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AUTOMATION TECHNOLOGY
25 JUNE 1980 (FOUO 10/80) 1 OF 2

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25 June 1980

USSR Report

CYBERNETICS, COMPUTERS AND AUTOMATION TECHNOLOGY

(FOUO 10/80)

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USSR REPORT

CYBERNETICS, COMPUTERS AND AUTOMATION TECHNOLOGY

(FOUO 10/80)

CONTENTS

 [III - USSR - 21C S&T FOUO]

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ORGANIZATIONS

ACADEMY OF SCIENCES OF THE BELORUSSIAN SSR

Minsk AKADEMIYA NAUK BELORUSSKOY SSR in Russian 1979

[Excerpts from the book "Akademiya nauk Belorusskoy SSR" by P. T. Petrikov, N. V. Tokarev and O. V. Libezin, Izdatel'stvo Nauka i tekhnika, 152 pages]

[6]

The main stages in establishment and development of the Belorussian SSR Academy of Sciences--the main scientific center of the republic--during a 50 year period are outlined in the book. The most important achievements of the academy scientists in different fields of the natural and social sciences, acceleration of scientific and technical progress and cultural development at the modern stage are shown and the characteristics of its structural subdivisions are given. Reference material is presented.

The book is illustrated.

[54-57]

The Department of Physicomathematical Sciences (the academic secretary is Academician of the Belorussian SSR Academy of Sciences, Hero of Socialist Labor F. I. Fedorov) is one of the leading departments in the Belorussian SSR Academy of Sciences. It includes the following institutes: mathematics, physics, solid-state physics and semiconductors and electronics. Corresponding Member of the USSR Academy of Sciences, Academician of the Belorussian SSR Academy of Sciences N. A. Borisevich, Academicians of the Belorussian SSR Academy of Sciences B. B. Boyko, F. D. Gakhov, N. P. Yerugin, M. A. Yel'yashevich, V. I. Krylov, V. P. Platonov, N. N. Sirota, B. I. Stepanov, D. A. Suprunenko, F. I. Fedorov and S. A. Chunikhin and Corresponding Members of the Belorussian SSR Academy of Sciences B. V. Bokut', V. G. Vafiadi, A. M. Goncharenko, V. P. Gribkovskiy, G. P. Gurinovich, A. P. Ivanov, Ye. A. Ivanov, L. I. Kiselevskiy, V. V. Klubovich, V. A. Pilipovich, V. G. Sprindzhuk and V. D. Tkachev make up the Department of Physicomathematical Sciences.

Scientific councils on the following problems--algebra and number theory, investigation of analytical, qualitative and asymptotic properties of solutions of systems of differential equations, computer mathematics, development and application of field and group methods of describing processes of fundamental interactions, spectroscopic and quantum electronics, solid-state and semiconductor physics and optoelectronics--function in the department.

The Institute of Mathematics of the Belorussian SSR Academy of Sciences (the director is Academician of the Belorussian SSR Academy of Sciences V. P. Platonov). It was founded in 1959 as the Institute of Mathematics and Computer Technology on the basis of the mathematics laboratories and laboratory of computer technology of the Institute of Physics and Mathematics. It was renamed the Institute of Mathematics in 1965. It participates in the work of the Committee for Multilateral Cooperation of the Academies of Sciences of the socialist countries on the problem "Scientific Problems of Computer Technology." The republic stock of algorithms and programs which contains developments on general-purpose software of the Minsk series of computers functions at the institute. The institute includes the Gomel' Department and the Computer Center of the Belorussian SSR Academy of Sciences. The editorial board of the All-Union scientific journal DIFFERENTSIAL'NYYE URAVNENIYA operates there. It has had a postgraduate program since 1959.

The main trends of scientific research include differential equations, algebra and number theory, the theory of groups, algebraic geometry and topology, computer mathematics and computer software.

The institute (including the Gomel' division) numbers about 480 research associates, of which 216 are scientific associates, including eight doctors and 44 candidates of sciences. Academicians of the Belorussian SSR Academy of Sciences Ye. A. Barbashin and N. P. Yerugin and corresponding member of the Belorussian SSR Academy of Sciences Ye. A. Ivanov worked at the institute and academicians of the Belorussian SSR Academy of Sciences V. I. Krylov, D. A. Suprunenko and S. A. Chunikhin and corresponding member of the Belorussian SSR Academy of Sciences V. G. Sprindzhuk worked at the institute.

The institute has achieved significant results in development and introduction of computer software. Applied program packs which realize general methods of numerical analysis and mathematical statistics, translated from algorithmic languages ALGAMS and ALGOL-60, and information retrieval systems have been developed at the institute during the past few years. These developments of the institute have been introduced at more than 2,000 organizations of the country. The saving from the introduced developments comprised 15.8 million rubles during the Ninth Five-Year Plan and it comprised 13.4 million rubles during 3 years of the 10th Five-Year Plan.

[63-65]

The Institute of Electronics of the Belorussian SSR Academy of Sciences (the director is corresponding member of the Belorussian SSR Academy of

Sciences V. A. Pilipovich). It was founded in 1973 on the basis of the laboratory of electronics of the Belorussian SSR Academy of Sciences. A special production design office with experimental plant functions at the institute. It has had a postgraduate program since 1969. The main trends of scientific research include the physical fundamentals of vacuum microelectronics, physical investigations on solid-state optoelectronic devices and optical storage components for computers, scientific instrument building (development of methods and devices for automated measurements), the physics of thin films and microelectronics.

The institute numbers approximately 700 research associates, of which 134 are scientific research associates, including two doctors and 27 candidates of sciences. Corresponding member of the USSR Academy of Sciences V. N. Avdeyev worked here.

A number of original devices for optical information processing has been developed at the institute. Among them are electrooptical and acousto-optical addressing devices, a binary information input device based on liquid crystals, photodetector and light diode matrices with high degree of integration and specimens of electro- and photochrome media for internal holographic storage devices. New methods of achieving microstructures by combining the technology of silicon and gallium arsenide which permit creation of integrated optrons have been developed. Optical high-capacity lasers with narrow emission spectrum have been developed for use in holography. The light-induced effect in liquid crystals, which permits reversive recording of information and spatial frequency of more than 400 lines per millimeter, has been discovered and investigated.

An essentially new production design method of creating structures for integrated circuits has been developed in the field of vacuum microelectronics. Specimens of vacuum integrated circuits have been created on its basis. Highly sensitive electrometric and thin-film magnetometric converters and the method and operating principle of automated analysis of the quality of periodic microstructures have been developed.

The institute cooperates with many scientists, planning-design and production organizations. An efficient electrometric amplifier with high sensitivity, automatic selection and switching of the range of the measured value has been created for the Institute of Space Research of the USSR Academy of Sciences. A system for processing large information files using optical methods was developed for the All-Union Scientific Research Institute of Hydrometeorological Information. A number of devices of scientific and industrial designation has been created. For example, a system for automatic control of a mining machine, which accomplishes automatic orientation of its motion along a salt seam, has been turned over to the Association Beloruskaliy for experimental industrial operation.

The achievements of young scientists of the institute were rewarded with the Leninist Komsomol Prize of Belorussia in 1974. The saving from introduction of the institute's developments into the national economy comprised 9.1 million rubles during three years of the 10th Five-Year Plan.

[76-79]

Institute of Engineering Cybernetics of the Belorussian SSR Academy of Sciences (the director is Candidate of Technical Sciences O. I. Semenkov). It was founded in 1965 on the basis of laboratories of cybernetics profile of the Institute of Mathematics and Computer Technology of the Belorussian SSR Academy of Sciences and the Institute of Machine Sciences and Automation of the Belorussian SSR Academy of Sciences. It is the country's leading organization on the problem of automating processes of technological preparation of production in machine building. It organizes operation of the subsection "Automation of design in machine building" of the Scientific Council on Computer Technology and Control Systems of the USSR State Committee on Science and Technology and of the Presidium of the USSR Academy of Sciences. It cooperates with scientific and production organizations of CEMA countries. The editorial board of the All-Union Scientific and Technical Collection VYCHISLITEL'NAYA TEKHNIKA V MASHINOSTROYENII functions at the institute, it has the republic stock of algorithms and programs for automated design and an experimental design center and special production design office with experimental plant is in operation. It has had a postgraduate program since 1965.

The main trend of scientific research includes automation of design and production design processes in machine building and instrument building on the basis of mathematical methods and computer equipment.

The institute numbers more than 1,200 research associates, of which 322 are scientific associates, including four doctors and 73 candidates of sciences. Corresponding members of the Belorussian SSR Academy of Sciences G. K. Goranskiy and I. S. Kovalev worked at the institute and corresponding member of the Belorussian SSR Academy of Sciences A. D. Zakrevskiy works there.

The scientists of the institute have carried out a wide range of scientific and experimental design work to develop automated design systems (SAPR) with respect to technically complex objects of machine building. A program complex has been developed for automated description of objects in SAPR and performing design operations on them. The geometrically oriented algorithmic language FAP-KF with translator which is an expansion of FORTRAN-4 language by geometric variables and operations has been developed. An operating experimental model of SAPR based on the proposed methodological principles of developing dialogue devices for automation of design has been created. The institute scientists are successfully solving problems of designing operational graphic systems. A method of semiautomatic formation of a model of precision graphic images of arbitrary complexity has been determined in which the image fragments are read automatically. An important achievement is development of a hardware complex for graphical support of automated design systems.

The institute has created a complex of modelling and design-installation planning programs on computers of the YeS series. Programs for technical normalization of single-tool machining have been developed for computers of the Minsk-32 series and an automated system for designing standard and separating dies of simple and joint action has been created. Scientists have solved a number of theoretical problems in the fields of the abstract theory of automatons, synthesis of automatons and algorithms, logic synthesis, the structural theory of automaton reliability, synthesis of discrete accessories of special classes and analysis and diagnosis of industrial automatic equipment circuits and have developed methods of coding and decoding cyclic codes.

A system of programs for synthesis of asynchronous discrete devices in algorithmic language and a digital automated system for controlling vibrational tests with software have been developed at the institute. The results of the scientific research work of the Institute of Engineering Cybernetics of the Belorussian SSR Academy of Sciences find wide application in the national economy. The saving from introduction of the developments comprised more than 7.8 million rubles during the Ninth Five-Year Plan and the saving comprises 12.1 million rubles during three years of the 10th Five-Year Plan.
[275-6521]

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UDC 658.012.011.56

CERTAIN PROBLEMS IN THE DEVELOPMENT OF MULTICOMPUTER CENTERS

Moscow METODOLOGICHESKIYA OSNOVY IVAUCHNO-TEKHNICHESKOGO PROGNOZIROVANIYA [Methodological Principles of Scientific and Technical Prediction] in Russian, Seminar on Problems of the Automation of Branch Long-Range Planning in Krasnodar in 1978, 1979 pp 110-114

GERASIMENKO, A. V. and SHCHEMELEV, B. N.

[From REFERATIVNYY SBORNIK, ORGANIZATSIYA UPRAVLENIYA No 9, 1979 Abstract No 9.67.148 by Yu. P. D.]

[Text] The physical realization of a multilevel hierarchic computer center is exemplified by the experimental collectively used computer center developed at the Institute of Electronics and the Computer Center of the Latvian SSR Academy of Sciences. The system consists of 4 macrocomputers (two YeS-1030 and two M-4030) designed to perform the principal computational and data processing operations and interfaced via four-channel adapters and a common external storage unit. M-400 minicomputers, which relieve the upper-level computers of the solution of routine teleprocessing tasks and assure control of communication channels, commutation of the flow of assignments, and distribution of the results of the implementation of assignments, serve as buffer or communication devices. A reorganization of the computer system served to increase by 30-50% the capacity of the upper-level computers when performing tasks in the batch mode. Remote minicomputers used in the capacity of intelligence terminals may be used as subscriber stations for the computer center; on the basis of these remote minicomputers, interactive program-debugging ans assignments-originating systems have been developed for the upper-lev el computers, as has been a local subscriber station control system....The development of multicomputer centers requires: selecting the primary computer, usually one of low capacity, which performs the functions of organizing the effective load on the processors and other facilities of the center in accordance with the specific features of the problems to be solved. It is then also necessary for the primary computer to perform the functions of the communication processor by organizing exchange between the computer system and the external storage unit, the input-output devices, the user subscriber stations and communication channels, and other data-processing systems, as well as to perform such "inconvenient"--for the operating system used--operations as the loading of assignments into the system, the printout of findings and their display at the user terminals, the planning of the flow of assignments, etc. In addition, the primary computer employs time quantization or sets limits on the assignment processing time to preclude the possibility of the monopolization of the processor by an individual user. Furthermore, it should be considered that the secondary computers have complete monopoly over their direct-access memories and use only magnetic-disk storage units as their peripherals....
[120-1386]

PERSONALITIES

YEKATERINA LOGVINOVNA YUSHCHENKO

Kiev KIBERNETIKA in Russian No 6, 1979 p 147

[In commemoration of 60th birthday of Ye. L. Yushchenko (8 Dec 79), doctor in physico-mathematical sciences, corresponding member of the Ukrainian Academy of Sciences, head of the Division of Program Automation of the Institute of Cybernetics of the Ukrainian Academy of Sciences]

[Text] Dear Yekaterina Logvinovna!

The editorial board sends you its best wishes on the occasion of your birthday.

Your inexhaustible energy, scientific principles, sense of high civil duty, attention to people and humanity--these are the qualities which won you the high scientific authority and deep respect of coworkers, graduates and students and propelled you into the limelight of famous Soviet scientists in the field of programming theory and automated data processing systems. You are one of the founders of the Ukrainian school of programming; you developed the address language, one of the first high level programming languages in the world, several fundamental methods of automation of the process of translator design from programing languages and development of parametric data processing systems; the State Standard of COBOL language was developed under your supervision ; your have written training manuals and monographs on programming.

We wish you health and new innovative success!

[218-8617]

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FIFTIETH BIRTHDAY OF ACADEMICIAN OF THE UKRAINIAN SSR ACADEMY OF SCIENCES VLADIMIR SERGEYEVICH MIKHALEVICH

Kiev KIBERNETIKA in Russian No 1, 1980 p 145

[Excerpts from article by the Editorial Board of the journal KIBERNETIKA]

[Excerpt] The well-known Soviet scientist, prominent specialist in the field of mathematics and cybernetics, Deputy Director of the Institute of Cybernetics of the Ukrainian SSR Academy of Sciences, Academician of the Ukrainian SSR Academy of Sciences Vladimir Sergeyevich Mikhalevich will celebrate his 50th birthday on 10 March 1980.

The active scientific research activity of V. S. Mikhalevich began in the mid-1950s. At that period he was the first to formulate and solve the problem of constructing sequential Bayes solutions for Poisson and Wiener random processes, he proposed original approaches to construction of the general theory of optimum statistical solutions and the theory of controlled random processes and achieved a number of new results in the field of nonparametric statistics.

V. S. Mikhalevich's main scientific activity since 1959 has been continuously linked to the Institute of Cybernetics of the Ukrainian SSR Academy of Sciences, where he has headed the Department of Economic Cybernetics for more than 20 years and has been Deputy Director since 1962.

V. S. Mikhalevich has worked long and fruitfully in the field of mathematical and economic cybernetics and has made an important contribution to successful solution of a number of problems related to efficient use of mathematical methods and computers in economic research, planning, design and control.

V. S. Mikhalevich formulated the principles of constructing methods of sequential analysis of variants--the most effective procedures for solving practical problems based on significant use of the specific properties of considered phenomena and processes during solution. This permitted generalization of the idea of the theory of statistical solutions and calculating methods of dynamic programming.

He completed a number of original investigations on the use of network methods in planning and successfully developed a number of ideas in the field of control theory advanced by Academician V. M. Glushkov.

During the past few years V. S. Mikalevich has been devoting a great deal of attention to problems of optimum control of complex systems and to problems of development and introduction of automated control systems of different levels. He is the scientific supervisor of investigations to develop ASPR (Automated System of Planning Calculations) of Gosplan of the Ukrainian SSR and a number of sector automated systems. He has participated actively in development of republic and All-Union automated information gathering and processing systems for accounting, planning and management of the national economy.

Many scientific and practical results achieved by V. S. Mikhalevich and his students have become widely known not only in our country but abroad. He is the author of more than 110 scientific papers, a winner of the State Prize of the Ukrainian SSR and of the Prize of the Ukrainian SSR Academy of Sciences imeni N. Krylov. He was elected a corresponding member of the Ukrainian SSR Academy of Sciences in 1967 and was elected an academician in 1973. He has frequently given reports at All-Union and international scientific conferences and symposia.

V. S. Mikhalevich carries on multifaceted pedagogical work: he systematically lectures to students, participates actively in development of new academic programs and devotes much attention to working with post-graduate students. A total of five doctoral and more than 30 candidate dissertations have been prepared and successfully defended under his supervision.

