, robotic devices and complexes in crop production and animal husbandry. Agricultural robots are identified and described: robot weeders, thinning robots, harvesting robots, robots for performing operations in vineyards and gardens, self-mobile monitoring robots, and robots for animal husbandry. The advantages of using robots in each of the areas, as well as trends in technological innovations, are identified. Conclusions are made about the prospects of the global market of agricultural robotics and about its positive impact on agriculture in terms of economics, technology and ecology.

Keywords: robot, agriculture, robotics market, autonomous tractors, robotic devices.

METHODS OF SOLVING FUZZY SYSTEMS OF LINEAR EQUATIONS. Part 2. Incomplete systems

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Abstract. The methods of solving incomplete fuzzy systems of linear equations (FSLE) are described using the extension of the original system in the case when it is low dimensional. It is noted that in the Friedman embedding method the fuzzy system is immersed in the traditional one, which can be solved using the traditional methods of linear algebra. The peculiarity of the doubled in the sense of dimensionality traditional system of linear equations is determined by the structure of its matrix. Like in solving the complete FSLE, here too the strong / weak solutions appear. The doubled Friedman embedding method is used to solve the doubled FSLE, which arise in solving the Volterra – Fredholm equations. The Ezzati embedding method is a chain of obvious relationships. The Abbasbandy embedding method is valid when the right-hand side of the FSLE is represented by a vector, each component of which has the membership functions in the form of an isosceles triangle. The main advantage of the center method is the non-use of the augmented matrix and the absence of restrictions on the symmetry of the membership functions of the components of the FSLE right-hand side vector. Methods described are illustrated by examples of solving the problem of fuzzy interpolation and of fuzzy linear regression. In a case of a significant FSLE dimension, the sets of iterative methods are considered for solving them, based on the Q–T-decomposition of the initial matrix S of the extended FSLE, when decomposition (splitting) of the matrix S into two matrices Q and T is performed. It is noted that depending on how the matrix Q is specified, there is a set of iterative methods. In the Richardson method, the matrix Q is assumed to be the unit matrix, in the Jacobi method, the matrix Q consists of the diagonal elements of the matrix S, in the Gaus – Seidel method the matrix Q is formed from the elements of the lower triangular or upper triangular matrix S. The HSS method uses Hermition-Skive splitting of the matrix S. The methods of obtaining the pseudo solution of FSLE are described and the traditional methods of linear algebra of obtaining pseudo solutions are listed.

Keywords: fuzzy systems of linear equations, fuzzy interpolation, fuzzy linear regression, fuzzy iteration methods, fuzzy pseudo-inversions.

QUASI-TERMINAL CONTROLLERS SYNTHESIS

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Abstract. In the class of linear algorithms of linear stationary multi-connected objects control the subclass is distinguished of quasi-terminal algorithms with implicit aiming at the boundary conditions moving along the program of the required change of the state vector coordinates and being at a fixed interval from the current time. Aiming is realized by calculating the programs of changing the future control vector components in the form of power series segments that depend on the future time and provide a solution of the two-point boundary value problem. In idealized model conditions of the complete controllability and the availability of an accurate information about the control object state and equations, as well as of the instantaneous and accurate implementation of the calculated commands, the quasi-terminal algorithm provides the asymptotic stability of a closed multi-connected system and as high pre-set rate of transients convergence as needed, regardless of whether the control object model is stable. The relatively simple and easy to implement in MATLAB non-optimization method of algorithm synthesis is suggested based on the use of the matrix representation of the control object model in the state space and of the apparatus of exponential functions of matrices. Quasi-terminal algorithms can be used in multi-connected stabilization systems and, in particular, in stabilization systems of mobile terminal objects with respect to trajectories calculated by the terminal control system.

Keywords: terminal control, predictive model, asymptotic stability.

THE PRINCIPLE OF PERMISSIBLE INTERVALS AND EXTREME CHALLENGES IN ADJUSTMENT FOR MACROECONOMIC SYSTEMS

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Abstract. The article substantiates the fruitfulness of the application of the principle of permissible intervals for the study of dynamics of macroeconomic systems. On the basis of achievements of predecessors, the authors trace the cognitive trend, in which the formulation and solution of traditional extreme problems associated with the optimization of the values of key macroparameters becomes insufficient – this is only the first step to identify the range of acceptable, sustainable values of those parameters. The application of the principle of permissible intervals is illustrated by the example of such a key indicator as the annual inflation rate for the Russian economy for the period 2001–2018. Based on the regression analysis of time series, middle-run trends are constructed, expressing the functional relationship between the annual rate of inflation and some macroeconomic parameters. Comparing the obtained extreme points, we come to the fact that the permissible values of the annual rate of inflation should be maintained, tend to lie in the range of 7,38% and 16,10%. In addition, studying the middle-run dependencies between the inflation rate and annual GDP increments found by the method of moving intervals, we combine the extreme points of the middle-run trends into one dynamic series and find a long-run envelope of those trends. In conclusion, the connection of the principle of permissible intervals with the tasks of ensuring the stability and security of economic

