Andrianov S. N., Artamonov S. A. **An optimal algorithm and programs for isochronic magnetic field designing on the base of static equilibrium orbits for accelerators with azimuth variations.**

An effective algorithm for designing a magnetic field ensuring both motion stability and isochronism of particle acceleration at full range of radii is discussed. The procedure for optimal designing the isochronic field in accelerators with azimuth variations is considered. The procedure for optimal designing the isochronic field in accelerators with azimuth variations is considered. The algorithm is realized on Fortran for two possible variants of magnetic field periodicity: with the period $T = 2\pi/N$ and superperiod $T = 2\pi$. For this purpose the authors use a special procedure for finding static equilibrium orbits and evaluation of the accelerated particle period. As an attendant results we obtain both radial and azimuth frequencies defining motion equilibrium and other parameters being of practical interest. The corresponding packages are absolutely autonomous ones, and can be realized using any programming platforms. This algorithm is characterized by some properties which allow us to realize it in a special coordinate system used by experimental physicists and the motion equations are not linearized. All necessary field, amplitude, phase derivatives and so on are numerically evaluated according to the five-point scheme, and in intermediate points we produce the quadratic interpolation for field map data.

Key words: isochronic magnetic field, static equilibrium orbits, accelerator with azimuth field variations, optimal algorithm.

Eremin A. S. **Modification of the theory of labelled trees for the structural method of solving systems of ODEs.**

The deirvation of equalities, connecting parameters of Runge–Kutta type methods and providing a certain order for an approximation of the exact solution, is quite a cumbersome task. It can hardly be done for high order methods. The theory of labelled trees by J. C. Butcher and E. Hairer allowed automatisation and computer realisation of the process. It can be efficiently applied to many one-step methods. However, for a group of methods named *structural* its direct application is impossible because of their algorithmic peculiarities. In the present work a necessity of such theory for structural methods is demonstrated, the theory is modified for case of structural methods and algorithm of order conditions derivation is presented.

Key words: ODE, Runge–Kutta, order conditions, labelled trees.

Kvitko A. N. **About one algorithm for solving a boundary problem for a nonlinear delay controlled system.**

While designing the control systems of different mobile objects (such as aircrafts, robot-manipulators, gyroscopic systems, etc.) in a real time and their modeling one should take into consideration the fact that the control action to the control object occurs with some delay towards the moment of time when the control signal was generated. This is caused by the response rate of the executive elements of the control systems. This fact makes it necessary to add control functions with a lagged variable into equations of control objects motion. Some of the most significant and complicated aspects of the mathematical control theory are problems that are connected with the search of the constructive design methods of control functions with a delayed argument, when solutions of different classes of ordinary differential systems connect given points in the phase space. At the same time the theory of the boundary problem solving for nonlinear systems subject to the delay of general control is being in the process of its development and is facing a number of difficulties. The following article has been focused on the development of simple enough algorithms

from a numerical implementation point of view. These algorithms find synthesis solutions of the specified problem for a wide class of nonlinear control systems subject to constraints of the control and phase coordinates. The above objective has been achieved by reducing the initial problem to a problem of continuous stabilization of linear nonstationary system of special form and the following Cauchy problem solving for the supporting system of ordinary differential equations.

Key words : boundary conditions, phase coordinates, control functions, stabilization.

Korobeynikov A. I. **Comparison of parameter estimates for one special model of survival curves for sample with interval censoring.**

In practice time to event data cannot be observed directly. Usually, one can only know some time interval, where observation lies in, thus data became censored. The mixed case interval censoring is one of the most important models of censoring seen in the practical applications. We consider the problem of parameter estimation for one special survival curve model in these conditions of censoring. In particular, we propose new parameter estimator based on non-parametric estimater of distribution function. The computation procedure is described as well. Large sample properties of this new estimator such as consistency, efficiency, robustness in presence of outliers are studied on model samples. All these properties are compared with the same properties of ordinary maximum likelihood estimates. It was found, that compared to maximum likelihood estimates proposed estimates have slightly bigger variance. However, they possess better robustness properties, when sample contains some amount of outliers.

Key words: survival, interval censoring, parametric estimates, maximum likelihood estimates, robustness.