Along with fruitful work in the position of Assistant Editor in Chief of the journal KIBERNETIKA, V. S. Mikhalevich carries out a number of responsible commissions along the line of scientific organizing activity. He is the Deputy Academician-Secretary of the Department of Mathematics, Mechanics and Cybernetics of the Ukrainian SSR Academy of Sciences and the Deputy Chairman of the Scientific Council of the Ukrainian SSR Academy of Sciences on the problem of cybernetics. He supervises the work of a number of scientific committees and seminars. He participates actively in party and public work.
[264-6521]

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CSO: 1863

INFORMATION ABOUT AUTHORS

Kiev KIBERNETIKA in Russian No 6, 1979 p 152

[Biographical data about authors published in KIBERNETIKA No 6, 1979]

[Text]

Adasovskiy, Boris Igorevich; candidate in phys.-math. sciences, senior scientific research worker of the Institute of Cybernetics, Ukrainian Academy of Sciences, Kiev

Akinfiyev, Girgoriy Aleksandrovich; engineer, Kiev

Alekseyev, Oleg Glebovich; doctor in technical sciences, professor of military artillery of the Lenin Order Red Banner Academy imeni Kalinin, Leningrad

Anisimov, Anatoliy Vasil'yevich; candidate in phys.-math. sciences, docent of Kiev State University

Berkovich, Mark Yerakhmil'yevich; senior scientific research worker of the All-Union Scientific Research and Planning Institute on Sector Automated Control Systems, Moscow

Brodetskaya, Tat'yana Sergeyevna; candidate in phys.-math. sciences, junior research worker of Institute of Cybernetics, Ukrainian Academy of Sciences, Kiev

Burdyuk, Vladimir Yakovlevich; candidate in phys.-math. sciences, docent of Dnepropetrovsk State University

Galas', Mikhail Ivanovich; candidate in phys.-math. sciences, Dnepropetrovsk

Gordiyenko, Yevgeniy Il'ich; candidate in phys.-math. sciences, senior scientific research worker, Moscow

Grigor'yan, Yuriy Georgiyevich; candidate in phys.-math. sciences, laboratory head of the Armenian Scientific Research Institute of Energy, Yerevann

Yeremin, Ivan Ivanovich; doctor in phys.-math. sciences, division head of the Institute of Mathematics and Mechanics UNTs, USSR Academy of Sciences, Sverdlovsk

Zhilinskas, Antanas Genriko; candidate in technical sciences, senior scientific research worker of the Institute of Mathematics and Cybernetics of the Lithuanian Academy of Sciences, Vilnius

Kaniovskiy, Yuriy Marianovich; candidate in phys.-math. sciences, junior research worker of the Institute of Cybernetics, Ukrainian Academy of Sciences, Kiev

Kesel'man, Dmitriy Yakovlevich; candidate in phys.-math. sciences, senior instructor of Irkutsk State Univeristy

Komolov, Sergey Vladimirovich, graduate student of Moscow Physico-Technical Institute

Kondrat'yev, Andrey Ivanovich, candidate in phys.-math. sciences, junior scientific worker of the Institute of Cybernetics, Ukrainian Academy of Sciences, Kiev

Kornoushenko, Yevgeniy Konstantinovich, junior research worker of the Institute of Control Problems, USSR Academy of Sciences, Moscow

Kul'chitskiy, Oleg Yur'yevich, candidate in phys.-math. sciences, assistant of Leningrad Polytechnical Institute imeni Kalinin

Kur'yerov, Yuriy Nikolayevich; head of scientific research group, Institute of Metallurgy imeni A. A. Baykov, USSR Academy of Sciences, Moscow

Leonenko, Nikolay Nikolayevich; candidate in phys.-math. sciences, assistant of Kiev State University

Letichevskiy, Aleksandr Adol'fovich; doctor in phys.-math. sciences, senior scientific research worker, Institute of Cybernetics, Ukrainian Academy of Sciences, Kiev

Mazurov, Vladimir Danilovich; doctor in phys.-math. sciences, division head, Institute of Mathematics and Mechanics UNTs, (Ural Scientific Center), USSR Academy of Sciences, Sverdlovsk

Makeyev, Sergey Petrovich; junior research worker, Computing Center, USSR Academy of Sciences, Moscow

Maksimenkov, Aleksandr Vasil'yevich; candidate in technical sciences; sector head, All-Union Scientific-Research Institute of Problems of Organization and Control at GKNT, (State Committee of the USSR Council of Ministers on Science and Technology), Moscow

Malyukov, Vladimir Pavlovich; junior research worker, Institute of Cybernetics, Ukrainian Academy of Sciences, Kiev

Merzhanov, Valentin Yur'yevich; senior scientific research worker, Lenin Order Red Banner Academy of military artillery imeni Kalinin, Leningrad

Morozov, Ivan Ivanovich (dec.); doctor in technical sciences, professor of Chelyabinsk Polytechnical Institute

Nikolenko, Vladimir Nikolayevich; engineer, Kharkov

Novikova, Natal'ya Grigor'yevna; graduate student of Dnepropetrovsk State Univeristy

Norkin, Vladimir Ivanovich; engineer, Institute of Cybernetics, Ukrainian Academy of Sciences, Kiev

Onopchuk, Yuriy Nikolayevich; candidate in phys.-math. sciences, senior scientific research worker, Institute of Cybernetics, Ukrainian Academy of Sciences, Kiev

Ostapenko, Valentin Vladimirovich; graduate student of Institute of Cybernetics, Ukrainian Academy of Sciences, Kiev

Petunin, Yuriy Ivanovich; doctor in phys.-math. sciences, professor of Kiev State University

Popov, Vyacheslav Aleksandrovich; candidate in technical sciences, docent of Kharkov Aviation Institute

Primenko, Eduard Andreyevich; candidate in phys.-math. sciences, docent of Moscow Institute of Electronic Machine Building

Pshenichnyy, Boris Nikolayevich; doctor in phys.-math. sciences, division head, Institute of Cybernetics, Ukrainian Academy of Sciences, Kiev

Rappoport, Iosif Simovich; engineer, Institute of Cybernetics, Ukrainian Academy of Sciences, Kiev

Rzhevskiy, Sergey Vladimirovich; engineer, Institute of Cybernetics, Ukrainian Academy of Sciences, Kiev

Senkene, El'vira Aloizo; candidate in phys.-math. sciences, junior research worker, Institute of Mathematics and Cybernetics, Lithuanian Academy of Sciences, Vilnius

Serov, Gennadiy Petrovich; candidate in phys.-math. sciences, docent of Moscow Physicotechnical Institute

Skibenko, Igor' Timofeyevich; candidate in technical sciences, senior instructor, Kharkov Aviation Institute

Khenkin, Mark Zusmanovich; senior scientific worker, Scientific-Research Institute of Automation of Ferrous Metallurgy, Dnepropetrovsk

Chebotarev, Anatoliy Nikolayevich; candidate in technical sciences, senior scientific research worker, Institute of Cybernetics, Ukrainian Academy of Sciences, Kiev

Shakhnov, Igor' Fedorovich; candidate in phys.-math. sciences, senior scientific research worker, Computing Center, USSR Academy of Sciences, Moscow

Shul'deshov, Georgiy Aleksandrovich; engineer, Institute of Cybernetics, Ukrainian Academy of Sciences, Kiev

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AUTHORS OF PAPERS IN JANUARY-FEBRUARY 1980 ISSUE OF KIBERNETIKA

Kiev KIBERNETIKA in Russian No 1, January-February 1980 p 148

[Text]

Agibalov, Gennadiy Petrovich, candidate of physicomathematical sciences, laboratory head of the Siberian Physicotechnical Institute, Tomsk.

Al'perovich, Il'ya Vladimirovich, senior scientific associate of VNIIKAN-eftegaz [All-Union Scientific Research, Planning and Design Institute of Complex Automation in the Petroleum and Gas Industry], Moscow.

Bakenrot, Vladimir Yuzefovich, laboratory head of the Planning-Design and Production Institute of Forge and Press Automatic Device Construction, Taganrog.

Bandman, Ol'ga Leonidovna, doctor of technical sciences, senior scientific associate of the Institute of Mathematics of the Siberian Department of the USSR Academy of Sciences, Novosibirsk.

Baskakov, Vyacheslav Alekseyevich, engineer of the Scientific Research Sector of the Rybinsk Aviation Technological Institute.

Belov, Yuriy Anatol'yevich, candidate of physicomathematical sciences, assistant professor of Kiev State University.

Beresnev, Vladimir Vladimirovich, candidate of physicomathematical sciences, Kiev.

Burdyuk, Vladimir Yakovlevich, candidate of physicomathematical sciences, associate professor of Dnepropetrovsk State University.

Vidomenko, Valeriy Petrovich, candidate of technical sciences, senior scientific research worker, Chief Designer of the project of the state All-Union Design-Production Office on Design of Calculating Machines, Leningrad.

Voytishin, Yuriy Valentinovich, postgraduate student of the Institute of Cybernetics of the Ukrainian SSR Academy of Sciences, Kiev.

Gayvoronskiy, Aleksey Alekseyevich, postgraduate student of Moscow Physicotechnical Institute, Kiev.

Gladshteyn, Mikhail Arkad'yevich, candidate of technical sciences, assistant professor, Rybinsk Aviation Technological Institute.

Golodnikov, Aleksandr Nikolayevich, junior research worker of the Institute of Cybernetics of the Ukrainian SSR Academy of Sciences, Kiev.

Gorshkov, Pavel Vladimirovich, assistant at Kiev State University.

Dem'yanov, Vladimir Fedorovich, doctor of physicomathematical sciences, professor of Leningrad State University.

Yevtimov, Venelin Krystev, candidate of physicomathematical sciences, junior research worker of the Soviet-Bulgarian Scientific Research and Planning Institute Interprogramma, Sofiya.

Yevtushenko, Nina Vladimirovna, senior scientific research worker of the Siberian Physicotechnical Institute, Tomsk.

Yerusalimskiy, Yakov Mikhaylovich, candidate of physicomathematical sciences, assistant at Rostov-na-Donu State University.

Kaspshitskaya, Mariya Fadeyevna, candidate of physicomathematical sciences, senior scientific research worker of the Institute of Cybernetics of the Ukrainian SSR Academy of Sciences, Kiev.

Kas'yanov, Viktor Nikolayevich, candidate of physicomathematical sciences, Head of a group of the computer center of the Siberian Department of the USSR Academy of Sciences, Novosibirsk.

Komarov, Valeriy Mikhaylovich, senior engineer of the Scientific Research Sector of the Rybinsk Aviation Technological Institute.

Korneyev, Viktor Vladimirovich, candidate of technical sciences, junior research worker of the Institute of Mathematics of the Siberian Department of the USSR Academy of Sciences, Novosibirsk.

Kukhta, Tamara Konstantinovna, junior research worker of the Institute of Cybernetics of the Ukrainian SSR Academy of Sciences, Kiev.

Levin, Mark Shmuilovich, technical supervisor of a Group of the Experimental-Methodical Expedition of Automated Control Systems of the Ministry of Geology of the RSFSR, Moscow.

Le Din' Fung, postgraduate student of Kiev State University.

Lisovick, Leonid Petrovich, candidate of physicomathematical sciences, senior teacher, Kiev State Unversity.

Norkin, Vladimir Ivanovich, engineer of the Institute of Cybernetics of the Ukrainian SSR Academy of Sciences, Kiev.

Petrenyuk, Anatoliy Yakovlevich, candidate of physicomathematical sciences, senior teacher of the Kirovograd Institute of Agricultural Machine Building.

Petrenyuk, Lidiya Petrovna, programmer-engineer of the Kirovograd Typewriter Plant.

Primak, Mordukh Yevseyevich, candidate of physicomathematical sciences, senior scientific research worker of the Ukrainian branch of the Scientific Research Institute for Planning and Standards of Gosplan of the USSR, Kiev.

Rzhevskiy, Sergey Vladimirovich, senior engineer of the Institute of Cybernetics of the Ukrainian SSR Academy of Sciences, Kiev.

Romov, Boris Aronovich, junior research worker of the Institute of Automatics, Kiev.

Rystsov, Igor' Konstantinovich, senior engineer of the Institute of Cybernetics of the Ukrainian SSR Academy of Sciences, Kiev.

Svetlov, Gleb Glebovich, engineer of VPKTI Atomkotlomash, Rostov.

Sergienko, Ivan Vasil'yevich, corresponding member of the Ukrainian SSR Academy of Sciences, head of department, Institute of Cybernetics of the Ukrainian SSR Academy of Sciences, Kiev.

Fedorenko, Irina Konstantinovna, postgraduate student of Kiev State University.

Shepilov, Mikhail Aleksandrovich, candidate of physicomathematical sciences, assistant professor of Vladimir Polytechnical Institute.

Shomesova, Valentina Konstantinovna, assistant at Syktyvkar State University.

Yastremskiy, Aleksandr Ivanovich, candidate of economic sciences, Senior Teacher of Kiev State University.
[264-6521]

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CSO: 1863

PUBLICATIONS

UDC 621.3.049.774.2.001.57

AUTOMATING THE DESIGN, FABRICATION AND TESTING OF INTEGRATED CIRCUITS

Kiev INSTITUT KIBERNETIKI AKADEMII NAUK UKRAINSKOY SSR. PREPRINT in Russian No 78-8 signed to press 3 Aug 78 pp 9, 22, 30

[Excerpts from the booklet edited by N.V. Grigorenko, 30 pages, 300 copies]

[Excerpt] The layout stage for geometrically standardized components (diodes) in the case of a computerized design of a topological network variant for four-cycle MOS LSI will be treated in this paper. . .

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[258-8225]

8225
CSO: 1863

THE POSSIBILITY OF USING COMPUTERS TO CONTROL RAPIDLY DEVELOPING PROCESSES

Kiev INSTITUT KIBERNETIKI AKADEMII NAUK UKRAINSKOY SSR, PREPRINT in Russian No 35, 1978

[Excerpts from the preprint by M. M. Dargeyko and F. B. Rogal'skiy, Institute of Cybernetics of the Ukrainian SSR Academy of Sciences, 300 copies, 30 pages]

[3-4]

A great deal of attention has been devoted in recent years to problems of controlling rapidly developing processes. These problems are encountered in synthesis of nuclear reactor control systems, spacecraft, plasma confinement in physical experiment installations, chemical reactors for polymer production and many other processes. It is known that rapidly developing processes are in most cases typical for systems with distributed parameters.

Some problems of using modern computer equipment to develop automatic control systems for rapidly developing processes are considered in the present article.

[5]

A promising trend is development of laser-based optical AVM [Analog computers]. An optical AVM which uses a luminous flux as a machine variable has exceptionally high speed. Thus, the computer issues the result of multiplying a 10^4-nery vector by a square matrix of dimension 10^4 within 10^{-3} second [15].

[23-24]

Conclusions

The specifics of the problems of controlling rapidly developing processes which arise in different fields (control of chemical production, plasma control, nuclear experiment and so on) leads to the need to develop new ideas and methods of realizing them. Modern computer equipment has the most widely functional capabilities for solving the indicated problems. Attempts to introduce control computers in closed SAU [Automatic control systems] of rapidly developing processes have been undertaken both in our country and abroad. There is already experience in using many computers in development of laboratory computer systems for scientific research and data processing in real time; control of some magnetic fields can be more easily accomplished by using computers; control computers are used successfully in nuclear power plant control systems and so on. As can be seen from the given communication, modern computers, whose speed has reached several tens of millions of operations per second, permit one to develop effective process control systems characterized by times on the order of milliseconds. However, the evolution of computers is far from complete and realization of new ideas in the field of computer development permits one to hope for achievement of higher indicators on computer capacity and reliability.

The most promising among presently available computer equipment for use in high-speed SAU (in the presence of simple, finished control algorithms) are modern highly productive microprocessors and also specialized computer devices formulated on the basis of individual functional blocks.

Analysis of control system structures shows that the use of adaptive systems and direct digital control systems is limited at the modern stage of computer development by processes with typical times on the order of hundreds of microseconds. Various types of combination automatic control systems can be developed to control processes with smaller typical times. The control machine in these systems either realizes the program part of the overall control system or performs functions of adjusting analog regulators.

The construction of hierarchical control systems, where the capabilities of combination SAU are combined with those of separation and compression of information and more operational processing of it, may be promising for complex production processes.

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[262-6521]

6521
CSO: 1863

UDC 519.867

NEW AGGREGATION TECHNIQUE FOR LINEAR, CONVEX PROGRAMMING

Kiev INSTITUT KIBERNETIKI AKADEMII NAUK UKRAINSKOY SSR. PREPRINT in Russian No 50, 1978 p 2.

[Annotation of Booklet: "Solving Large Problems of Linear Programming Using Aggregation"]

[Text] This booklet proposes and substantiates an original technique of aggregation for solving large linear and convex programming problems. The numerical experiment given demonstrates the comparatively high efficiency of the technique.

11,176
CSO:1863

UDC 621.317

USES OF MINICOMPUTERS IN COMPLEX SYSTEMS

Kiev INSTITUT KIBERNETIKI AKADEMII NAUK UKRAINSKOY SSR. PREPRINT in Russian No. 51, 1978 pp 2, 26-29, 34, 35, 45, 46.

[Annotation, excerpts, and abstracts from booklet: "The Application of Minicomputers and Analysis of Stochastic Processes in Multimachine Complexes"]

[Excerpts] This booklet considers questions of the functioning of complex systems and minicomputers: an analysis is made of the efficiency of systems based on stochastic processes; the law of functioning of the autostatement of a multiprocessor line is optimized; a variation of the structure of a controlling minicomputer is described; the minimum modification of a device for communication with units of the Sektor system of technical devices is determined; an algorithm is described for encoding microcommands with a limitation on their word length. The questions considered in this booklet will be of interest to specialists in the development and introduction of minicomputers.

