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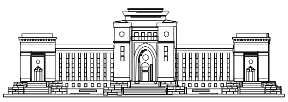

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MATHEMATICAL MODELS OF INFORMATION PROCESSING AND MANAGEMENT SYSTEMS

Abstract. The modern scientific and technical revolution is accompanied by the rapid penetration of digital and computer equipment into technical systems for various purposes, which opens up prospects for the implementation of increasingly complex and efficient information processing and control algorithms. This led to an increase in interest in the theory of linear non-stationary systems (LNS), which, firstly, provides models of modern complex control objects and information transfer channels, and, secondly, is the theoretical basis for the synthesis of non-stationary systems with significantly richer potential than stationary systems. A similar situation is observed simultaneously in various fields of theory and technology, including automatic control, the theory of information processing systems, radio engineering, the theory of pattern recognition, etc.

Keywords: mathematical models, information, user research, human perception, assessment methods, information processing.

INTRODUCTION

At present, one of the main problems in modeling information-processing systems is the no stationarity of information transmission channels, which manifests itself in a random or relatively “fast” change in the parameters of these systems over time. In this regard, a promising direction for solving problems of analysis and synthesis of non-stationary information processing systems is the construction of their models in the class of non-stationary modulation systems (M-Systems). M-Systems correspond to many real technical systems, such as systems with quadrature decomposition of signals, communication channels with random parameters, Keynes models, etc.

An essential feature of such models is the separation of inertial and inertia less signal transformations, and only inertia-free transformations determine the non-stationarity of the system as a whole. Separating non-stationary systems, M-Systems in the class allows us to significantly simplify the mathematical description of these systems by representing them in the form of parallel (MR), sequential (MB) and parallel serial (MRB) structures.

MAIN PART

The concept of a model approach. Increases the variety of models used. A computer technology has been used to be a computer technology. The number of simulated objects is not analog, but it is discrete or combined (combined digital) systems. This requires a digital form. In this case, it is in the form of a transition to simulation modeling. In fact, the simulation algorithm is a direct description. It has been found that it is not necessary to express the information. In addition, from a methodological point of view, it is preferable to describe all links of M-Systems. In this case, we are talking about a discrete (digital) form.

The computer systems are currently used in computer control systems. Processes [1-6]. The requirements for quality control are determined. He also gave an opportunity to provide new opportunities for information technology.

IGOs,

- Parallel computing and supercomputers;
- Cloud computing and technology;
- Embedded computing and systems.

It is obvious that you are not in the first place. In the case of a small group of people, it is not a problem. What is the difference between information systems management specialists.

Nevertheless, it should be noted that the use of modern computer technologies in any variant when creating control systems is primarily determined by the need to provide the required functionality, which is achieved on the basis of formalized (mathematical) approaches at the research design stage. The main objective of the whole complex of works that are performed at this stage is to form mathematical models of control devices or control laws that provide the desired dynamics for systems operating in all possible navigation modes.

The involvement of modern information and computer technologies in the field of marine ship management is carried out within the following six generalized interrelated areas:

- Mathematical modeling of existing or developed elements and the control system as a whole, including the marine environment;
- Computer modeling in accordance with the constructed mathematical models and criteria for the quality of functioning;
- Analysis of the structural, dynamic, functional and other properties of the system as a whole and its individual elements;
- Synthesis of algorithms for the functioning of the system and its individual variable components in the form of their mathematical models;
- Support of operation algorithms and information flows in the system in real time;
- Algorithmic and software of test benches and training complexes for training crews and maintenance personnel working with the control system.

For each of these areas there is a well-defined ideology of actions aimed at achieving the best results when using information and computer support.

For the issues under consideration, a special role is played by digital control and signal processing systems based on modern computer elements. Obviously, for such systems, the use of modern information and computer technologies significantly suppresses all other approaches within the above directions. This is due to the obvious specifics of modeling, analysis, synthesis and implementation of digital systems. Note that the principal feature of the use of computers in control systems is that they simultaneously serve as both an object and a tool for research and design, as well as a basic element for implementing synthesized digital control algorithms.

Within the framework of formalized approaches, the desired elements of the designed system, or rather, their mathematical models, most often, are formed as the results of solving various optimization problems [7]. This essentially distinguishes modern design ideology from classical approaches, where optimization methods were usually used only as an auxiliary tool, which makes it possible to widely use computer technologies with a significant improvement in the quality of design solutions.

In particular, at present, various approaches are widely used, based on I-theory, which allow minimizing the matrix “gains” of elements of projected systems, which are represented by norms in the corresponding Hardy spaces. The theory of H2 and H-optimization [8 - 10] is very popular, associated with solving a wide range of problems in the field of synthesizing feedbacks, simplifying mathematical models of objects, ensuring robust stability and quality, etc.