systems is discussed, the advantages of this principle in comparison with the traditional optimization problems are shown, and the directions of further research in this area are outlined.

Keywords: principle of permissible intervals, economic dynamics, regression analysis, macroeconomic adjustment, rate of inflation, economic growth, extreme challenges.

MODELING OF SCENARIO DEVELOPMENT OF RURAL TERRITORIES BASED ON FUZZY COGNITIVE MODEL

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Abstract. Application of cognitive modeling to such complex semistructured social and economic systems as rural territories is considered. The fuzzy cognitive model of complex development of rural territories is developed, a set of significant parameters (concepts) of model is determined in backbone spheres of activity, such as social, demographic, economic, institutional and ecological. The technology of modeling is complemented with authors' techniques of parametrical identification of fuzzy cognitive maps and its scenario analysis on the basis of fuzzy model of pulse process. On the basis of the structural and target analysis of system indicators of the fuzzy cognitive map its defined that the greatest impact on target concepts and a system in general is made by factors of the institutional environment, such as development of market infrastructure and rural self-government, which defines them as the most effective applications of the operating influences. The results of scenario modeling of model of complex development of rural territories allowing planning and quick estimation of development of a territorial recreational system in the conditions of the fast-changing external environment are presented. Results of the research can be used by state authorities of agro-industrial complex on all levels for forming effective strategy and developing programs of social and economic development of rural territories.

Keywords: complex development of rural territories, cognitive modeling, fuzzy cognitive model, semistructured systems, structural and target analysis, scenario analysis.

ADAPTIVE ALGORITHM OF QUASI-STATIONARY PERIODIC PROCESSES MEASUREMENTS CONTROL

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Abstract. The aim of the work was to create an effective method of control of linear measuring systems functioning in the conditions of the prevailing influence of distortions caused by variability in time of measuring conversion parameters. The method and the algorithm of control of measurements of the quasi-stationary periodic process spectrum in frequency-domain and form in time-domain are presented, consisting in the simultaneous separate observation of the parameters of the process under probe and the parameters of the measuring system with the subsequent introduction of corrections. The control of system parameters is carried out using the artificial stationary polyharmonic sample impact. The spectra of the main and sample processes are not intersected. A synthesizing method of the form in time-domain of the sample impact process is presented. The main limitations and the range of conditions for the possible application of the

method are determined, its effectiveness is shown on the example of the experimental data obtained during the low-frequency inductive electrical prospecting system functioning in alternating magnetic field measuring mode.

Keywords: measurements control, conversion parameters control, adaptive correction, quasi-stationary periodic process.

MATHEMATICAL MODELING OF ANTITUMOR VACCINE THERAPY CONTROL

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Abstract. The results are presented of exploring the different strategies of applying the antitumor viral vaccines using the mathematical modeling. The model describes the two stages of the tumor cells' death as a result of immune response to the introduction of the viral vaccine. The results are obtained by performing the computing experiment using in the MatLab-Simulink system complex. The analysis of the results obtained has shown that the tumor size at the beginning of the treatment requires the calculation of the appropriate dosage to perform the effective strategy of vaccine introduction control. As the result of the computing experiment, the doses of the viral vaccine and the moments of its introduction are determined that provide the complete elimination of the tumor cells with the single injection. However, the complete recovery with the single introduction of the viral vaccine is possible only for the small-sized tumors. It is shown that the strategy of restraining the tumor in its pre-treatment size is to be implemented by periodic re-introduction of the vaccine. The doses and the intervals between the introductions are calculated based on the tumor size at the beginning of the treatment. The strategy of suppressing the tumor growth until complete elimination of the tumor cells is performed by reducing the time intervals between recurrent vaccine introductions. The dosage, the initial interval between injections, and the duration of the treatment are also calculated depending on the tumor size at the beginning of the treatment.

Keywords: mathematical model, tumor cells, antibodies, vaccine introduction moment, vaccine effectiveness, immune response, virus, vaccine therapy.