There are areas of application of specialized digital computers where operating conditions and the designation of the computer impose supplementary requirements which are often conflicting (for example, maximum speed, high reliability, limited weight and dimensions, low energy-intensity, and low service requirements).

Specialization of computers to solve a particular class of problems assumes that this class of problems has definite characteristics and, thanks to specialization of the machine, it is possible to obtain the required characteristics and satisfy the above-mentioned conflicting demands.

These principles can be used fully for controlling specialized computers that are expected to solve one or several similar control problems, whereas it is unwise or simply impossible to use general-purpose computers for this same work. We are referring to on-board machines designed to control motion or a technological process in real time.

The set of requirements imposed on such machines forces developers to seek maximum use of possibilities presented by the specific features of the problem being solved which are reflected in the structure of the specialized computer.

The particular techniques for planning the special computers are determined individually in each particular application. We will attempt here to investigate one possible structure of a specialized digital computer using the example of a machine designed to solve the problem of straightening railroad tracks and included in the circuit of the automated control system of an VPO-3000 straightening device.

Calculating the straightening of a railroad track involves solving a problem of nonlinear programming with bilateral constraints on dependent and independent variables. This problem typically has a large number of variables and constraints (800 variables and 1,600 constraints), which creates significant computing difficulties in seeking the optimal variation.

To reduce the dimensions of the problem the Central Scientific Research Institute of the Ministry of Railroads developed a method that makes it possible to calculate a microplan based on incomplete raw data on the condition of the road [3]. This approach made it possible, instead of solving an initial problem of dimensionality p, to find a sequential solution to p by solving lower-order problem m, with the order of magnitude of m set at about 15. However, even in this case the problem remains quite complex from a computing standpoint.

As a result of research [4] a generalized gradient technique using the penalty function method was selected to solve this problem. A solution algorithm for the problem and a simulation program for the BESM-6 computer were developed on the basis of this method. The results of solving test problems confirmed that this is an efficient technique, but they also showed that the control machine must have an effective speed commensurate with that of a large computer to meet the speed requirement. Analysis of the speed capabilities of various small domestic computers confirms this.

The possibility of constructing an analog computer to simulate the problem was reviewed. However, the necessity of a large volume of analog memory and a significant number of code-controlling admittances, as well as the problem of stability of problem-solving with the analog model made the use of the analog special computer alternative unacceptable. As a result it became necessary to develop an alternative structure of a specialized digital computer which would meet the requirements of high speed, high reliability, and small weight and dimensions, in other words, the optimal structure to satisfy the given quality criterion. This can be achieved by establishing the maximum correspondence of machine structure to the algorithm found.

It can be assumed that a specialized minicomputer with high effective speed could meet the given quality criterion.

One of the chief ways to increase the productivity of minicomputers is to eliminate the causes of downtime in the operations block, especially when the problem-solving algorithm envisions sequential performance of a series of "short" addition-type operations. Therefore, we must search for structural concepts which permit the greatest reduction in the number of operations involving storing and moving intermediate results, and the like.

To eliminate downtime in the operations block it is necessary to combine the work of different blocks and devices in the process of carrying out a single command and to combine preparation for subsequent commands in the process of performing the current ones. Such combination is possible with special memory organization and control layout.

The problem to be solved has a certain regular cycle, and this makes it possible to suggest the wisdom of stack or magazine memory containing several sections. The number of sections should correspond to the number of vectors of the variables taking part in the computation procedure and the number of constraint vectors. Such a system insures timely feeding of operands to the operations block as space becomes available. The depths of the stacks is determined by the order of the system of equations or inequalities being solved.

We know [5, 6] that no-address commands are typical for this kind of organization of internal memory. In addition, a no-address computer permits an increase in effective speed by reducing the operations of copying and selecting intermediate results. During execution of the programs stored in memory it becomes necessary to distinguish operators and operands arriving in a definite sequence. The usual way to do this is to allocate additional bit positions in memory cells, which may occupy more than 10 percent of memory volume. Equipment and time is used. Therefore, it is advisable, for purposes of memory economy and reducing word length with due regard for the specific characteristics of the problem being solved, to store only operands in internal memory and to fix the program for solving the problem in some rigid manner in the control device. This also makes possible to increase machine speed.

On the basis of the above, the following conclusions may be drawn:

1. The structural characteristics of a specialized digital computer that make possible a significant increase in effective machine speed are no-address organization of the computer, organization of internal memory by sections and stacks, combining the functional operational block and memory block in time, structural scaling and the absence of coding of commands and related decoding operations, and combining commands and microcommands.

2. Fixing the program in the control blocks of the control unit and allocating internal memory space only for operands makes it possible to reduce the word length of the special digital computer to 16 bit positions.

3. Maximum correspondence between the structure of the control unit and the problem-solving algorithm greatly simplifies operation of the machine and monitoring its functioning.

4. Building all blocks and assemblies of the computer with the same basic elements reduces demands on the power supply block with respect to number of power sources needed.

5. These principles have been realized in the structure of the Put' special digital computer which is designed to control the process of straightening railroad tracks. Development of the Put' machine was completed with manufacture of a sample model in 1975. Test problems confirmed the effectiveness of the structure, and technical specifications meet the assigned requirement.

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UDC 621.317.088

Mikhaylov, V. M., and Semotyuk, M. V., "Hardware Determination of the Parameters of the Ejections of Random Processes"

This article considers questions of constructing digital devices to determine the parameters of the ejections of random processes. The composition of necessary assemblies to construct such devices is determined and techniques for analyzing the parameters of the ejections of random processes are described. These techniques are the basis for performing computations in these devices. The article has two bibliographic entries and three illustrations.

UDC 519.21

Akimov, A. P., "A Model Mass Service System with Variable Structure and Foreorder"

This article considers the problem of analyzing a two-channel mass service system with losses, variable structure, foreorder, elementary input flows of demands, and an effective service layout. An important characteristic of the system is determined: the function of distribution of the time of the first failure of a requirement, which is obtained on the basis of using the apparatus of semi-Markovian processes together with a consolidation algorithm. The article has three bibliographic entries and one illustration.

UDC 519.21

Semesenko, M. P., "Nonstationary Random Processes with Identification of the Concealed Periodic Component Oriented to Small Computers"

This article considers the problem of forecasting random processes whose probability characteristics change over time for the case where the mathematical expectation of a nonstationary random process is a semi-harmonic function. The article has three bibliographic entries and one illustration.

UDC 681.325

Vlasenko, Yu. V., Proskurin, Ye. A., and Trayanin, E. Z., "Version of the Structure of a Control Specialized Digital Minicomputer"

This article describes the principles of development of a minicomputer with high effective speed using the example of synthesizing the structure of a special digital minicomputer. The article has eight bibliographic entries.

UDC 681.327

Reutov, V. B., Vavilin, G. V., and Sevast'yanov, A. K., "Minimum Modification of a Device for Communication with the Units of the Sektor System of Technical Devices"

This article describes the minimum modification of a standardized device for communication with experimental research units. The device considered may be used effectively in those cases where a limited number of technical devices are required to organize communication with the units. The article has two bibliographic entries and two illustrations.

UDC 681.3.19/47

Belitskiy, R. I., "Coding Microcommands with Constraints on their Word Length"

This article considers questions of the efficient use of the microprogram memory of a mini- or microcomputer for the case where constraints on the word length of control : words are given.

11,176
CSO:1863

UDC 681.3.06.51

MODULAR ANALYSIS OF STATISTICAL PROCESSING OF TIME SERIES

Kiev INSTITUT KIBERNETIKI AKADEMII NAUK UKRAINSKOY SSR. PREPRINT in Russian No 53, 1978 p 2.

[Annotation of booklet: "Modular Analysis of Problems of Statistical Processing of Time Series"]

[Text] This booklet is devoted to a modular analysis of the class of problems of statistical processing of time series, which is one of the stages in the development of contemporary program packages. In this case the particular class of problems is represented by a sequence of five levels of investigation: elementary statistical analysis (evaluation of statistical characteristics), elimination of nonstationary features (reduction to stationary form), evaluation of second-order statistics, spectrum (autospectrum) analysis, cross-spectrum (mutual spectrum) analysis. At each level of investigation the problems, structure of raw data, and algorithms for their solution are analyzed and a system of program modules is constructed.

The results of this work have found application in the SYePAK integrated instrument system of program packages being developed at the Institute of Cybernetics of the Academy of Sciences Ukrainian SSR.

11,176
CSO: 1863

APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000200090046-0

UDC 62-50:669.1+519.9:62-83

MODELING AND OPTIMIZING METALLURGICAL PRODUCTION PROCESSES

Kiev INSTITUT KIBERNETIKI AKADEMII NAUK UKRAINSKOY SSR. PREPRINT in Russian No 54, 1978 pp 47-48

[Abstracts of articles from booklet: "Modeling and Optimization of Production Processes in Metallurgical Production"]

[Excerpts]

UDC519.9:62-83

Volchenko, Yu. M., "Optimal Control of Nonlinear Discrete Systems with Rigorously Increasing Righthand Parts"

This article studies the class of nonlinear discrete systems in which the vector function, composed of the righthand parts of the system, increases rigorously for all components of the vector of state. The author proposes principles for optimizing such systems and algorithms for the construction of sets of optimal control strategies. These proposals are outstanding for their simplicity and convenience of computer realization.

The article demonstrates the application of the results obtained both to the general mathematical model of optimal distribution of processing time for semifinished parts for M machines and its particular variations: models of processes for rolling batches of semifinished parts in two- and three-high reversing mills.

UDC 62-50:669.1

Tarenko, P. O., Ionov, A. V., and Chuberkis, V. P., "Construction of Mathematical Models of the Functioning of Steel Smelting Systems"

This article reviews a procedure for describing the operation of a steel smelting system. The technique involves an informal level of compiling a logical structural diagram and subsequent investigation and transformation of it using the modified language of K lists. Results are given from statistical investigation of particular types of open hearth furnaces as control objects.

UDC 62-50:621.783

Pryatskin, L. L., Tkachenko, V. N., "Investigation of the Parametric Sensitivity of Mathematical Models of the Process of Heating Bodies"

This article considers a number of problems of analyzing the sensitivity of the parameters of mathematical models of the process of heating bodies. The properties of the sensitivity functions of the model are investigated in a broad range of input actions. A procedure identifying the parameters of the model using variable information on the heating process is constructed on the basis of sensitivity functions.

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UDC 658.012.011.56:624.012

AUTOMATED CONTROL SYSTEMS FOR REINFORCED CONCRETE PRODUCTION, DELIVERY

Kiev INSTITUT KIBERNETIKI AKADEMII NAUK UKRAINSKOY SSR. PREPRINT in Russian No 58, 1978 pp 2, 5-8, 9-11, 56

[Annotation, excerpts of articles, and table of contents of booklet: "Automated Control Systems for Production and Deliveries of Reinforced Prefabricated Concrete"]

[Excerpts] This booklet considers the basic questions of modeling the problems of planning and operational control of the production and complete delivery of reinforced prefabricated concrete, plan optimization, enterprise specialization, and data processing technology.

The articles describe the primary results of experimental use of a set of problems by the Ministry of Industrial Construction of the Ukrainian SSR together with the Scientific Research Institute of Automated Systems in Construction of Ukrainian SSR Gosstroy. The data presented will be of interest to employees at computing centers and engineering-technical personnel of construction and installation organizations engaged in preparation for production and organizing full deliveries of reinforced prefabricated concrete to construction sites.

Many examples can be given of the use of computers to plan full delivery of reinforced prefabricated concrete, mortar, concrete, asphalt-concrete, and steel construction components, to monitor performance of full supply schedules, and to calculate the requirement for metal, cement, and other materials to make assembly components (Territorial Main Administration for Construction in Western Regions of the RSFSR of the USSR Ministry of Construction, the Ministry of Power and Electrification, the Volgograd Zhelezobeton Production Association of the USSR Ministry of Industrial Construction, the Ministry of Rural Construction, the Ministry of Construction of Heavy Industry Enterprises, and others).

Until now, however, the problem of full supply to construction sites has been solved at the level of scattered local problems without broad dissemination.

The principal factors behind this lack of coordination in solving the problem are that construction organizations have different types of computers (the Ural, Minsk-22, Minsk-23, Dnepr, Ruta, Nairi, and M-600YeS) and the lack of coordination of developmental work.

The necessary prerequisites have now been established for a comprehensive (systems) solution to the problem of automated control systems in construction, above all the problem of full supply to construction sites as the most timely and technologically independent subsystem of the construction automated control system.

Construction organizations are being supplied with compatible third-generation YeS series computers.

USSR Gosstroy has ratified standard technical specifications for the subsystem "Control of Industrial Production in Construction," which establishes a list of priority jobs in supply to construction sites.

NIIASS [Scientific Research Institute of Automated Systems in Construction] of Ukrainian SSR Gosstroy has been named the head organization in the USSR for the development of standard design concepts for the subsystem "Control of Industrial Production in Construction."

The Ukrainian SSR Ministry of Industrial Construction, the Ukrainian SSR Ministry of Construction of Heavy Industry Enterprises, and NIIASS of Ukrainian SSR Gosstroy have worked out target programs to set up automated control systems for the production and delivery of reinforced prefabricated concrete and control of the entire construction industry.

USSR Gosstroy approved the basic principles of the problem sets of the first phase of the automated control system being developed by the Ukrainian SSR Ministry of Industrial Construction, the Ukrainian SSR Ministry of Construction of Heavy Industry Enterprises, and NIIASS for full supply of reinforced prefabricated concrete articles and recommended that Ukrainian construction ministries and departments make use of the practices of these ministries in their development work.

The first phase of the Ukrainian SSR automated system being developed includes standard design concepts for sets of problems to supply construction sites with all needed prefabricated reinforced concrete articles.

The first phase of the supply automated control system under development at the Ukrainian SSR ministries of Ministries of Industrial

Construction and Construction of Heavy Industry Enterprises is based on the principle of a comprehensive solution to the problem within the framework of a large, provisionally self-contained construction association covering all levels of management from the brigade to the ministry and all stages of the control cycle from yearly planning to records and monitoring.

A comprehensive solution to the problem of supplying construction sites with reinforced prefabricated concrete within the framework of a republic construction ministry is accomplished by establishing uniform information, technical, mathematical, and organizational support for six interrelated sets of problems:

1. Formulating site and summary records of the needs of construction organizations for reinforced prefabricated concrete;

2. Devising indexes of the production feasibility of lines to produce reinforced prefabricated concrete;

3. Annual planning of production and batches of reinforced prefabricated concrete to be delivered on the basis of optimal assignment of suppliers to customers;

4. Quarterly planning of production and delivery of reinforced prefabricated concrete obtained by balancing construction schedules with schedules for production of articles at reinforced prefabricated concrete enterprises;

5. Operational (weekly-daily) planning of articles on the production lines at reinforced prefabricated concrete enterprises based on maximum satisfaction of the needs of construction organizations;

6. Records of production and monitoring deliveries of reinforced prefabricated concrete with imposition of penalties for violation of deadlines for supplying full needs and organization of accounts between suppliers and receivers.

Successful completion of the planned program for development and introduction of the supply automated control system in the Ukrainian SSR ministries of Industrial Construction and Construction of Heavy Industry Enterprises and its spread to other ministries and departments require that a number of organizational questions be settled.

1. The question of setting up schools of progressive know-how is the most difficult and pressing matter. Dissemination of automated control system problems to numerous construction organizations through the efforts of developers retards the rate of development of new problems and complicates the process of training the purchaser's personnel during the period when traditional problem solving methods are combined

with new ones. Setting up permanent schools of progressive know-how based at leading construction organizations (base organizations) will make it possible to step up the introduction of new problems significantly.

The base organizations should have new equipment, financing, and teachers and instructors. The training process at base organizations must be coordinated with the process of selection and placement of managers and administrative workers in construction organizations.

2. Significant reserves for accelerating the development and introduction of supply automated control systems can be realized by further cooperation among automated control system developers at different ministries and departments.

Unfortunately, duplication of development oriented to the use of third-generation computers continues today.

Through the offices of Ukrainian SSR Gosplan, Ukrainian SSR Gosstroy, and the main technical administrations of the ministries and departments we must put an end to lack of communication and strictly coordinate further development work.

Coordination of this work can be assigned to NIIASS of Ukrainian SSR Gosstroy. Financing for development work not reconciled with the coordinating body should be stopped beginning in 1978.

3. The lack of a uniform methodology for modeling the problems of calendar planning of construction and installation is a serious obstacle to standardization of supply problems for a broad range of construction organizations.

The diversity of types of work and coordination of the list and composition of norm-controlled processes at the level of plan and estimate documents and at the level of production planning norms do not permit the creation of a standardized model of the problem of optimizing calendar planning for construction and installation.

The proposed NIIASS scheme for matching the list and composition of norms of labor processes in the stage of development of planning and estimate papers and production planning norms for resources significantly reduces the parameters of the model of the problem of calendar planning and offers ways to develop standard planning concepts reconciled with supply problems.