Latypov V. N. **Automatization of solution of ordinary differential equations.**

One of important topics in modern applied mathematics is the automatic creation of generic numerical integration procedures for ordinary differential equations. Usually these procedures are based on automatic differentiation. In the present paper other algorithms suitable for systems with polynomial right-hand sides are considered. The system for automatic generation of computational procedures implementing time-stepping integration schemes based on Taylor series method and Poincare's small parameter method is proposed. Step size detection using known error estimates for the solutions of polynomials systems can be implemented. For the small parameter method considered in the article all the required formulae allowing to automate the calculation of arbitrary order approximation are derived. The following two tasks are considered : rotational motion of the artificial satellite around its mass center and the periodic solutions of the Lotka–Volterra system.

Key words: differential equations, automatic programming, Taylor series, small parameter method.

Makarov A. A. **One variant of spline wavelet decomposition of B-spline spaces.**

B-splines of third degree are investigated in the paper. The approximation relations are regarded as a system of linear algebraic equations. The right part of the system is equal to vector-function which is called spline generating vector-function. Polinomial generating vector-function $\varphi(t) = (1, t, t^2, t^3)^T$ is regarded in the paper. The obtained polinomial splines are twice continuously differentiable and have the minimal compact support. The procedure of polinomial spline normalization is shown in the paper. The normalized polinomial B-splines of third degree are constructed. The system of biorthogonal linear functionals to B-splines is constructed in the paper. The solutions of some interpolation problems generated by the mentioned biorthogonal system are derived in the space of B-splines. Calibration relations connected with refinement of grids are established. They gives representation of B-splines for initial grid as a linear combination of B-splines for refined grid. An embedding of B-spline spaces is established for arbitrary refinement of grids. Telescopic systems of B-spline spaces are obtained. Using of the biorthogo-

nal system of functionals allows to construct wavelet decomposition of telescopic system in the case of sequence of refining irregular grids. The obtained wavelet basis has compact support. Formulas of decomposition and reconstruction are done. The mentioned formulas are easily parallelized.

Key words: approximation theory, splines, wavelets, data compression, parallel algorithms.

Matrosov A. V. **A numerical-analytical algorithm of a method of initial parameters for the analysis of long bearm on an elastic foundation.**

A computational instability of a traditional algorithm of a method of initial parameters for the analysis of long elastic beams on an Winkler foundation is investigated. A series of computing tests which results have shown ways to overcome a computational instability of a traditional algorithm by increasing a number of intervals in a decomposition of a beam along its length and a number of terms in power series for unknowns has been carried out. However, that approach does not always lead to stable calculations. In these cases calculation with increased stagnant part of the number for reals allows to get reliable results. A numerical-analytical algorithm of a method of initial parameters which does not need a decomposition of a beam along its length on short intervals of integration is proposed. To ensure its convergence and computational stability it is necessary to keep a sufficiently great number of terms in power series for unknowns, and as in case of a traditional algorithm of the method to calculate with increased stagnant part of the number for reals. The benefit of this algorithm in comparison with the traditional one is that a solution is built along the whole length of a beam but is not glued from Cauchy problem solutions for small intervals. The results of numerical experiments on investigation of an influence of a length of a stagnant part of number on numerical stability of the algorithm are presented. All algorithms are realized in the system of analytical calculation Maple which allows to organize calculation with an arbitrary number of digits in a stagnant part of a number and suggests a large set of graphical functions for presenting the results.

Key words: beam on elastic foundation, boundary problem, numerical-analytical algorithm, computational stability.

Ovsyannikov A. D. **Control of charged particles beam with consideration of their interaction.**

The paper is devoted to the problem of the optimization of the dynamics of intensive beams of charged particles in accelerating and focusing structures. A mathematical model of mutual optimization of program and disturbed motions of beam of interacting particles is suggested. This mathematical model includes integral-differential equations that in essence are analogs of Vlasov equations allowing to take into consideration interactions of particles and thus to determine self-consistent motion of charged particles beam in external field. Parameters of accelerating and focusing fields is necessary to determine as a result of the optimization of functionals characterizing charged particles beam dynamics. The paper examines a variation of a functional based on the approaches of theory of optimal control. Analytical representation of the representation of the first variation with use of auxiliary (conjugated) functions is found and optimality conditions in the form of principal of maximum by Pontryagin are formulated.

Key words: modelling and optimization, charged particle beams, control processes.