Discrete models of the dynamics of motion control systems

The dynamics of marine moving objects are usually represented by nonlinear systems of ordinary differential equations.

$$x = Fin(+ Fhd((t) , \quad (1)$$

Where the vectors are x = ^ xp} eE12, V = E3, and y = {s, yu, y2} eE3

Respectively, the state, the linear and angular velocities of the MPO are determined, and the vector xp £ E - its movements and angles of rotation. The vector § £ Et represents the control actions on the MPO, whose motion occurs under the influence of forces and moments Fin, Fhd of inertial and hydrodynamic nature, as well as specially distinguished external forces and moments {G (G).

The mathematical model (1) is supplemented by the equations of the dynamics of the drives

$$S = Fs (t, S, and), \quad (2)$$

Where and £ Et is the vector of control signals, as well as the equations of meters

$$Y = Fy (t, x, 8), \quad (3)$$

Where y £ EP is the vector of measured dynamic variables.

If the mode of stabilization of MPO is considered during its longitudinal motion at a constant speed, linearization of equations (1–3) is usually performed, reducing it to

x = Ax + B 8 + W ^), 8 = u,
^)> (4)
Y = Sh,

Where x £ En is the MPO state vector, which determines the deviations from the equilibrium position, A, B, C, and H are matrices with constant components.

Mathematical formalization of the corresponding substantive problems is proposed to be based on the theory of optimization, setting quality functionals on the motions of discrete models of the systems under consideration.

On the example of stabilization of a given course, a new approach to the synthesis of digital filters, included in the multi-purpose structure of control laws, is proposed in the work. In contrast to the currently used methods, it is based on the non-standard task of minimizing the intensity of control of a ship moving in conditions of sea waves.

Simulation is used if experiments with real objects, systems is impossible or too expensive. The main difference of modeling from other methods of studying complex systems is the possibility of optimizing the system before its implementation.

Distributed information management systems (I & C) are multifunctional interconnected sets of stationary and mobile elements distributed in space with developed technical means for receiving, transmitting and processing information. Regardless of the type and purpose of such systems have the following characteristic features [1].

Distribution. ISCs are located on large areas from regional to global scales and include a large number of controlled, controlling and combined elements.

The mobility of the elements. The elements of the system can be stationary, mobile or moving. The movement of elements is carried out continuously or periodically along deterministic or stochastic trajectories.

Availability zones. The implementation of functional interactions between moving and stationary (mobile) elements of distributed ILEs is possible, as a rule, only when the moving element is located in the zone of accessibility ("visibility") of the fixed (mobile) element. The accessibility zone is determined by the mutual arrangement of elements in space and the types of technical means used.

Speed performance. The need for the operational development of control actions determines the high requirements for the execution time of the corresponding functions by the elements and the system as a whole.

Inadmissibility of loss of information. For distributed I & C systems, as a rule, an important condition is the inadmissibility (strict limitation) of loss of information of certain types. This requires special measures to analyze and control the completeness of the transmitted, processed and received information.

Vitality. In some cases, the functioning of the systems of the class under consideration proceeds under conditions of adverse impacts, which leads to a violation of the regular modes of operation of individual elements and the system as a whole.

Typical examples of distributed information and control systems are: automated aircraft control systems (ACS LA), satellite communication systems, operational services management systems, etc.

An example of a digital course management system

The proposed approach to digital filtering as part of the multipurpose control law (7), (8) will be illustrated by the example of a stabilization system for the course of a transport vessel with a 6000t displacement.

A mathematical model of a ship moving at a constant speed of V = 8 m / s in the presence of sea waves with an intensity of 5 on the Beaufort scale is the following system of linear difference equations:

In [k + 1] = an in [k] + a 12 a [k] + L1 5 [k] + ^ d [k],
A [k + 1] = a21 in [k] + a22 a [k] + l2 5 [k d [k], (20)
[[k + 1] = Ta [k] + [[k], 5 [k + 1] = Ti [k] + 5 [k], y [k] = [[k].

Here in - the angle of drift, and - the angular velocity of the course, f - yaw angle, 5 - the angle of deviation of the vertical rudders. For the period of discreteness T = 1, we have the following values of the coefficients:

An = 0.955, a12 = 0.560, a21 = 0.0267, a22 = 0.592, h1 = —0.0132, h2 = —0.00742, / = —0.0648, / = —0.00456.