4. It is impossible to solve supply problems without formation of the appropriate technical base for automated control systems at construction organizations. Experience with planning hardware complexes for the sectorial automated control systems of the Ukrainian

SSR Ministries of Industrial Construction and Construction of Heavy Industry Enterprises testifies to the need to set up a specialized planning organization to work out plans for supplying and developing comprehensive hardware for the particular regions. The problem of equipping primary data processing points at plants, trusts, and construction and installation administrations is especially pressing.

Infatuation with large computing centers without a broad network of primary data processing points and communications equipment puts the employees of lower-ranking organizations in a situation where they have little interest in the use of computers and introduction of automated control system problems.

Solving these organizational problems will permit a significant acceleration of the development and large-scale introduction of supply automated control systems and will provide an annual economic impact from growth in labor productivity in construction of roughly 3 million rubles by the end of the 10th Five-Year Plan.

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UDC 658.012.011.56:69.005

DEVELOPMENT OF AUTOMATED CONTROL SYSTEMS FOR CONSTRUCTION

Kiev INSTITUT KIBERNETIKI AKADEMII NAUK UKRAINSKOY SSR. PREPRINT
in Russian No 59, 1978, pp 2, 4-5, 55

[Annotation, excerpt of article, and table of contents of booklet: "Basic Principles of Methodological Uniformity of Construction Automated Control Systems"]

[Excerpts] This booklet considers the basic principles of systems modeling of the production processes of organizational control, formulating the problems of construction ASU's [automated control systems], classification of types of jobs and resources, shaping flows of production and norm information. Results are given from studies by NIIASS [Scientific Research Institute of Automated Systems in Construction] in the fields of designing and experimental operation of a series of construction ASU's. Recommendations are given on first-priority organizational steps to develop and ratify uniform methodological materials for formulating the construction ASU of the Ukrainian SSR.

The material in the booklet is intended for ASU developers, engineering-technical personnel at construction, planning, and scientific research organizations, Orgtekhstroy trusts, and information and computing centers, and teachers and students at construction higher educational institutions.

A number of objective factors prevented the development of effective automated control systems during the last five-year plan:

a. for a long time the sector did not have definite basic principles for classifying components of production processes;

b. until 1975 the country was not producing a standard system of electronic computer equipment and construction organizations employed more than six types of computers, which did not provide technical and program compatibility among systems being set up;

c. the construction sector had not established large collectives with experience in the development and operation of sets of construction ASU problems, which prevented the development of a uniform methodology for devising control systems. Foreign and domestic practice shows convincingly that methodological principles for such major problems as construction ASU's can only be worked out by large collectives who have gathered the necessary experience, both positive and negative, in their own development work.

In 1974-1976 the necessary conditions for working out a methodology of formulating and improving the efficiency of construction ASU's came about:

a. principles for the classification of components of production processes were worked out;

b. production of a standard system of third-generation computers with compatible hardware and software was organized;

c. several large collectives of system developers were formed.

The lack of a standard methodology for setting up ASU's led and still leads to a number of serious problems in the systems being developed above all to incompatibility with respect to formulation, technology, organization, software, and hardware and the impossibility of broad dissemination of available, expensive development work among the construction organizations of the country. Therefore, various efficient systems set up in Moscow, Leningrad, Khar'kov, Minsk, Tallin, Donetsk, Kiev, and other cities are local and cannot, for the reasons indicated, be disseminated broadly in the sector. Moreover, without methodological uniformity there is no need to think of developing standard design concepts in construction ASU's, efficient realization of any coordination plans, or elimination of duplication of expensive development work.

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CSO:1863

INCREASING THE PRODUCTIVITY OF INFORMATION PROCESSING EQUIPMENT

Kiev INSTITUT KIBERNETIKI AKADEMII NAUK UKRAINSKOY SSR, PREPRINT in Russian
No 60, 1978

[Excerpts from the collection "Povysheniye proizvoditel'nosti sredstv obrabotki informatsii" edited by L. V. Tverdov, Institute of Cybernetics of the Ukrainian SSR Academy of Sciences, 300 copies, 61 pages]

[2]

UDC 681.3.06:51

Problems devoted to organization of graphical information processing in an automated system for design of machine building objects and also problems of optimum design of a system for automation of scientific experiment, development of a problem-oriented complex and deparallelling of the computer process are considered.

[3]

The system for automation of designing machine building objects (SAPR M) consists of the following basic components:

a data bank, an operational system, input language interpreter and geometric information processing module pack [1, 2].

The module pack for geometric information processing depends mostly on the class of problems toward which the SAPR is oriented. Therefore, even if there is an insignificant variation of the class of problems during operation of the system, great efforts are required to modify the pack. To reduce these efforts to a minimum, one must:

process complex tasks (operators) by a unified scheme (technique);

use the developed internal language of data presentation.

[4]

The structure of the complex task and the corresponding complex module for fulfilling it is shown in Figure 1. Examples of complex modules are TANGENTIAL, INTERSECTION and CONJUGATION, which include the elementary modules SEGMENT, ARC and CIRCLE.

[6]

The considered module pack is realized on the M-6000 computer using the SIGD graphical display and the VIDEOTON-240 alphanumeric display.

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[6-7]

With regard to the lability of laboratory experiment considered as an object of automation, analysis of the external algorithm of experiments to be automated acquires special importance in design and operation of systems for automation of scientific laboratory experiment (SANLE). The results of this analysis determine to a significant degree the composition and structure of the hardware and software of SANLE.

[59-60]

UDC 681.3.06

Formalized Analysis of an External Algorithm for Experimental Research, Solov'yev, V. P. and N. I. Alishov

The generalized structure of the process of experimental research considered as an object of automation is investigated, the concept of an external algorithm of experimental research is given and determination of the step by step structure of the experiment is introduced. The criteria of optimizing the functioning of the scientific experiment automation system are formulated on the basis of formulization of the introduced conecpts.

UDC 681.3.02; 681.325

Realization of the Pair Product Sum Operator, Kozlov, L. G.

Various methods of deparallelling the calculating process and technical realization of the group operator of the sum of pair products are considered and comparative analysis of the computer devices which realize this typical operator is presented according to the apparatus expenditures and speed as a function of the number of added products of pairs of numbers and as a function of the digit capacity of representation of the input information and the results of calculations. Figures 6, references 4.

UDC 681.3.06:94

Some Algorithms for Solving Systems of Linear Algebraic Equations on Problem Oriented Computers, Kovlov, L. G.

Problems of constructing problem-oriented computer complexes are considered in which high productivity and effectiveness of calculations are achieved by orientation of the device to solution of a specific class of problems and the use of special algorithms designed for apparatus realization. Modified algorithms for solving systems of linear algebraic equations are proposed which permit significant simplification of the computer and extensive deparallelling of the calculation process. Figures 8, references 1.

UDC 681.3.06:51

Processing Geometric Information in an Automatic Design System, Dodonov, S. B. and T. P. Potapova

The paper is devoted to development of a machine graphics system and specifically to processing of user tasks. The mode of using a luminous keyboard, the advantage of which is the use of a language close to natural, for example, for constructing a sketch and formation of a part drawing from it, is considered. Figures 2, references 3.
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UDC 658.562-12.2:007

CONSTRUCTING DECISION-MAKING MODELS WITH OPERATIONAL CONTROL OF THE WORK OF A SEGMENT WITH SINGLE AND SMALL-SERIES NATURE OF PRODUCTION

Kiev INSTITUT KIBERNETIKI AKADEMII NAUK UKRAINSKOY SSR, PREPRINT in Russian No 66, 1978, p 2

[Annotation from the preprint "Postroyeniye modeley prinyatiya resheniy v usloviyakh operativnogo regulirovaniya raboty uchastka s yedinichnym i melkoseriynym kharakterom proizvodstva" by P. P. Zhukov, Institute of Cybernetics of the Ukrainian SSR Academy of Sciences, 300 copies, 51 pages]

The problem of constructing a model of an automated operational control system of the work of a production section is considered.

The model of determining the completion times of performing a production operation by a production worker, when his labor productivity varies during the working shift, is constructed.

Decision-making models in the most typical situations occurring during operational control in sections with unit and small-series nature of production are constructed.

The preprint is intended for designers of operational control and regulation systems, foremen of production sections, planners, engineering and technical personnel of enterprises and scientific research organizations. [262-6521]

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CSO: 1863

METHODS OF SOFTWARE DESIGN FOR ASUS PROBLEMS

Kiev INSTITUT KIBERNETIKI AKADEMII NAUK UKRAINSKOY SSR, PREPRINT in Russian No 79, 1978

[Table of Contents from the collection "Metody proyektirovaniya matematicheskogo obespecheniya zadach ASUS," Institute of Cybernetics of the Ukrainian SSR Academy of Sciences, 400 copies, 57 pages]

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CSO: 1863

PROBLEMS OF ECONOMIC AND MATHEMATICAL MODELLING OF THE COST OF COMPUTER EQUIPMENT

Kiev INSTITUT KIBERNETIKI AKADEMII NAUK UKRAINSKOY SSR, PREPRINT in Russian No 81, 1978 pp 17-19, 39

[Excerpts from the collection "Voprosy ekonomiko-matematicheskogo modelirovaniya sebestoimosti sredstv vychislitel'noy tekhniki," Institute of Cybernetics of the Ukrainian SSR Academy of Sciences, 300 copies, 41 pages]

Table 3. Calculation of the Saving at the Kursk Plant Schetmash Due to an Increase of Labor Productivity and Return of Funds and Due to a Reduction of the Specific Weight of Expenditures for Control and Maintenance of Production

Number of Item	Indices	1975	1976	1977
1	2	3	4	5
1.	Commercial products, thous. rubles	98,871	107,600	118,300
2.	Increase, thous. rubles		9,729	10,700
3.	Labor productivity, rubles	11,571.3	13,266	18,278.7
4.	Rate of increase of labor productivity, percent		14.6	37.78
5.	Percent of reduction of level of expenditures per ruble of commercial product due to the effect of the increase of labor productivity compared to the previous year (line 4 X 0.036)		0.53	1.36

[Table continued on following page]

Table 3 (Continued).

1	2	3	4	5
6.	Expenditures per ruble of commercial product, kopekcs	75		
7.	Level of reducing expenditures due to growth of labor productivity ((line 5 X line 6)/100, kopecks		0.3975	1.02
8.	Profits achieved from growth of labor productivity (line 7 X line 2) (1,000/100), rubles		38,673	109,140
9.	Specific weight of expenses for control and maintenance of production, percent	21.05	18.3	17.94
10.	Increase, percent		-2.75	-0.36
11.	Percent of reducing the level of expenditures due to the effect of reducing the specific weight of expenses for control and maintenance of production compared to the previous year (line 10 X 0.09)		0.2475	0.0324
12.	Level of reducing expenditures due to reduction of specific weight of expenses for control and maintenance of production (line 11 X line 6)/100, kopecks		0.1856	0.0243
13.	Profits achieved from reduction of specific weight of expenses for controlling maintenance of production (line 12 X line 2) (1,000/100), rubles		18,057	2,600
14.	Return of funds	4.98	5.78	6.14
15.	Rate of increase of return of funds, percent		16.06	6.22

[Table continued on following page]

Table 3 (Continued).

1	2	3	4	5
16.	Percent of reducing the level of expenditures per ruble of commercial product due to the effect of increase of return of funds compared to the previous year (line 15 X 0.1)		1.606	0.622
17.	Level of reducing expenditures for ruble of commercial produce due to increase of return of funds ((line 16 X line 6)/100), kopecks		1.2	0.4665
18.	Profit achieved due to increase of return of funds (line 17 X lin2) (1,000/100), rubles		116,748	49,915.5
19.	Total profit achieved by plant with regard to intensification of production (line 8 X line 13 + line 18), rubles		173,478	161,655.5

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PROBLEMS OF DESIGNING SPECIALIZED DIALOGUE INFORMATION SYSTEMS

Kiev INSTITUT KIBERNETIKI AKADEMII NAUK UKRAINSKOY SSR, PREPRINT in Russian No 82, 1978 p 41

[Table of Contents from collection "Voprosy proyektirovaniya spetsializirovannykh dialogovykh informatsionnykh sistem," Institute of Cybernetics of the Ukrainian SSR Academy of Sciences, 300 copies, 44 pages]

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CSO: 1863

UDC 519.283:518

STATISTICAL ESTIMATION BASED ON LOG-PSEUDOINVERSE OPERATORS

Kiev INSTITUT KIBERNETIKI AKADEMII NAUK UKRAINSKOY SSR. PREPRINT in Russian No 78-33 signed to press 4 Aug 78 pp 2, 38

[Annotation and Table of Contents from the booklet by V.I. Meleshko, 38 pages, 300 copies]

[Text] The properties of log-pseudoinverse operators are formulated and proved. Recurrent expressions are determined for the calculation of log pseudosolutions and log-pseudoinverse operators, specified in infinite Hilbert spaces. By using the established properties of the log pseudo-inverse operators, optimal log-affine estimates are constructed in general regression statistical problems for the elements of measurable infinite Hilbert spaces and recurrent algorithms are derived for the calculation of these estimates.

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[258-8225]

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CSO: 1863

UDC 519

COMBINATORIAL ALGORITHMS FOR THE SOLUTION OF CERTAIN MATHEMATICAL PROGRAMMING PROBLEMS

Kiev INSTITUT KIBERNETIKI AKADEMII NAUK UKRAINSKOY SSR. PREPRINT in Russian No 78-37 signed to press 15 Nov 78 pp 2, 33

[Annotation and Table of Contents from the booklet edited by Ye.N. Stepanenko, 33 pages, 300 copies]

[Text] The preprint is devoted to a study of problems related to making optimum decisions, questions of mathematical programming and network planning.

The preprint is intended for engineers and scientific workers involved in the development of optimization methods and their practical applications to the national economy.

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[258-8225]

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CSO: 1863

UDC 681.3.06:51

AN ANALYSIS OF ALGORITHMIC LANGUAGES FOR THE DESCRIPTION OF CHECK AND CONTROL PROBLEMS AND THE FORMULATION OF REQUIREMENTS ON THEM

Kiev INSTITUT KIBERNETIKI AKADEMII NAUK UKRAINSKOY SSR. PREPRINT in Russian No 78-15 signed to press 10 Apr 78 pp 2, 31, 32, 34, 44-45, 47

[Excerpts from the booklet by Yu.G. Shcherbinin, edited by Z.V. Bogemskaya, 54 pages, 300 copies]

[Excerpt] Literature related to the automation of programming in testing and measurement systems, as well as systems for the automation of the control of test installations and stands has become widespread at the present time. This work contains a survey of the existing languages which are problem oriented towards the writing check and control problems, as well as for the formal description of the control and check systems themselves.

Along with a review of the languages, this work also analyzes the check problems, as a result of which the author formulates requirements placed on languages for the description of testing algorithms.

The algorithmic language for the description of check problems (ALYaZK). . . . . has two levels: a reference standard and specific representation level.

Special language operators can be changed in accordance with the orientation for a specific ASK [automated checkout system]. The checkout object (OK) is defined in the algorithmic language as the set of assignments of signals and their parameters with the characteristics, while the check process is defined as the set of algorithms for testing the parameters. The specification of the signals and their parameters makes it possible for the ASK designer to determine the composition and work out the design of the measurement and generator portions of the ASK (the set of stimulus signal generators, primary transducers, normalizers, etc.), as well as to determine the manner and sequence of combining them.

A further development of the ALYaZK language is the KONTROL' version of it. . .

The AKDRV Language [31] belongs to the class of machine oriented languages, however, it contains a number of tools which provide for relative universality in describing algorithm fragments for RV [real time] systems, which involve the deparalleling of the computational process and the synchronization of parallel branches with each other, the coupling of the execution of the branches to external events and the timer, and interchange with special peripherals which have a specific mode of access. The language is utilized in a programming automation system for a real time system which takes the form of a two-level complex. The upper level is realized by a universal processor, while the lower is realized by a sufficiently specialized preprocessor, which is connected directly into the control loop.

Engineering languages comprise a special and rather extensive class of languages for real time systems, many of which are the input ones for the automated programming systems which have been realized. Such a name for this class by a number of authors underscores the fact that writing programs in these languages does not require special knowledge of programming techniques, while the program can be composed by an engineer, a specialist in the specific field of application of the language. The following are included among such languages: ART [52], SYMAP [53], BETCh [54], PROSPRO//1800 [55], SPALT [17], SAP [56], TEKHNOLOG-67 [57], APROKS [58] [59], SAP-2 [60] [61], YaZON [62].

5. Kondrashov A.S., Verzhbitskiy A.S., Frumkin I.S., "Nekotoryye voprosy programmirovaniya avtomatizirovannogo kontrolya slozhnykh mnogoparalltricheskikh ob"yektov" [" Some Questions in the Programming of Automated Monitoring of Complex "mnogoparalltricheskikh" [sic, unknown] Objects"], VOPROSY RADIOELEKTRONIKI, SERIYA RT [QUESTIONS IN RADIOELECTRONICS, RT SERIES], 1971, No 8, pp 48-52.