Ossipkov L. P. **Stochastization in homogeneous graviplasmas.**

We discuss a time-scale of divergence of nearby trajectories for steady gravitating systems (a stochastization time). Following Gurzadyan–Savvidy's paradigm we need to know an average square of a random force to estimate this time. Truncated Holtsmark's distribution must be used for this purpose for homogeneous systems. It is found that if a truncation radius is equal to $4Gm/\sigma^2$ (that means neglecting close encounters) then a ratio of a stochastization time to crossing time does not depend on N, a number of particles. The latter coincides with results of a study by Rastorguev

and Sementsov and N-body simulations by Kandrup and others though contradicts to conclusions by Gurzadyan and Savvidy. Taking into account close encounters we found (in accordance with Rastorguev and Sementsov) that then a ratio of time-scales is proportional to $N^{1/5}$. We conclude that a hierarchy of time-scales of collisional relaxation exists for gravitating systems.

Key words: stellar dynamics and celestial mechanics – stellar systems: evolution – methods: analytical.

Pronina Yu. G. **Concentrated forces and couples in an elastic half-plane with a hole.**

The plane problem of the theory of elasticity for the linearly elastic semiinfinite plane with a free-form hole bounded by a smooth contour is investigated. The half-plane is considered to be subjected to the tension at infinity, external load at the rectilineal boundary and at the surface of the cavity. Concentrated forces and moments are also supposed to be applied at points within the body involved. The problem has been formulated using the Kolosov–Muskhelishvili complex stress potential technique. Results have been obtained by the superposition of two auxiliary problems. The first of them is the problem of the intact half-plane (without a hole) under given outside load at the straight boundary, at infinity and under known concentrated forces and couples. The second one is the problem of the intact half-plane under unknown inside load (applied at points within the body) to be defined. Complex potentials for single forces and moments and for distributed forces at points within a semiplane being used, the solution found thoroughly satisfies boundary conditions at the straight-line border of the half-plane and at infinity. For the surface of the cavity resolving Fredholm integral equations of the first kind in unknown load are derived. Further the problem has been reduced to the system of linear algebraic equations. Moreover the formulas for periodic load at the rectilinear edge and periodic forces and couples at points within the elastic semiplane with a hole has been written. The results obtained can be easily adapted to the problems of different types of singularities at any cavity within the elastic half-plane. A worked out example for the semiinfinite plane with a circular cut is presented, the single force being applied near the cut in the direction normal to its surface and to the straight-line boundary of the half-plane. Some details of the numerical implementation of the method proposed is discussed. It is found that increase of the radius of curvature of the boundary leads to the stress growth in that area.

Key words: elastic half-plane, hole, concentrated forces and couples, stress concentration.

Strokan P. V., Matsuhisa T. **Informational equilibrium in communicational systems.**

In this paper authors present early considered mathematical model of communication process between several players, based on the model of awareness and belief. There are no restrictions on players' knowledge in presented model as those in the standard model with a partition information structure. The main result is the creation of software that models a described communication process and consideration of a control example calculated on paper and with the use of a computer. Software was developed using Java 5 language for algorithm realization and Swing library for user interface. Using these technologies provides us to use application on different software and hardware platforms. Algorithmic part was build using a dependency injection pattern, that gives us ability for customization on the other similar models. In fact, authors developed a calculation library. This software can speed up further research and adaptation of the model to real processes.

Key words: awareness, belief, communication process, consensus, protocol, agreeing to disagree, computer modeling.

Tulupyev A. L. **Probabilistic estimates consistency in conjuncts and disjuncts ideals.**

Algebraical Bayesian networks (ABN) belong to the same class of probabilistic graphical modes of knowledge pattern bases with uncertainty as Bayesian belief networks (BBN) and Markov networks (MN) do. The general idea incorporated in these probabilistic networks architecture and inference algorithms is that domain knowledge can be decomposed into relatively small knowledge