The desired quality of development of team corrections for the course provides the following basic control law:

And = to 1 in + to 2 a + k3f + k05 + vy, (21)

Where k 1 = 0.912, k = 6.11, k3 = -2.22, k0 = -0.339, V = 3.44. For this law, we have the eigenvalues of the matrix Ac: z1 = 0.658, z2 = 0.757, = 0.870, = 0.922.

Form an asymptotic observer

z 1 [к +1] = a 11 z 1 [к] + a12 Z2 [к] + ^ 5 [к] + д 1 (у [к] -Zз [к]), z 2 [к +1] = a21 z 1 [к] + a 22 Z2 [к] + Ь 2 5 [к] + д 2 (у [к] -Zз [к]), (22)

z3 [k +1] = Tz2 + z3 + d3 (for z3), where g1 = 0.0335, g2 = 0.00446, g3 = 0.0944.

For these coefficients, the matrix A – gc has the eigenvalues z1 = 0.560, ^, 3 = 0.946 ± 0.0183 /.

The equations of the stabilizing control law for the observer's output (22) without a filter are

And = to 1 g1 + to 2 g 2+ to 3 g3 + to 0 5 + vy. (23)

A mathematical model for the formation of control loops has been built, taking into account the choice of optimal values of the controlled parameters of control objects and means of observation. The algorithm of the solution is described in the general case with the implementation of the optimal distribution at each step of the search for the optimal values of the controlled parameters.

The problem of optimizing the functioning of the systems of the class under consideration is closely related to the tasks of a formalized description of the functioning processes, procedures for collecting, processing and analyzing the relevant characteristics of the elements and their interrelationships affecting the quality of control of the system as a whole.

CONCLUSION

In the process of developing and improving distributed I & C systems, there are complex problems of evaluating the effectiveness of their functioning (in terms of the listed and other characteristics) with different structural options, adverse effects, schedule changes and element trajectories, emergency situations, various management strategies, etc.

One of the most convenient means of mathematical modeling used in analyzing the functioning of the systems of the class in question are simulation models that describe the structure and behavior of the system as a program for a PC and allow machine experiments to obtain the necessary data on the functioning of the elements and the system as a whole. Certain time intervals. This paper describes a simulation model designed to solve these problems in the aircraft control system and to carry out machine experiments.

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Ж.Е. Кенжебаева

«Қаржы академиясы» АҚ

АҚПАРАТТЫҚ ЖӘНЕ БАСҚАРУ ЖҮЙЕЛЕРІНІҢ МАТЕМАТИКАЛЫҚ МОДЕЛЛЕРІ

Аннотация. Қазіргі заманғы ғылыми-техникалық революция цифрлы және компьютерлік техниканың әртүрлі мақсаттарға арналған техникалық жүйелерге тез енуімен бірге жүреді, бұл ақпаратты өңдеу және бақылаудың алгоритмдерін барынша күрделі және тиімді түрде жүзеге асырудың болашағын ашады. Бұл, ең алдымен, заманауи кешенді басқару объектілерінің модельдерін және ақпаратты беру каналдарын ұсынатын желілік стационарлық емес жүйелердің (LNS) теориясына қызығушылықты арттырды, екіншіден, әлдеқайда бай әлеуеті бар стационарлық емес жүйелерді синтездеудің теориялық негізі болып табылады стационарлық жүйелерге қарағанда. Осындай жағдай теория мен технологияның әртүрлі салаларында, соның ішінде автоматтандырылған басқару, ақпараттық өңдеу жүйелерінің теориясы, радиотехника, үлгіні тану теориясы және т.б.

Түйін сөздер: математикалық модельдер, ақпарат, пайдаланушы зерттеулер, адам қабылдау, бағалау әдістері, ақпаратты өңдеу.

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Ж.Е. Кенжебаева

АО «Финансовая Академия»,

МАТЕМАТИЧЕСКИЕ МОДЕЛИ СИСТЕМ ОБРАБОТКИ ИНФОРМАЦИИ И УПРАВЛЕНИЯ

Аннотация. Современная научно-техническая революция сопровождается бурным проникновением цифровой и компьютерной техники в технические системы различного назначения, что открывает перспективы реализации все более сложных и эффективных алгоритмов обработки информации и управления. Это обусловило повышение интереса к теории линейных нестационарных систем, математическому моделированию, которая, во-первых, предоставляет модели современных сложных объектов управления и каналов передачи информации, а, во-вторых, является теоретической основой синтеза нестационарных систем, обладающих существенно более богатыми потенциальными возможностями, чем системы стационарные. Подобная ситуация наблюдается одновременно в различных областях теории и техники, среди которых автоматическое управление, теория систем обработки информации, радиотехника, теория распознавания образов и др.

Ключевые слова: математические модели, информация, исследование пользователя, восприятие человека, методы оценки, обработка информации.

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