[258-8225]

8225
CSO: 1863

UDC 681.2.08

THE DETERMINATION OF THE OPTIMUM OBSERVATION PERIOD FOR RANDOM PROCESSES FROM EXPERIMENTAL DATA FOR PROCESS CONTROL COMPUTERS

Kiev INSTITUT KIBERNETIKI AKADEMII NAUK UKRAINSKOY SSR. PREPRINT in Russian No 78-21 signed to press 4 Aug 78 p 2

[Annotation to the booklet by M.P. Semesenko, 49 pages, 300 copies]

[Text] Estimates of the optimum period for the observation of experimentally obtained realizations of random processes are treated, as well as an estimate of the correlation range in the case where exponential cosine and power correlation functions are used, and the possibility of the utilization of the latter for random processes which are steady-state in the broad sense of the word and their practical applications are demonstrated. Computational algorithms are given for the calculation of the integrals of the indicated kinds of functions, estimates of the precision are given and the problem of the dispersion analysis of the random process spectra is solved in determining the period of the observations and the number of realizations; the total mean square error is minimized, and illustrative examples and graphs showing the error as a function of the number of the realization [sic] and the observation time are presented.

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UDC 681.142.2+519.8

A DIALOG SYSTEM FOR THE SOLUTION OF UNCONDITIONAL OPTIMIZATION AND APPROXIMATION PROBLEMS

Kiev INSTITUT KIBERNETIKI AKADEMII NAUK UKRAINSKOY SSR. PREPRINT in Russian No 78-38 signed to press 15 Nov 78 pp 2, 4-6, 33, 34

[Excerpts from the booklet by V.B. Raspopov, 34 pages, 300 copies]

[Excerpt] The ORBITAL' dialog system is intended for the solution of unconditional minimization problems and problems of approximating experimental points with functions having variable parameters. The set of programs was designed for the BESM-6 computer (the "Dubna" monitor system) and is added on to the previously developed software for the ASPRO-2 display [1, 2].

The ORBITAL' dialog system offers the following basic capabilities: screen display of a graph of the values of a function being minimized (and random realizations, if a problem in stochastic programming is being solved) plotted as a function of the iteration number; during the solution of a problem, repeatedly changing the minimization algorithm, choosing one of the six algorithms existing in the system; correcting the parameters of the selected minimization algorithm from the screen of the display; checking, and where necessary, changing the current argument value; observing what the value of the gradient of the function being minimized is at a point of interest to the researcher; displaying commentaries, graphs or a table on the screen which explain the problem to the user; plotting the cross-section of a target function on the display screen along any axis of interest to the user.

Up to three graphs, corresponding to the three different directions, can be displayed simultaneously on the screen, something which is quite useful for the comparison of the rate of decline of a function along the various axes.

When solving a user's problem, various data on the course of the minimization process are fed out to an alphanumeric printer.

The ORBITAL' dialog system was initially conceived as a specialized dialog system for the solution of approximation problems which are encountered in the field of molecular physics. Because of this, it can operate in two modes: optimization (which has already been noted above) and approximation. When working in the approximation mode, the investigator is likewise offered rich service capabilities. By entering up to nine sets of experimental points simultaneously into the computer (with no more than 20 points in each series) and writing the subroutine for the calculation of the approximating function with the parameters which must be determined, the investigator can arrive at a selection of the best parameters. The criteria of whether the algorithm parameters are the best ones can be: a minimum of the mean square deviation and the minimax Chebyshev criterion.

Dialog between the investigator and the computer is realized by means of a light pen and the alphanumeric keyboard of the ASPRO-2 display [1]. The ORBITAL' system has flexible dialog logic, i.e., the user has the option each time of using the light pen to mark one of the alternative directives, and depending on his actions, the computer shifts over to the execution of various subroutines.

The ORBITAL' dialog system software is designed for the monitor system of the BESM-6: the Dubna, and is composed of a set of programs written primarily in FORTRAN. The overall volume of program software including the subroutines which service the display [2] amounts to 27 memory pages.

1. Zinchenko A.M., Zlobina G.I., Pogrebinskiy S.B., Skurikhin V.I., "Komplekt graficheskikh ekranov dlya EVM BESM-6" ["A Complex of Graphic Displays for the BESM-6 Computer"], in the collection, "Upravleniye i informatsiya" ["Data and Control"], the issue, "Mashinnaya Grafika i yeye prilozheniya" ["Computer Graphics and Their Applications"], Vladivostok, 1975, pp 19-26.

2. Bobkov V.A., Bazilevich I.V., Bestsennyy Yu.G., Kochin V.N., Svistov A.Ya., "Graficheskiy paket DISGRAF" ["The DISGRAF Graphics Package"], in the collection, "Upravleniye i informatsiya", the issue, "Mashinnaya grafika i yeye prilozheniya", Vladivostok, 1975, pp 57-64.

9. Bazilevich I.A., Bestsennyy Yu.G., Bobkov VA.A, Kochin V.N., Svistov A.Ya., "DISGRAF. Rukovodstvo dlya pol'zovatelya" ["DISGRAF. Instructions for the User"], Published by the Institute of Automation and Control Processes of the Far East Scientific Center of the USSR Academy of Sciences, Vladivostok, 1974, 22 pp.

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8225
CSO: 1853

UDC 681.142:51

THE MIR-2 COMPUTER AS A TEACHING TOOL IN A COURSE IN HIGHER MATHEMATICS

Kiev INSTITUT KIBERNETIKI AKADEMII NAUK UKRAINSKOY SSR. PREPRINT
in Russian No 78-11 signed to press 28 Jul 78 p 2

[Annotation to the booklet by B.A. Bublik, edited by Z.V. Bogemskaya, 31 pages, 300 copies]

[Text] The capabilities of the Mir-2 computer as a teaching tool are revealed in this work. The presentation is illustrated with specific programs for the Mir-2 computer, which are of a computational and modeling nature, as well as with dialog teaching complexes for a course in higher mathematics.

The work is intended for Mir-2 computer users and teachers in the higher educations institutes familiar with the "Analitik" language.

[258-8225]

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CSO: 1863

UDC 65.011

QUESTIONS IN THE DEVELOPMENT OF MODELS FOR THE AUTOMATED CONTROL SYSTEM FOR PLAN CALCULATIONS

Kiev INSTITUT KIBERNETIKI AKADEMII NAUK UKRAINSKOY SSR. PREPRINT in Russian No 78-29 signed to press 4 Aug 78 pp 2, 3-6, 12-13, 22-23, 26, 35, 41-42, 52

[Excerpts from the collection of papers edited by V.A. Koshevaya, 52 pages, 300 copies]

[Excerpt] Questions of the methodology and experience with the construction and application of economic mathematical models in practice by the Ukrainian SSR Gosplan are treated in this preprint. A general concept of economic mathematical modeling of the processes of long term, intermediate range and current planning is presented, which is taken as the basis for the construction of specific models corresponding to different stages in the planning process and sectors of the Ukrainian SSR economy, and conclusions are also drawn concerning the applicability of balance sheet and optimization models to the operation of the Ukrainian SSR Gosplan.

1. As is well known, the main task of ASPR [automated control system for plan calculations under Gosplan] is that of increasing the optimality and balance of plans based on the use of economic-mathematical models, and primarily, balance sheet and optimization models.

At the present time, about 40 tasks based on balance sheet and optimization models have been experimentally tested within the framework of the ASPR of the Ukrainian SSR Gosplan. Considerable work has been done on the selection of the modeling object, the formulation of the task, the gathering of the data, the programming and solution on computers, the analysis of the solution and the more precise specifying of the formulation in preparing them for implementation. But, nonetheless, not only did none of the tasks based on balance sheet and optimization model come to replace manual calculation of the corresponding Gosplan forms, none of them became the basis for it, i.e. the basis for decision making. A similar situation with various deviations is also observed in the ASPR's of other republics.

What are the reasons for the situation which has developed? How do they appear to us at present? What can now be done to improve the situation?

2. To ascertain the answer to these questions, we shall analyze the models which are the closest to practical implementation in the work of the Ukrainian SSR Gosplan within the framework of the ASPR.

2.1. We shall analyze the balance sheet models. Definite experience has been acquired in the ASPR in the compilation and experimental processing of balance sheet models. The most significant work in this field is dynamic intersectoral balance sheet breakdown (DMOB) of the republic from the point of view of several tens of sectors, which was compiled under the supervision of N.F. Shatilov. Besides this, a static interproduct balance sheet (MPB) was drawn up for 44 products in the Ukrainian SSR for 1980 in the Institute of Cybernetics and the Institute of Economics of the Ukrainian SSR Academy of Sciences based on the reported interproduct balance sheet for 1972 and the projections of the Ukrainian SSR Gosplan for 1980. As far as we know, both the results of the DMOB calculation and the results of the MPB calculation did not find substantial applications in the planning practice for the Ukrainian SSR Gosplan, i.e., they had no direct impact on the indicators of the project plan or the approved five-year plan for the development of the republic's economy.

The major reason for this, in our opinion, consists in the fact that the DMOB (or MPB) encompasses through computation those indicators which are not provided by the existing planning procedures, and consequently, are not provided by the existing forms of the Ukrainian SSR Gosplan. The supply and demand norms for products, being produced in the territory of the republic by union and union-republic ministries, for example, are included among such indicators in the annual and five-year plans, although the manufacture of these products is planned by the Ukrainian SSR Gosplan. It is clear that given this situation, thre results of the DMOB (or MPB) calculations will have no place to go. In order to achieve the implementation of the DMOB (or MPB) in the planning practice of the republic Gosplan, it is necessary, in our opinion, to employ it for planning those sectors, the production and distribution of the products of which are handled by the republic Gosplan.

Certain deficiencies in the model itself likewise have a definite influence on the failure to introduce the DMOB: the lack of a solution to the "tail" problem and the optimization period. Moreover, the DMOB (or MPB) is, as a rule, built on the basis of reporting information, taking into account expert estimates concerning the variation in the expense norms (coefficients, direct outlays) and the final product, but not the plan data. Because of this, the understanding of the information system for the models by the practical workers is made more difficult, and consequently, the possibility of a dialog between specialists from Gosplan and the developmental workers of computer centers and institutes is sharply curtailed.

To eliminate these drawbacks to the model, work is underway on further refining the DMOB and MPB in the Institute of Cybernetics of the Ukrainian SSR Academy of Sciences.

Moreover, it is necessary to develop these models to come up with a comprehensive ASPR model in fundamental terms, and primarily, from the viewpoint of selecting the optimization timeframe, since direct calculations based on a comprehensive model are impossible at the present time. The selection of the DMOB and MPB for the refinement also pursues the following goals: the working out of a procedure for linking consolidated intersectoral calculations to more detailed interproduct calculations, and ascertaining the possibility of their informational support with reporting and plan information.

The major results which were obtained from the 19-sector DMOB model are described in detail in the paper by L. Shvets (see this preprint). They reduce to the following:

a) The heuristics of the model can be significantly reduced if the strict limitations on resources in Shatilov's model, which sometimes lead to negative solutions, are replaced by inequalities;

b) The problem of the "tail" can be partially solved by means of establishing a tie-in between the funds of the first and last periods;

c) The optimization period in the model should be two to three times greater than the planning period (then extending it will not exert a great influence on the results of the planning period calculations).

The work on refining the DMOB model has been substantially facilitated by the fact that close approaches and proposals are contained in the works of the NIEI [Scientific Research Institute for Economics] of the USSR Gosplan, the IEOPP [not further defined] of the Siberian Department of the USSR Academy of Sciences, the Ukrainian Affiliate of the NIIPiNa [Scientific Research Institute for Planning and Standards], etc. Specific difficulties have arisen in connection with the forecasting of the capital-output ratios for the Ukrainian SSR due to changes in prices and the lack of agreement of the products list of the Central Statistical Administration for capital investments and the products list of the DMOB, as well as because of difficulties in the solving of the DMOB for five and seven periods on a computer.

In concluding the review of the models being developed in the Institute of Cybernetics of the Ukrainian SSR Academy of Sciences for the ASPR, we will note that their development has passed only the first stage: the formulation, data gathering, one to two calculations and one to two discussions in Gosplan, and for this reason, there is still considerable work to be done in making them more precise, and perhaps even altering them. After sufficient work on them, some of these models can be used in the "Displan" dialog planning system, developed under the supervision of academician

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V.M. Glushkov. In this case, there will arise the possibility of operationally combining the enormous experience of republic Gosplan specialists with the colossal speed of computers and the capabilities of mathematics.

Thus, it can be asserted that the implementation of balance sheet and optimization models in the operational practice of the Ukrainian SSR Gosplan urgently requires the following:

1. The products lists of the indicators of the models be practically in complete agreement with or take into account the products lists of the indicators of the corresponding Gosplan forms. Because of this, the full scale introduction of DMOB (or MPB) into the planning practice of the Ukrainian SSR Gosplan over the entire territory of the Ukrainian SSR is hardly possible at the present time. Developmental work on balance sheet models is expedient primarily for products for which balance sheets are presently being drawn up.

2. Consolidated products lists of products and resources lead, in the optimization case, to a comparable form in terms of the internal assortment, or are detailed down to the requisite level of uniformity.

3. The main limitations should be ascertained with sufficient accuracy either by means of analyzing the documentation data or as a result of conversations with Gosplan specialists both in the model formulation stage and during the discussion of the calculation results.

4. The final polishing work on the models can be done during their operational utilization in the "Displan" dialog planning system mode.

Considerable attention is presently being devoted to the introduction of balance sheet models, and primarily, MPB's in planning practice. Still, despite the considerable efforts, MPB calculations have not gone beyond the experimental stage. There are several reasons for this. The major ones consist in the fact that MPB calculations are performed slowly - not in real time - and the fact that an MPB is based on raw data which do not always fully correspond to the information circulating in the planning organs. To eliminate these factors, work is underway at the Institute of Cybernetics of the Ukrainian SSR Academy of Sciences to develop a model for the "Displan" system.

We will note in conclusion that, in our opinion, the construction of an MPB is primarily expedient for those sectors for which intense intrasectoral demand is characteristic, i.e., there are complex interproduct relationships. These include such sectors as: construction materials, light industry, the food industry and a few others.

The following conclusions can be drawn from the analysis made here:

1. There is the necessary information for drawing up an MPB of considerable size (1,000 products) in the planning organs.

2. The information found in plan documents is sufficiently reliable that plan calculations using an MPB model can be based on it.

3. The existing data on the substitution of some materials for others can serve as a prerequisite for the realization of computer dialog between planning organs.

One of the most important and detailed divisions of the annual plan for the development of the economy of the Ukrainian SSR is "Agriculture and Forestry".

The following conclusions were drawn on the basis of the calculations which were performed and the analysis of them:

1. The feasible optimum specialization model for the production of vegetables in the republic described above, taking into account its subsequent detailing with respect to consumers is an effective tool for calculating the optimal annual plan of purchases and utilization of vegetables by the yearly plan of the Ukrainian SSR Gosplan.

The procedure for designing it and setting it up can serve as the basis for constructing optimum specialization models within the framework of the annual plan of the Ukrainian SSR Gosplan, where these models have a broader products list of agricultural products which are uniform with respect to technical and economic indicators.

2. Calculations of variants one through five assure a reduction in outlays by 1.5 - 8.3%, a savings in sown areas amounting to 5,000 to 9,500 ha, or an increase in vegetable production by 10 to 15% as compared to the final authorized plan of the Ukrainian SSR Gosplan for 1977.

3. Variants one and three make it possible to compute a stable vegetable production plan in the republic which satisfies all demands even under conditions of reduced crop yield as compared to the planned figures of the Ukrainian SSR Gosplan for 1977.

4. By working from the structure of optimal plans for vegetable purchases in the oblasts, the areas of optimal placement of vegetable production can be determined.

5. Calculations have shown that in spite of the high losses during the transportation of vegetables, an increase in the volumes and an expansion of the network for their transportation is effective.

At the present time, further correction of the model and calculations for several more precise variants are underway at the Institute of Cybernetics of Ukrainian SSR Academy of Sciences.

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CYBERNETICS COLLECTION TABLE OF CONTENTS

Moscow PROBLEMY KIBERNETIKI in Russian Issue 36, 1979 p 3

[Table of Contents from the collection "Problems in Cybernetics" edited by S. V. Yablonskiy, USSR Academy of Sciences Scientific Council for the Integrated Problem "Cybernetics", 3,300 copies]

[Text] Table of Contents

[314-11004]

11004
CSO: 1863

UDC 519+681.14

STUDY OF OPERATIONS AND AUTOMATED SYSTEMS OF CONTROL

Kiev ISSLEDOVANIYE OPERATSIY I ASU in Russian, Issue 14, 1979 signed to press 11 Jul 79 p 2, 131

[Annotation and table of contents of collection, Kiev, Izd. "Vishela shkola," 1000 copies, 136 pages]

[Text] The collection examines mathematical-economic models of different levels, several approaches to the analysis and optimization of these models, data on their realization on computers and other important issues in the study of the operations and software of ASU's.