patterns (KP); in turn, these knowledge patterns can be interlinked though any KP can have just a few links with others. Interlinked knowledge patterns make a knowledge patterns base (KPB). From the viewpoint of their local structure, Algebraical Bayesian networks differ from other probabilistic networks with the mathematical model for the knowledge pattern representation. The model is based on a conjuncts ideal with either scalar or interval estimates of their probabilities. *The paper goal* is to analyze a conjuncts ideal with estimates of their probabilities as a knowledge pattern mathematical model used in the theory of ABN as well as to give concepts for and make study of reconciliation of the model and *a priori* inference in it. An alternative KP model based on disjuncts ideal will have similar consideration. At the beginning, the paper provides a set of definitions that allows for later usage of the matrix-vector formal language for representation of the objects and operations under consideration. In particular, an ABN knowledge pattern is represented with a specially ordered vector of conjuncts probabilities. The elementary outcomes space (each elementary outcome is referred to as a quantum proposition) is represented with another specially ordered vector of their probabilities. These two vectors can be mapped to each other with invertible linear mappings. The matrices corresponding to the forward mapping and its inversion have been explicitly specified with the Kronecker matrix degree; the formulae for generating the matrices elements are also given. Probabilistic logic axioms can be applied to quantum propositions immediately; subsequent restrictions on the quantum proposition probabilities can be expressed with the matrix-vector language. Appropriate variable substitutions in these restrictions lead to the matrix-vector inequality for scalar probabilistic estimates of conjuncts. The set of these estimates is consistent if and only if the inequality is true. In case of interval estimates, the initial data and the inequality form a set of linear programming problems with conjunct probabilities considered as the problem objectives. If a problem happens to be infeasible, the initial data are inconsistent; otherwise, the interval estimate can become narrower (i.e. more precise). Thus, verification and reconciliation of an ABN knowledge pattern renders to solving a set of linear programming problems. The probability of any propositional formula can be expressed as a linear function of conjunct probabilities. If conjuncts probabilities estimates are given, the probability estimate of this formula can be inferred. This procedure is referred to as *a priori* inference, it also renders to solving a set of linear programming problems. An alternative knowledge pattern model based on a disjuncts ideal can be considered with the same technique: the model verification and reconciliation as well as *a priori* inference in it render to the same types of calculations: either to matrix-vector transformations, or to solving linear programming problems in case of interval initial estimates. The proposed approach to the representation of conjuncts (or disjuncts) ideals and inference with them comes from a clear and precise probabilistic semantics of the corresponding knowledge patterns: a consistent knowledge pattern with scalar probabilistic estimates refers to a single probabilistic distribution over quantum propositions, a consistent one with interval estimates refers to the family of such distributions, and an inconsistent one refers to an empty family of distributions. The latter two cases are forbidden in traditional calculus of Bayesian belief networks and Markov networks.

Key words: probabilistic graphical model, knowledge uncertainty, knowledge pattern, Bayesian network, probabilistic logics, inference, interval estimate, consistency.

Chashnikov M. V. **On the uniqueness problem of Lyapunov matrix: a multiple delay case.**

The method of Lyapunov functionals is top-ranked for stability analysis of time-delay systems. Lyapunov matrix plays the key role for the construction of quadratic Lyapunov functionals for linear system. Originally, Lyapunov matrix was defined by means of a fundamental matrix of the initial system. In this article we use an alternative definition of Lyapunov matrix. This definition does not need the knowledge of a fundamental matrix. It allows to reduce the problem of search of the Lyapunov matrix to finding the special solution of a linear system without delay. Previously, the case of single delay systems has been studied. The uniqueness condition of Lyapunov matrix was

established in the terms of characteristic function's roots of the initial system. In the present article the uniqueness conditions was generalized for a differential system with multiple delays.

Key words: Lyapunov matrix, linear time-delay systems.

Chashnikov N. V. **Composite parametric Coons patches.**

Various methods of surface modelling have been developed in the theory of Computer Aided Geometric Design (CAGD). One of these methods which was invented by Coons is based on building a surface patch interpolating four given boundary curves along with the first derivatives. One can fill in a given network of curves by composing several Coons patches together. It gives a possibility to model a surface if some "feature curves" are specified. In the present paper the method of building composite Coons surface is described. It is shown that the compatibility conditions necessary to construct a parametric Coons patches are satisfied. Smoothness of the resulting surfaces and continuity of its mixed derivatives are proven. An example of building the composite Coons surface by a network of curves is given. An example is also presented which shows that it is possible to construct a closed surface by means of composite Coons surfaces.

Key words: computer aided geometric design, surface modelling, Coons patches.