For specialists in economic cybernetics, scientific workers, developers of ASU's and students in relevant departments. Drafting committee: Academician of Ukr. Academy of Sci. I. I. Lyashko (Ed-in-chief), Dr. phys-math sci I. N. Lyashenko (assist ed-in-chief), cand phy-math sci L. Ye. Kornilova (sec-in-chief), cand tech sci I. N. Aldokhin, cand econ sci Yu. S. Arkhangel'skiy, cand econ sci R. L. Dombrovskiy, corres-memb Ukr. Acad Sci Yu. M. Yermol'yev. Dr. econ sci V. A. Zabrodskiy, Dr. econ sci A. V. Krushevskiy, academician Ukr. Acad Sci V. S. Mikhalevich, cand phys-math sci, Yu. D. Popov, Dr. phys-math sci V. N. Red'ko.

Address of Drafting Committee: 252017, Kiev-17, Kiev State University, Dept. of Economic Cybernetics, Tele: 66-84-69.

CONTENTS

[205-9285]

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MINICOMPUTERS

Moscow MINIKOMP'YUTERY in Russian 1979 signed to press 15 May 79 p 2, 6

[Annotation, table of contents, editor's preface and author's preface from book by N. P. Brusentsov, "Nauka," 30,000 copies, 272 pages]

[Text] The minicomputer is a variant of digital computers representing, finally, a true instrument of production. The book is an attempt to shed light on the nature of minicomputers, to show how their extraordinary usefulness, which resulted in an avalanchelike expansion of their output and their rapid penetration into every domain of life, has been achieved. Attention is chiefly devoted to the special features of minicomputer architecture such as economical addressing and control over the course of the program under the conditions of a brief computer word, as well as the microoperational conversion of data and operational interfacing with peripherals. By way of example, the architecture of the principal minicomputer families is described in detail.

The book is designed for both the developers and users of minicomputer technology.

CONTENTS

Editor's Foreword

Minicomputers are coming into increasingly wider use as an effective means for the automation of all kinds of production processes and control of machines and systems. They have also found wide application in information processing and transmission systems along with large computers, performing such functions as the control of input/output devices and communication lines, the interfacing of main processors with the facilities they serve, etc.

N. P. Brusentsov, the author of this work, is also the developer of a once well-known small digital computer, the "Setun'," which is justly regarded as the prototype of minicomputers. His book elucidates the nature and application potential of minicomputer technology on the basis of foreign experience in this field as interpreted by the author. It expounds the principles of minicomputer design and describes in sufficient detail the architecture of the most widespread minimachines developed and manufactured by leading American companies.

At present in this country minicomputer technology is widely developed. New types of mini- and small computers are being projected and microcomputer systems produced, highly effectively in many fields of science and technology. Books containing material needed to master and utilize this new technology are being published or readied for publication. In this connection, N. P. Brusentsov's analysis of the state of minicomputer technology abroad will be extremely useful to both designers of Soviet minicomputers and systems and experts in their utilization.

L. N. Korolev

[redacted]

Author's Preface

This book is intended to promote the use in this country of minicomputers. Simple and effective mechanisms which nowadays represent the most significant and most rapidly growing branch of digital technology. Minicomputers served as the foundation for mass application of digital computers to the automation of production, scientific experiments, textual processing, digital communications, and many other forms of practical activity. Nevertheless, a deplorable failure to understand the nature and purpose of these remarkable mechanisms is not infrequently encountered: they are treated as "miniature[s of large] computers," used for extrinsic or purely computational purposes, and not provided with peripheral hardware for an operative interfacing with their environment. The author hopes that this book will be of assistance in dispelling these misconceptions.

The book is based on foreign experience in the development and applications of minicomputers. The author's personal experience is chiefly reflected in his approach to the subject, in the assessment of facts and developmental trends. The first five chapters deal with analysis of minicomputers in general and the last four, with the specific architecture of the most popular minicomputer types: the DEC PDP-8, the HP-2100, the DG NOVA, and the DEC PDP-111.

The author is indebted to L. N. Korolev for suggesting this book and serving as its editor, as well as to Kh. Ramil' Al'vares and Ye. N. Filinov for their valuable comments.

N. P. Brusentsov

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[redacted]

APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000200090046-0

MINICOMPUTERS AND AREAS OF THEIR USE

Vilnius MALYYE EVM I SFERY IKH PRIMENENIYA in Russian, 1976, signed to press 24 Dec 76, pp 2, table on page 30, 31, 38, 43

[Annotation, excerpts, table of contents from pamphlet by Y. Kasperunac, V. Kurakevich, V. Pokrovskiy, 597 copies, 44 pages LitNIINTI [Lithuanian Scientific Research Institute of Scientific Technical Data and Technical-Economic Research]]

[Text] The development, functional features and experience in using minicomputers was considered. Special attention was given to problems of the use of minicomputers in processing economic data. An analysis was made of using minicomputers as central processing local ACU [Automatic Control System] devices. The advantages of minicomputers compared to more powerful computer equipment in the organization of computer centers were shown. The review is intended for specialists in enterprises, organizations and establishments involved in the introduction and operation of computer equipment.

Six illustrations, eight tables, bibliography contains 15 titles.

At present, ASU were or are being developed in the republic using minicomputer M5000 (and its modifications) as a base for the following facilities: the Alitusskiy, the Vil'nyus and the Utenskiy meat combines, the Vil'nyus Department Store, the Kapsukskiy Rayon Consumer Union, and the Kaunas Commercial Organization.

Thus, an analysis of the results of concrete ASU developments using the M5000 minicomputer as a central processing device indicates that a computer of this class can handle the functions of the basic technical facilities of industrial and nonindustrial enterprises.

The experience of creating an ASU for the use of M5000 as a basic computer indicated that it can be used for an ASU for facilities with the technical-economic characteristics shown in Tables 4,5 and 6.

[redacted] [redacted]

Table 3

Comparative table of areas and staffs for data computer centers [IVTs] organized on the basis of various types of computers.

Computer type	Area of Machine Hall, m^2	Staff	IVTs Area, m^2	No of IVTs Subdivisions
M4030	90-110	84-94	885-903	14
YeS-1030	90-110	91-94	885-803	14
YeS-1020	90-110	68-87	746-866	14
M5000	50-60	About 22	186-188	4

Tables 7 and 8 show data for subsystems and problems for the following facilities: ASU-department stores, ASU-meat combine; ASU-milk combine, ASU-small instrument building (machine building) enterprise.

The rated economic effect obtained by introducing ASU using M5000 computers is 300,000 to 400,000 rubles and it pays for itself in one year.

ASU with M5000 computers used at present show that computers of that type may be used for local ASU in comparatively small enterprises (about 2000 workers with a volume of processed data of 2.5 x 10^9 decimal digits), as well as for central control system for preliminary and final data processing.

Content

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QUALITY AND RELIABILITY CONTROL OF COMPLEX SYSTEMS

Vladivostok UPRAVLENIYE KACHESTVOM I NADEZHNOST'YU SLOZHNYKH SYSTEM in Russian 1978 pp 2, 137

[Annotation and table of contents of symposium edited by V. V. Zdor and O. V. Abramov, candidates of technical sciences, 300 copies, 137 pages.]

[Text] The symposium presents papers on the quality and reliability control of technical facilities. In particular, forecasting the reliability and technical condition of parametric identification, modeling and selecting optimal operating modes are considered. Criteria are investigated for the quality of technical systems and technological processes. Most of the papers are of a practical nature.

The symposium is intended for specialists involved in problems of quality and reliability control of technical systems.

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CONTENTS OF AVTOMATIKA AND VYCHISLITEL'NAYA TEKHNIKA

Riga AVTOMATIKA I VYCHISLITEL'NAYA TEKHNIKA in Russian No 1, 1980, pp 93-94

[Contents from Journal, Avtomatika i Vychislitel'naya Tekhnika (Automation and Computer Technology), 1980, No 1]

Contents

[Text]

Minyayeva, L. N., Sabinin, O. Yu. Adaptive algorithms for statistical modeling of stochastic systems of control.

Kharchev, V. N. One method of approximation of a global multivariable extremum function.

Ustyuzhaninov, V. G. The limiting possibilities of random search algorithms.

Krylov, A. A. An algorithm for the selection of a minimum number of break-points in feedback loops.

Levin, A. G. An effective method of modeling faults in asynchronic circuits.

Burlakov, Ye. A. Optimization of periodicity of control of the work capacity of a system of complexes.

Guk, K. N. The identification of repeating segments of a microprogram for the control and correction of a computing process.

Sheptukha, S. M. A definition of the necessary characteristics of devices for hardware control of computing devices.

Rules for authors of papers, published in "Automation and computer technology."

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UDC 681.51:50

PROBLEMS OF THE SIMULATION OF COMPLEX SYSTEMS

Kiev VOPROSY MODELIROVANIYA SLOZHNYKH SISTEM in Russian, Institute of Cybernetics, 1979 89 pp

KUKHTA, T. K.. Editor

[From REFERATIVNYY ZHURNAL. TEKHNICHESKAYA KIBERNETIKA No 2, 1980 Abstract No 2.81.1 K by V. A. Garmash]

[Text] This collection contains the following works: an engineering approach to selecting the configuration of a class of computational systems in an early design stage; the selection of optimal control of operating time during the duplication of intermediate information; the processing of lists in PL/1 language; simulation by means of GASP-IV; and a general inventory control problem. Also considered are: the utilization of a GASP-IV batch in operating-system computers of the YeS type, the construction of interactive problem-oriented systems for the simulating of discrete processes; methodological aspects of the construction of simulation models in the GPSS simulation system; and special objects in simulation models of data processing systems. An account is given of problems of the automation of the construction of tests, for combination schemes by means of the NEDIS language, as well as problems of modeling combination schemes with inaccuracies by means of the NEDIS language.
[283-1386]

EMPIRICAL PREDICTION AND PATTERN RECOGNITION (COMPUTING SYSTEMS)

Novosibirsk VYCHISLITEL'NYYE SISTEMY in Russian, No 76, 1978 signed to press 29 Nov 78 p 2, 154-157

[Excerpts from the collection "Vychislitel'nyye Sistemy," Institute of Mathematics of the Siberian Department of the USSR Academy of Sciences, 800 copies, 157 pages]

[2]

ANNOTATION

The collection contains articles devoted to problems of the methodology of scientific and technical forecasting, the theory of empirical prediction, algorithms of pattern recognition and investigations on automatic identification of speech signals.

The materials of the collection may be of interest to specialists working in the indicated directions and to students of the corresponding specialties.

[154-157]

Abstracts

UDC 518.74

Regularities in the Language of Empirical Systems, Ye. Ye. Vityayev.

The possibilities of using measurement theory in pattern recognition and empirical prediction, specifically the possibility of using empirical systems as features, are considered in the paper. A set of principles expressed in the language of empirical systems is considered. It is shown how the laws of classical physics can be expressed in this language. The principles which have no analog in numerical form are also presented. The nonconvergence of the principles which utilize the ratio of order to principles in the scale of names is proved. The empirically interpreted property satisfied only by universal formulas which may in turn be expanded to formulas of special type is presented. The entire exposition justifies the need to develop algorithms which utilize empirical systems as features. References 7, figures 1.

UDC 518.74

Axiomatic Representation of Empirical Theories, K. F. Samokhvalov.

Two methods of representing empirical theories--axiomatic and algorithmic--are compared. It is shown that some imperfections of axiomatic theories usually related to the presence of theoretical terms in them are also retained in the absence of these terms. On the other hand, these imperfections do not exist within the framework of the algorithmic approach to representation of empirical theories. References 6.

UDC 578.087.1:519.9

Taxonomy in an Anisotropic Space, N. G. Zagoruyko.

The problem of taxonomy is formulated as one of dividing a set of objects into subsets (taxons) by the minimum loss criterion $\rho(p, q)$ occurring due to replacement of some objects q of the taxon by other objects p. Examples of various types of substitutions are considered. The problem is generalized for the case of an anisotropic space in which $\rho(p, q) \neq \rho(q, p)$. Algorithms for solving the problem of taxonomy with certain types of substitutions are described. References 3, figures 5, tables 2.

UDC 519.95:681.3.06

Logic Functions in Empirical Prediction Problems, G. S. Lbov.

An approach is formulated in the paper which utilizes logic functions to solve various problems arising when processing empirical tables. The need to develop this approach was determined by the existence of a class of tables (RP-tables) whose characteristic is the presence of features measured in scales of various types. The number of features in RP-tables can be large and the number of objects can be comparable to the number of features; omissions of some elements of the table are permissible. The advantages of the proposed approach for analysis of the indicated class of tables compared to the known advantages are considered when solving problems of pattern recognition, function restoration, automatic grouping of objects, ordering of objects, dynamic prediction and optimization. Descriptions of algorithms for solving these problems are presented. References 41.

UDC 681.3.06:621.391

A Method of Dynamic Forecasting Which Utilizes Logic Solving Rules, G. S. Lbov and Yu. P. Masharov.

Main attention has been devoted in the literature when studying complex dynamic objects to the case when all the features which characterize objects in time are quantitative. However, these features can be measured in different scales in some applied fields (for example, medicine, sociology and economics). A method is proposed in the given paper for finding the dynamic principlrs in a class of logic functions and for using these principles in different problems of predicting the time states of an object. References 6.

UDC 519.95:681.3.06

Approximation of Undecipherable Ratios, Yu. P. Drobyshev and V. V. Pukhov.

The problem of approximating ratios of general type by ratios from a given class is considered in the paper. Problems of taxonomy and ordering reduce to this postulation. A method of solving the problem is proposed and the relationship of the introduced method to solution of the problem which utilizes the appropriate metrics in the space of ratios is shown. The algorithm of taxonomy is found. References 7.

UDC 519.95:681.3.06

A Method of Pattern Recognition by the "Combined Antisyndrome," S. I. Gol'dberg.

The concept of the antisyndrome--a set of features which indicate that an object does not belong to a given class--is introduced in the paper. The set of antisyndromes minimum in some sense is described and the identifying rule based on this set is proposed. An algorithm which finds all the minimum antisyndromes is presented. References 4.

UDC 518.74

Methodological Fundamentals of the Problem of Comprehension in Prediction, K. F. Samokhvalov and D. I. Sviridenko.

The problem of "paradoxality" of predicting the future, dependent on the predictions themselves, is considered. Mathematical problems are formulated ted, solution of which would be a significant advance in solution of the indicated problem. References 1.

UDC 621.391:681.2.06

Investigation of Some Characteristics of the Intensive Speech Activity of Man, N. G. Zagoruyko and Yu. A. Tambovtsev

The average reading rates of announcers (males and females) without preliminary and with preliminary training are described in the paper, the effect of fatigue on the rate and reliability of reading is noted, the working conditions of operator-announcers with regard to their individual characteristics are proposed, the volume of speech information for oral introduction during the working day is established and the sociological ratio of the operator-announcer to his occupation is noted. References 5, tables 3.

UDC 519.226:534.784

Estimating the Parameters of the Speech Channel in a Class of Autoregression Models with Steady First-Order Seasonal Difference and Steady First-Order Difference, A. V. Kel'manov.

A method of determining the parameters of the speech channel in a class of autoregression models with steady seasonal first-order difference and steady first-order difference from an acoustic signal is considered. The possibility of determining the formant parameters from the parameters of the proposed model is shown. Experimental comparison of the proposed method to some of the known model and real signals is carried out. References 10, figures 4, tables 9.

UDC 519.226:534.78.681.327

A System of Recognizing Isolated Words By A Special Autocorrelation Function, A. V. Kel'manov.

Problems of constructing systems for recognition of isolated words by a special autocorrelation function are considered for an autoregression model with steady adaptive first-order difference, selection of the measure of similarity and order of the model and reduction of the decision-making time. The results of recognizing a glossary consisting of 100 words on the Minsk-32 computer for a single announcer are presented. References 11, figures 2, tables 4.

UDC 681.142.1

The Software of Applied Scientific Investigations, V. T. Yerkayev, V. I. Konstantinov, D. I. Sviridenko and N. T. Tukubayev.

The paper is devoted to methodological problems of the production technology of developing large program systems. The general requirements on production complexes for design of program packs are considered. The structures and capabilities of the developed TEKOM system are described as an example. References 11.
[273-6521]

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THE PRINCIPLE OF DECOMPOSITION FOR LINEAR OPTIMUM CONTROL PROBLEMS

Moscow PRINTSIP RAZLOZHENIYA DLYA LINEYNYKH ZADACH OPTIMAL'NOGO UPRAVLENIYA (The Principle of Decomposition for Linear Optimum Control Problems) in Russian 1978 signed to press 28 Jul 78 pp 2-4, 50-52

[Annotation, Introduction, Bibliography and Table of Contents from book by Vladimir Ivanovich Tsurkov, Vychislitel'nyy tsentr Akademii nauk, 301 copies, 52 pages]

[Text] The paper is devoted to the mathematical theory of large systems. A method of decomposition is proposed for linear optimum control problems with phase restrictions. The central results are formulation of the criterion of optimality of the reference solution and proof of the strict monotonic nature by the functional of the iterative process. Degeneration of intermediate problems and those related to convergence are studied. An example is proposed which permits analytical investigation of the method of decomposition. The possibility of application to dynamic problems of mathematical economics is indicated.

Introduction

The method of decomposition for optimum control problems is proposed in the present paper. The method is related to aggregation of the variables which are the controls in the considered case. The idea of aggregation is based on the paper of I. A. Vatel' and Yu. A. Flerov [1], where an iterative algorithm of decomposition for a partial linear programming problem was constructed and in this case introduction of aggregation was dictated by the specifics of the binding restrictions and the criterion. The central point of the constructions of [1] was the hypothesis of the monotonic nature with respect to the functional of the iterative process.