Yumagulov M. G., Vyshinskij A. A., Murtazina S. A., Nurov I. D. **Operational method of research local bifurcations multipleparameter dynamic systems.**

In clause substantive provisions of a new method of research of a wide class bifurcational the problems, construction of solutions leading iterative procedure are resulted. The method allows to model behaviour of dynamic systems depending on parameters, linearization which equations have multivariate degeneration. The dynamic system described by the ordinary differential equation is considered depending from scalar or vector parameter. It is supposed, that this equation at all values of parameter has the zero solution, thus corresponding matrix Jacobi at some value of parameter has cleanly imaginary own values. In this case are possible various local bifurcations in a vicinity of a zero condition of balance of dynamic system. The problem about local bifurcations can be shown to the equivalent operational equation. Linearization such equation (in a vicinity of zero) leads to the linear operator having eigenvalue 1. It is supposed, that frequency rate of this eigenvalue coincides with dimension of vector parameter. The concept of a correct point bifurcation in a direction of eigenvectors of the linear operator is entered. For research of a problem about correct bifurcations the new scheme based on ideas of a method functionalization of parameter and a method of Newton is offered. Attributes correct bifurcations for the operational equations are received, iterative procedure of the approached construction of solutions is offered, the program of computer modelling bifurcational processes in dynamic systems is developed. As appendices are considered a problem about bifurcation Andronov–Hopf of dynamic systems (in particular, Lorentz's models) and a question about bifurcations periodic solutions in the three-body problem. For the specified problems new attributes bifurcation are received and the scheme of their approached research is offered.

Key words: dynamic systems, bifurcations, computer modelling, the functionalizacion parameter, the operational equations.

Vasilieva N. S. **Bin width selection for color histograms in image retrieval.**

Color feature is one of the most important visual features used to measure image similarity. In image retrieval histograms are widely used to represent the color distribution in images. It is a common understanding that the efficiency of color histograms depends on binning scheme. However the question of optimal bin width selection is not adequately explored in the literature. This paper addreses the issue in the experimental study. Retrieval efficiency is evaluated for various binning schemes and two different similarity measures. The paper discusses the results and provides the recommendations to bin width selection in color histograms. Test results show that the increase

in the number of bins leads to the higher precision when Manhattan dissimilarity measure is used. In case of Cosine measure retrieval precision is lower for the bigger number of bins. The recall is decreasing with growing number of bins for both Manhattan and Cosine measures. Based on these results we conclude that one should select small number of bins when Cosine measure is used. That will increase both precision and recall of the system and reduce the size of the feature vector. When Manhattan distance can be used, one can get higher precision with the bigger number of bins. But this will lead to the storage and computation expenses growth caused by the increased feature vector size.

Key words: image retrieval, color features, color histograms, binning scheme.

Romanovsky K. Y. **Introducing reuse to phone exchanges family documentation by means of DocLine technology.**

The task of developing software product lines becomes actual due to increasing demands for creation of complex software systems. The main advantage that can be achieved by joint developing a set of software-intensive systems is the reuse of various common assets including source code. Multi-purpose technical documentation is a necessary part of modern software, but the existing methods of developing software product lines do not pay proper attention to the task of creating the documentation. An XML-based method DocLine for developing technical documentation of software product lines is proposed. This method is intended for reusing text fragments. DocLine uses visual modeling technique to support the design of the documentation. Also DocLine provides a means for adapting reusable text fragments according to the needs of various usage contexts. An adoption of DocLine is presented. Two manuals for a phone exchanges family software (about 300 pages in total) originally developed in Adobe FrameMaker were re-authored in DocLine with extraction and specification of reusable parts. Adoption results and classification of products variability types recognizable from the perspective of documentation development are presented. Conclusions are also given regarding competence of a technical writer who is capable of effective use of the proposed technology in industrial settings.

Key words: software product lines, reuse, technical documentation, visual modeling.

Sotnikova M. V. **Algorithms of marine ships routing taking into account weather forecast.**

The purpose of the weather routing algorithms is to assist the ship drivers in deciding which ship route should be selected in order to perform the optimal voyage. Selection of the ship route in the automate system is based on two optimization criteria, which should be determined by the user: general time of the motion or general fuel consumption. The correspondent optimization problems are considered in the paper as traditional objects of Calculus of Variations. It is noted that the complexity of a situation is determined by the presence of an extensive set of various constraints limited the route choice. As a result it is very difficult to decide mentioned optimization problems by the usual variation methods. To overcome this difficulty a few special methods are proposed on the base of the problems transformation to the finite dimensional optimization with sequential iterations making the result more precise. This approach is accepted as a basis for the working out of the automate weather routing system. Practical implementation and effectiveness of the obtained algorithms are illustrated with the help of concrete example of the ships routing.

Key words: marine ships, route, motion time, fuel consumption, optimization.