The method was developed in [2] for nonlinear mathematical programming problems, where the hypothesis of monotonicity was proved by means of application of the theory of marginal values. A class of systems was identified in the same paper [2] for which the indicated method is applicable. The corresponding restrictions were reduced to conditions of the convexity of entering functions.

Linear optimum control problems with phase restrictions are considered in the given paper. These problems were investigated in refined form by A. M. Ter-Krikorov in [3, 4]. The case when conditions which provide the closure of the cone for the operator in a Banach space are fulfilled, which corresponds to the linear optimum control problem [3, 4], is studied in the structures suggested below. In this situation the structures of the decomposition method become more transparent.

The contents of the paper are distributed in the following manner. Postulation of the problem together with auxiliary structures is given in Section 1. The method of decomposition is described in the same section. The criterion of the optimality of the reference solution is proved in Section 2. The main result of the given paper is the theorem of the monotonic nature with respect to the functional of the iterative process, proved in Section 3. Possible degeneration of problems with aggregated controls and those related to convergence are discussed in Section 4. An example is given in Section 5 which permits analytical investigation of the method of decomposition. Based on this example, some typical properties of the considered algorithm are established. Application of the method to dynamic Leont'yev models of mathematical economics is proposed in Section 6. The simplicity of the problems in aggregated variables permits one to hope for the effectiveness of the method of decomposition.

Contents

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[226-6521]

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PROBLEMS OF NONLINEAR PROGRAMMING

Novosibirsk OPTIMIZATSIYA in Russian No 22, 1978 signed to press 30 Nov 78, pp 3, 115-116, 123-124

[Contents and excerpts from OPTIMIZATSIYA (Optimization) 22 (39) A Collection of Scientific Studies, edited by N. V. Rutkovskiy, Institute of Mathematics, Siberian Division, USSR Academy of Sciences, 700 copies, 159 pages, Novosibirsk: 1978]

CONTENTS

[Excerpts from article by Ya. I. Fet: "Hardware Support of Mass Calculations" manuscript received 15 Oct 78]

[Excerpts] In recent years, the development of the architecture of computer complexes has been attracting more and more of the attention of scientists and engineers. This can be explained by the fact that the complexity of the problems and the demanded speed of solution and amount of necessary information processing has been growing continuously. Since the possibilities for increasing the physical speed of electronic elements have been almost completely exhausted, the development of new architectural principles: the creation of multiprocessor complexes, parallel computer systems, specialized processors etc. has taken on new meaning.

One of the important trends in the development of architecture is the use of mass, large-block operations [1, 2]. Proposals for the use of large-block constructions in programming problems and their computer implementations had been made during the first stages in the development of computer technology (Cf. review paper, [3]). Various mass operators are included in modern programming languages (APL, PL-1, etc). However, in all existing general purpose computers, mass calculations are performed using standard programs or microprograms, constructed on the basis of individual (scalar) operations and representing a traditional systems of commands.

If we take the efficiency of a computer system to be the relationship of its productivity (in the solution of a rather broad class of problems) to the total cost of its hardware and software, then a shift to hardware

[redacted]

implementation of mass operations can lead to a significant increase in efficiency.

Indeed, since mass operations in many problems comprise the principle portion of the work, their execution by special hardware modules (parallel processors) must lead to an increase in productivity. At the same time an expansion of the internal machine language, an increase in the level of hardware interpretation would simplify programming and decrease the cost of software.

Until recently the main obstacle to the wide use of "hardware support" was the comparative complexity of specialized processors and the necessity for large expenditure on hardware. However, the successes of microelectronic technology and the continuous decrease in the cost of integrated circuits has created at the present time the prerequisites for the manufacture of special processors and their inclusion in machines with a new architecture.

The General Structure of the System

As a whole the system must be a heterogeneous computer complex, consisting of a central machine and a set of functional modules. The central machine (a general purpose computer of average power) plays the role of the dispatcher, makes connections with the peripheral equipment, stores and maintains system programs and performs simple (scalar) processing. The functional modules receive jobs in the performance of mass operations from the central machine and execute them off-line.

Efficient operation of the system, of course, requires a good organization of distribution of work. loading of the file arguments and exchange of intermediate results.

The architecture considered here is not new. We point out here, however, the following features which seem to us to be essential:

---the large blocked nature of the functions of the special processors,

---the high level of hardware support (complex base operations of the special processors),

---the possibility of achieving sufficient "general purposeness" with a small number of special processors.

Using the figurative definition from [32], we can call the traditional general purpose machine with its set of scalar operations a system of "low qualification." The computer system considered above with a set of functional modules, oriented toward a hardware implementation of mass operators is a system of "moderate qualification." Further we may pose the question of systems of "high qualification," in which hardware support can be applied to more major processing, to individual important problems

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and to frequently used algorithms. Special processors having this type of function include, for example, sorting networks [33], BPF (rapid Fourier transformation)-processors [14], and matrix processors for the solution of systems of differential equations [34]. When necessary such processors can be included in a general purpose system, increasing its "qualification."

If we use as a criterion for evaluation, the number of basic operations (strokes), necessary for the implementation of some standard problem set, then the system described by the architecture can, evidently, lead to high efficiency.

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DIAGNOSTIC SYSTEMS FOR COMPUTERS

Kiev ORGANIZATSIYA SISTEM DIAGNOSTIROVANIYA VYCHISLITEL'NYKH MASHIN [The Organization of Diagnostic Systems for Computers] in Russian 1979 signed to press 7 Apr 79 p 2, 3, 4, 5, 6, 23, 109, 110, 111, 112, 114

[Annotation, table of contents and excerpts from book by Vasiliy Anatol'evich Gulyaev, Izdatel'stvo Naukova Dumka, 1150 copies, 115 pages]

[Text] This monograph is devoted to questions on diagnostic systems where the formal organization is based on processes of formalization of stages of generating elements and the choice of the most rational variant. We examine questions of the organization of the preparation of test sequences, the transformation of the structure of machines with the aim of improving its control suitability and the choice of programming hardware for the realization of proposed design methods.

The monograph is intended for specialists working in the area of technical diagnostics of computer equipment and may prove to be useful to students and graduate students in related specialities.

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AUTOMATION TECHNOLOGY

25 JUNE 1980 (FOUO 10/80) 2 OF 2

Introduction

One of the basic means of reducing the time and raising the development quality of computers and systems is the wide application of automated design that is based on the formal methods of digital computer development technology [1,5,13,39].

Along with the development of principles for the logical organization of machine structure an important role is played by the organization of methods for the technical diagnosis insuring high reliability and efficiency. By the organization of diagnostic systems we mean complex problems associated with determining their structures and functions, the choice of a rational set of technical devices and their distribution within the structure of the machine, a definition of the technical requirements for the system of test preparations, etc.

In the existing literature the question of the organization of diagnostic systems for computers and computer systems, and in particular, the formalization of early design stages (algorithmic and block synthesis), has hardly been touched upon. In several works [31,34,37, and others] a description is given of concepts being used in the general organization of diagnostic systems by machine designers. These concepts have, as a general rule, a heuristic character.

In the present monograph we set forth specific questions related to the formalization of design stages of diagnostic systems for computers. We pay special attention to the formalization of stages of generation of alternative variations of diagnostic systems, to questions of choosing perspective variations, and solution methods arising in the design process of optimal problems with respect to the distribution of the control mechanism in the structure with the aim of improving the characteristics of control-suitability.

The methods developed here are intended for application in both the composition of systems of automated computer design and in the autonomous state for the solution of separate problems of the organization of diagnostic processes.

In Chapter 1 we discuss the specifics of the organization of diagnostic systems for computers and systems, we introduce the basic usuable construction concepts, we give a formal formulation of problems of logical organization of diagnostic systems and we set forth a methodology for the solution of the optimal problems that arise.

In Chapter 2 we examine organization methods for diagnostic systems, in particular, we describe mathematical models for assigning variants to diagnostic systems, we set forth procedures for the choice of general principles for distributing control devices throughout the computer structure and we give an algorithm for the choice of an optimal distribution of control points and a rational composition of control devices in computers and systems.

Chapter 3 is devoted to an exposition of some transformation methods of the structures of computers with the aim of improving the characteristics of control-suitability. These questions have been left practically untouched in the literature.

Chapter 4 contains some questions on the organization of test diagnosis for digital computers.

Chapter 5 is devoted to the application of methods of imitation modeling in the synthesis of diagnostic systems. We examine mainly the questions of the analysis of the results of the modeling which is necessary for the choice of rational variants in diagnostic systems.

[Excerpts] The interpretation of many problems of rational choice in a network formulation permits us to apply to the solution of design problems specialized computers such as the "Ritm-2" and "Struktura-2" which allow us to solve a portion of the listed problems in the dialog mode and with high speed.

5.4. Questions of hardware organization in the solution of organization problems in diagnostic systems.

The specifics of problems that arise in the organization of diagnostic systems stipulate the necessity of a corresponding choice of programming and operational devices for simplifying calculations via existing models and algorithms.

Among these specifics we must first note that the given problems belong to the early stages of computer design, that the solution process has a multi-variant character and that we must first obtain the results of the solution in a convenient form in sufficiently coarse time intervals.

This stipulates sufficiently coarse criteria for the high-speed operation of the digital computer and its peripheral devices (the necessity of various displays, graph plotters, etc.).

The possibilities for the existence of computer devices of a universal allocation are sufficiently limited in the solution of complex problems of multivariant choice.

The organization of computer devices for the design of diagnostic systems coincides in many ways with existing principles of the organization of automated design systems. The methodology of the design as arranged in the automated design system influences the organization of computer devices.

The methodology set forth in this work includes a system of estimates, the generation of variant diagnostic systems and methods for the choice of rational variants.

If the first two components of the methodology are sufficiently easily realized on universal digital computers, then the solution of multivariant problems of choice in a dialog mode of the designer with the digital computer on universal machines demands large amounts of memory and time.

Meanwhile, a network interpretation of problems of rational organization of diagnostic systems permits us to use in the design specialized computers for network analysis of the "Ritm-2" and "Struktura-2" type. The main advantage of the machines of this class are their high speed, simple programming and the natural realization of dialog states.

In the solution of the whole complex of problems that arise in the process of organization of diagnostic systems, the most expedient is the combination of both universal (YeS 1022 and YeS 1050 type) and specialized ("Tima-2" type) computer devices. Questions on the application of universal computers for the solution of various design problems have already been sufficiently well discussed [1,5,13].

Below we will discuss some solutions of optimal design problems on specialized computers of the "Ritm-2" and "Struktura-2" type.

The optimization problem. The basic technical data on the "Ritm-2" is as follows:

1. Maximum number of branches in the net: 900.

2. Reduced error of the data system: ± 0.5% of the maximum length of a branch in the net.

3. It permits us to determine the longest and shortest routes and the resource allocation (of two forms).

4. Data input is accomplished via:

   1) the manual keyboard of the computer console;

   2) the keyboard of an electric typewriter;

   3) an ordinary punched tape.

5. Data output is accomplished via:

   1) a CRT;

   2) an electric typewriter;

   3) a punched tape.

The basis of the computing device is composed of numerical models of the branches of the net which are connected between themselves on a commutation board in correspondence to the topology of the net (in the "Struktura-2" computer the commutation is performed automatically). The solution on a computer such as this takes place during the transfer time, i.e., with account of the perception of the information by the person -operator, practically instantaneously.

The methodology of the solution of optimal design problems consists of the following:

1. The design problem that interests us is formulated as an extremal one on weighted graphs, in other words, we carry out a network interpretation of the synthesis problem (problems of this type were examined in Chapter 2 and in [20]).

2. We introduce the input information into the computer "Ritm-2" and carry out a procedure of constructing permissible routes by the i-th criteria, where $i = \overline{1,k}$.

3. We conduct a determination of the route M_{ext} from among the set of admissible routes.

The use of this methodology permits us to solve problems of seeking the extremum of a chosen efficiency indicator under several constraints on the parameters that influence this indicator.

Computers of this class are sufficiently effectively used also in the solution of design problems with the use of flow algorithms [27].

The problem of modeling logical circuits. Specialized computers of the "Struktura-2" type can effectively be applied also to the modeling of logical nets in the process of preparing tests. They insure the attainment of high-speed and can be used by personnal with little training.

Let us examine the modeling methodology.

The models of the knots of the machine are set with corresponding logical elements of the type "AND", "OR" and "NOT" and others. The branches are set with delays at every input. A model M constructed in this manner is isomorphic to the initial logical net S, and with its aid, problems of modeling circuits with faults can be solved. On this type of model the algorithms for the synthesis of tests (which are examined at the beginning of this chapter) are realized well.

The principles built into the construction of the computers such as "Ritm-2" and "Struktura-2" are very useful in the organization of microprocessor computer systems. This is stipulated by the linear dependence of the complexity of the system of commutation from the number of elementary processors.

These microprocessor systems can be used successfully for the modeling of complex logical nets with faults and in the synthesis of tests.

The methodology of the modeling consists of the following.

A complex logical net S is divided into a series of logical sub-nets s_i, where $i = \overline{1,k}$. Each of the subnets S_i is modeled on the i-th microprocessor.

For the coordination of the work of the individual microprocessor a special control microprocessor is used.

We should note that in these systems it is possible to have various principles of organization for the modeling processes that are differentiated by the method of distribution between microprocessors, by methods of assignment and analysis of faults.

As we know, the problem of checking the topology in the design of large-scale integration reduces to the problem of graph identification: the standard one and the one being investigated.

The above permits us to propose the following general organization for computer devices that insures the solution of a wide complex of problems, from the design of diagnostic systems to their realization.

The nucleus of an organization such as this is a universal digital computer and as peripheral devices we use specialized computers that are based on a network interpretation of synthesis problems. The given organization insures high speed and a natural realization of dialog state operations in a relatively conservative expenditure of resources.

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HERALD OF MOSCOW UNIVERSITY. SERIES 15. COMPUTER MATHEMATICS AND CYBERNETICS

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA. SERIYA 15. VYCHISLITEL'NAYA MATEMATIKA I KIBERNETIKA in Russian No 1, 1980 pp 70-71

[Index of articles published in the journal VESTNIK MOSKOVSKOGO UNIVERSITETA. SER. 15. VYCHISLITEL'NAYA MATEMATIKA I KIBERNETIKA in 1979]

Gusyatnikov, P. B., Mezentsev, A. V., Tsvetkova, N. B. Escape in a Differential Game with Integral Limits and Nonconvex Control Sets

Zaikin, P. N., Nefedov, V. N. On the Solution of Certain Lexicographic Problems of Interpretation

Il'inskiy, A. S., Zarubanov, V. V. An Algorithm for Calculating Distribution of Currents of Normal Waves of Asymmetric Strip Line

Kovach, M. (Hungary). Continuous Analog of Iterative Regularization of the Gradient Type

Kononov, D. A. A Theorem on a Main Line in Strong Form for Neumann Model with a Nonterminal Target Function

Korolev, L. N. Problems of Applied and Theoretical Programming

Kostomarov, D. P. Basic Methodological Problems in the Course "Methods of Mathematical Physics"

Krasnoshchekov, P. S. Mathematics and Planning

Kruglov, V. M. Convergence on Poissonian of Sums of Independent Streams of Requirements

Kulaichev, A. P. Means of Expression and Basic Conceptions of Language for Modeling Decision Making

Novikova, N. M. An Hierarchical Game for n Persons with a Controllable Coalition Structure

Paskhin, Ye. N. An Analysis of Modern Automated Teaching Systems

Smelyanskiy, R. L. On the Construction of the Solution of a Problem Using Rules of Statement

Sokolov, A. V. On the Minimaximality of Optimum Equivariational Solutions in Hilbertian Space

Tikhonov, A. N. Computer Mathematics and Scientific-Technical Progress

Tikhonov, N. A. On One Problem of Determining a Nonlinear Coefficient of a Differential Equation

Tynyanskiy, N. T., Arutyunov, A. V. Linear Processes of Optimum Speed

Furugyan, M. G. An Approximate Solution of Endless Antagonistic Games with Selection of Several Moments of Time

Shabarov, A. Yu., Sychugov, D. Yu. Numerical Analysis of the Stability of a Cylindrical Plasma Pinch in Relation to Axially Symmetric Perturbations

Shestopalov, Yu. V. Substantiation of a Method of Calculation of Normal Waves in Microstrip Devices

Brief Reports

Ardelyan, N. V. On the Stability of Differential Systems for Multidimensional Equations of Acoustics

Berzan, S. P. On One Linear Differential Game of Pursuit with Incomplete Information

Zlotnik, A. A. On Estimation of the Speed of Convergence of One Projection-Differential System for One-Dimensional Nonstationary Equation of Diffusion

Ionkin, N. I. On Finding a Numerical Solution of One Nonclassic Problem

Mityugova, S. A. Introduction of Type FORMULA in ALGOL 60

[224-7872]

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METHODS OF INFORMATION PROCESSING

Novosibirsk VYCHISLITEL'NYYE SISTEMY in Russian No 74, 1978 signed to press 14 Sep 78 p 2, 4-5, 20, 149-151

[Excerpts from the collection, "Vychislitel'nyye sistemy," Institute of Mathematics of the Siberian Department of the USSR Academy of Sciences, 800 copies, 152 pages]

[2]

ANNOTATION

Papers on a system of automation of editorial-publishing activity (the general concept, the use of R-technology and the problem of carry-overs), on methods of symbolic information processing (automatic coding and error correction and associative search) and on the information contained in a teaching sample (ordering of objects by prospect, synthesis of grammars by their results and algorithm of tone-noise classification) are presented in the collection.

The materials of the collection may be of interest to specialists in the field of automation of text information processing, programming technology and pattern recognition.

[4-5]

Systems for automation of text editing being developed in our country have still not gone beyond the experimental stage. Most of these systems are directed toward meeting the internal needs of the given organizations--preparation of readings, instructions, preprints and so on by using computers and operational editing facilities presented to displays. Carry-overs are either generally forbidden or are resolved with appreciable deviations from existing norms [6], which prevents their use for published editions. ASPID systems based on the BESM-6 computer [8] and the SOYuZ system based on the Minsk-32 computer [9] are the most perfected. The ASPID system is designed to prepare typewritten and rotoprint editions. As the authors state, the problem of carry-overs has been resolved in it. However, when a preprint prepared by using the system was analyzed, an appreciable number of unrealized carry-overs was determined where they are permitted by standards. The SOYuZ system is oriented toward printing by using a photoset of simple editions of the abstract type. The problem of carry-overs has not been resolved in it.

As one can see, there now is no system for editing texts in the Russian language which would be comparable to systems for English and other languages according to the requirements indicated above. This makes investigations in the given direction very timely.

The PARIS system (Total Automated Editing-Publishing Service), during development of which an attempt was made to meet all the requirements indicated above, is described in the given article. Main attention is devoted in this case to the properties of the system which provide wide use of it. The algorithm of carry-overs used in the PARIS system has been described in [18], written at our initiative. Experiments showed that the given algorithm yields the same quality of carry-overs as in existing publications.

[20]

8. Vayakovskiy, Yu. M. and S. T. Mishakova, "Avtomatizirovannaya sistema podgotovki publikatsiy i dokumentov (ASPID)" [An Automated System for Preparation of Publications and Documents (ASPID)], (Institute of Applied Mathematics of the USSR Academy of Sciences, Preprint No 19), Moscow, 1977.

[149-151]

UDC 519.688

Using R-Technology for Automation of Editing-Publishing Work, Yu. G. Kosarev, A. A. Moskvitin and N. A. Chuzhanova.

The use of R-technology for automation of editing-publishing work is discussed. The discussion is conducted on the basis of the experience accumulated in developing the PARIS system. The advantages of using R-technology and also the additions which must be made to develop systems of similar type are indicated. References 4, figures 5, tables 3.

UDC 655.25+801.4

Automatic Determination of the Location of the Carry-Over in a Sentence, L. S. Yudina and A. S. Nudel'man.

The main content of the paper comprises a discussion of the general principles of the carry-overs of part of a word to the next line according to the rule of spelling and the possibilities of algorithmization of them.

An algorithm for automatic determination of the location of a carry-over both within a word and between words is proposed: a description of experiments on automation of the carry-overs in a real text is presented. References 12, appendices.

UDC 681.3.06

Fundamentals of Constructing an Automatic Coding, Checking and Text Information Correction System, V. V. Khabarov.

Problems of constructing a system for processing input data prepared in languages similar to natural language is considered in the paper. A method of automatic coding and error correction in text information is described and the probability model of the method is presented. The errors of typists in typing technical texts are investigated. The main requirements on the system are determined. The use of the apparatus of R-grammars in development of the system is shown. The operating modes and main parameters of the system realized on the Minsk-32 computer are described. References 8, figures 5, tables 3.

UDC 8.74

Experimental Investigations of the Effectiveness of Arrangement Functions, V. D. Gusev and T. N. Titkova.

Experimental investigation of the effectiveness of various arrangement functions in key files represented by nonrepetitive one-grams (connected sequences of one-symbols) of Russian text, was carried out. The variable parameters were the load coefficient of the arranging field α , the length of the key l, the location of the key and the determined address digits within the machine word, the degree of "randomization" of keys in the file and the type of coding of the alphabet symbols. Special attention was devoted to explanation (and recommendations to correct) the abnormal effects manifested in significant deviations of the sampling coefficients of filling the arrangement field from those anticipated according to the Poisson scheme of address designation. References 6, tables 7.

UDC 8.74

A Tabular Algorithm for Calcuating the Remainders From Division of Arbitrary Whole Numbers by a Fixed Whole Number, T. N. Titkova.

A tabular algorithm for accelerated calculation of the remainder from division of whole numbers, oriented toward the case when it becomes necessary in multiple division of arbitrary whole numbers by a fixed whole number without any restrictions on the divisor, is proposed. The clear example of these problems is the associative coding procedure (hash coding). References 5.

UDC 519.688

Automatic Synthesis of Algorithms From Dynamic Input Data, Yu. G. Kosarev and N. A. Chuzhanova.

The inductive approach to construction of syntactically controlled algorithms and methods of automating it is considered. Examples of synthesizing algorithms for solution of some problems of applied linguistics are presented. References 4, figures 5.

UDC 681.3.06:621.391

One Approach to Forecasting the Prospects of Objects, A. N. Manokhin.

The problem of selecting the μ most promising objects from ν objects by the characteristics $X_1,\ldots,X_m$ is considered at the maintenance level. Formalization of this problem within the framework of the statistical model is proposed. The criterion of quality is the mean value of the number of objects of the first form which entered the aggregate of the determined objects. The problem of constructing an optimum strategy of selection is investigated under the conditions: a) the known probability characteristics and b) the unknown probability characteristics (by the teaching sample). Rather simple algorithms for realizing the strategy are proposed. References 7.

UDC 519.226:534.44

An Algorithm for Tone/Noise Classification Based on the Criterion of the Adequacy of the Autoregression Model, A. V. Kel'manov.

Problems of the adequacy of describing a speech signal by the autoregression model when solving the problem of analyzing the speech formation process are considered. It is shown that vocal sounds, unlike nonvocal sounds, are inadequately described by the autoregression model. It is suggested on this basis that the criterion of adequacy be used for automatic tone/noise classification. An algorithm for classification and experimental results is presented. References 13, figures 7.
[271-6521]

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UDC 681.325.5

THE USE OF DIGITAL AND ANALOG COMPUTER SYSTEMS FOR THE SOLUTION OF CERTAIN MATHEMATICAL PROBLEMS

Kiev INSTITUT ELEKTRODINAMIKI AKADEMII NAUK UKRAINSKOY SSR. PREPRINT in Russian No 183, 1978 signed to press 17 Oct 78 pp 2, 62

[Annotation and Table of Contents from the book by V.F. Yevdokimov, Institute of Electrodynamics of the Ukrainian Academy of Sciences, Kiev, 150 copies, 63 pages]

[Excerpt] The Use of Digital-Analog Computer Systems for the Solution of Certain Mathematical Problems.
V.F. Yevdokimov. Preprint 183. Institute of Electrodynamics of the Ukrainian SSR Academy of Sciences, Kiev, 1978, 63 pp.

Questions of the use of digital-analog computer systems for the solution of systems of linear and nonlinear algebraic equations are treated, as well as systems of ordinary differential equations based on the use of the principle of digital analogs. The proposed goal is achieved by using differing degrees of deparalleling of the computational process in solving the indicated problems.

Questions of utilizing digital-analog computers for digital signal processing are also treated, as well as the principles of designing digital-analog processor structures which are intended for use in general purpose systems.

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UDC 621.391:355

CYBERNETICS IN MILITARY SYSTEMS

Moscow KIBERNETIKA V SISTEMAKH VOYENNOGO NAZNACHENIYA in Russian 1979 signed to press 16 May 79 pp 5-36

[Chapter 1 by Viktor Nikolayevich Zakharov from the book "Kibernetika v Sistemakh Voyennogo Naznacheniya" edited by him, Voyennoye Izdatel'stvo Ministerstva Oborony SSSR, 7,500 copies, 263 pages]

[Text] CHAPTER 1. GENERAL PRINCIPLES OF THE CONSTRUCTION OF CYBERNETIC SYSTEMS

1.1. Operating Principle of a Cybernetic System

A cybernetic system (Figure 1.1) consists of five component parts: the object of control (controlled process), the control system (control algorithm), the measuring system (sensors of the process's characteristics), the assigning system (program), and the monitoring system (monitoring algorithm). These parts are connected to each other and form two control circuits: the basic circuit with feedback through the measuring system (units 2, 1 and 3) and the auxiliary circuit (units 5, 4, 2 and 1).

The basic circuit insures the operation of the cybernetic system during the process of the development of signals R from the assigning system and has the purpose of maintaining the values of the object's output coordinates Y in accordance with those required by the assigning signals R in such a fashion that the error E = R - X is within given limits. Besides this, the basic circuit must be stable and have the required quality indicators for the system's transient process.

The auxiliary circuit insures the monitoring of the system's operation. In the case of any abnormalities in its operation, this circuit readjusts the assigning system's algorithm and changes the control system's algorithm for the purpose of insuring normal functioning of the basic circuit. The object of

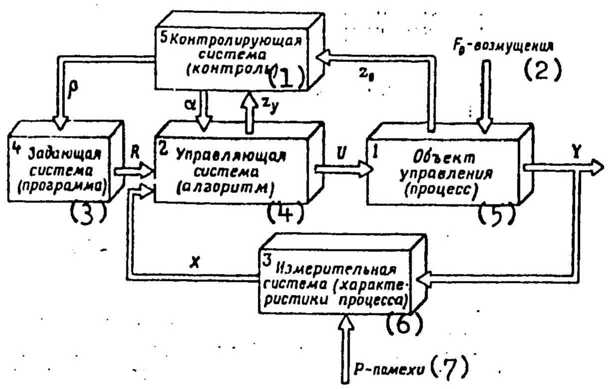

Figure 1.1. Functional diagram of a cybernetic system.

Key:
1. Monitoring system (monitor)
2. Disturbances
3. Assigning system (program)
4. Control system (control)
5. Object of control (process)
6. Measuring system (of the process's characteristics)
7. Interference

control can be any material body or any physical process, such as a rocket, a submarine, an airplane, the temperature and pressure inside a closed volume, the fuel combustion process in a reactor, and so on.

With the help of sensors, the measuring system measures the actual values of the object's or process's output parameters, which -- regardless of their physical meaning -- are called the generalized output coordinates Y.

In accordance with the control algorithms incorporated in it, the control system sends signals to the power members, which in turn provide the necessary effects U on the object. Thus, the control actions are worked out in accordance with the information produced by the sensors of the object's actual generalized output coordinates and their required values, as produced by the assigning system. This control principle is called deviation control and insures the high quality of a cybernetic system's operation. The set of devices consisting of the sensors and the assigning and control systems is called the regulator.

As the control system it is possible to use, for example, a digital computer or any combination of equipment and man. In accordance with the algorithms incorporated in it and the initial data, the assigning system works out the program for the change in the required values of R. The signals from the assigning device that enter the control system are called assigning actions.

The monitoring system serves to monitor the correctness of the system's functioning and to reorganize the algorithms for producing the control and assigning actions. If malfunctions and failures of individual elements appear, the monitoring system sends correcting signals (α, β) to the control and assigning systems in accordance with the actual state of the control parameters (Z_0, Z_y). The system's hierarchical principle of construction provides it with increased reliability and vitality. It is important to mention here that the system operates with random, previously unknown external disturbances F_0 acting on the object. In addition to this, there can be random interference P in the measuring system's sensors, so at the sensors' output we receive signals X, by which it is possible to determine the approximate values of the output coordinates Y of the state of the object.

1.2. Classification of Cybernetic Systems

Systems are classified according to three indicators: purpose, the form of the dynamic processes, and the degree of perfection.

All cybernetic systems are divided into two classes: automatic and automated systems (Figure 1.2).

The first class includes systems that function automatically, without the direct participation of a person (operator) during the generation of the control signals; an example of this is a flight control system for a rocket.

The second class consists of systems that operate with the direct participation of a person (or collective of people); examples of this class of system are an aircraft flight control system, a system for changing a ship's course, and so on.

Composite systems, in which the same system can be regarded as automatic in some functional modes and automated in others, are also encountered in practice. For example, in the absence of interference the tracking of a radar target proceeds automatically, while under complicated interference conditions it is tracked by a person (operator).

It should be kept in mind that the theory of automated systems has not yet been sufficiently fully developed, since it is still not possible to describe the behavior of man in the system adequately, with a degree of approximation to actual

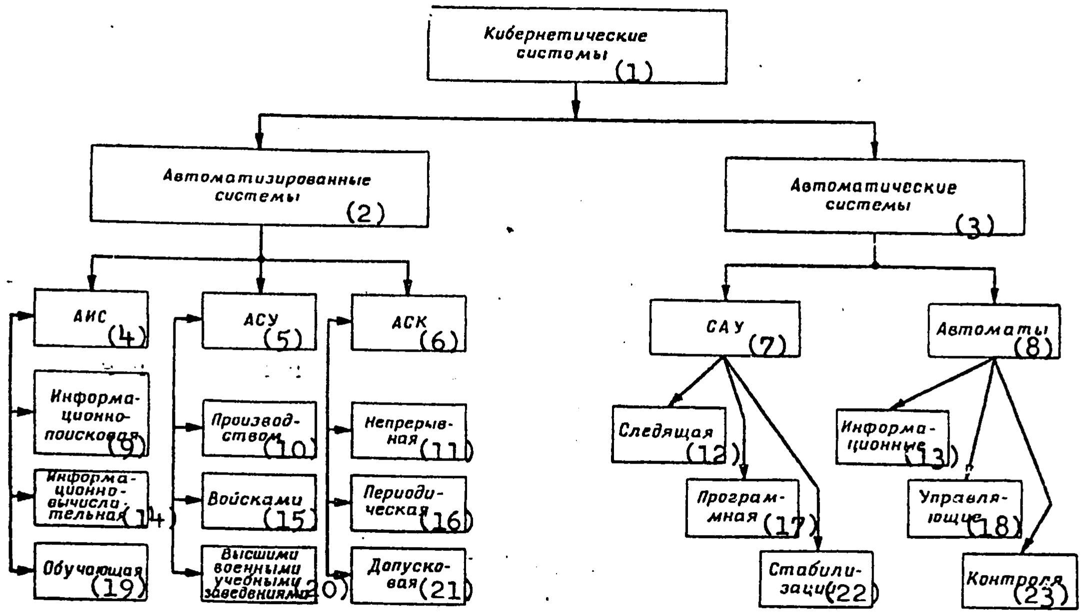

Figure 1.2. Classification of cybernetic systems.

Key:
1. Cybernetic systems
2. Automated systems
3. Automatic systems
4. AIS
5. ASU
6. ASK
7. SAU
8. Automata
9. Information retrieval
10. Production
11. Continuous
12. Servosystem
13. Information
14. Information and computing
15. Troops
16. Periodic
17. Programmed
18. Controlling
19. Teaching
20. Military VUZ's
21. Tolerance
22. Stabilization
23. Monitoring

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reality that is sufficient for practical purposes, by means of mathematical relationships.

In turn, automatic and automated systems can be divided into a number of subsystems. In particular, automatic systems are subdivided into automata and automatic control systems (SAU).

Automata are divided into the following types, according to their purpose: information, control, and monitoring. Typical representatives of automata are robots and digital computers. The simplest automata include instruments for monitoring environmental parameters such as gas composition, temperature and so on.

A more complicated automaton is the perceptron, which is a device for recognizing patterns. This type of automaton includes, for example, reading machines. From the viewpoint of cybernetics, the basic feature of an automaton is the fact that its operation is determined by a finite number of states that replace each other according to a completely defined program.

According to the form of the assigning signals, automatic control systems are subdivided into programmed systems and servosystems. In servosystems the law governing the change in the assigning actions is unknown beforehand and the actions, as a rule, are of a random nature. An example of such a system is a radar station that tracks aircraft for the purpose of determining their flight parameters. In contrast to a servosystem, a programmed SAU operates according to an assigning action that is known beforehand. For example, the control system of a missile of the "ground-to-ground" type turns its axis through a pitch angle in accordance with the previously given program for turning during the active section of the flight trajectory.

Let us mention here that in some cases an SAU can contain some kind of automaton. An example of such a system is a control system for a rocket with an on-board digital computer. In this case the computer (automaton) acts as the control system.

Automated systems are divided into the following subsystems, according to purpose: automated information systems (AIS), automated control systems (ASU) and automated monitoring systems (ASK).

In turn, each of these subsystems is subdivided by purpose into separate types, as shown in Figure 1.2.

An automated information retrieval system (IPS) is used to collect, sort and store information and produce different references and information at the user's request. In foreign armies (such as that of the United States, which uses a TOS ASU), such systems serve the commanders and staffs of units (soyedineniye) and formations (ob"yedineniye), keep track of personnel, equipment and weapons, and store and produce information on the combat readiness of units (chast'), among other things.

In addition to collecting and processing information on the state of one's own troops and data on the enemy, information and computing systems (IVS) perform the calculations needed for the purpose of making recommendations and varying the conduct of combat activities. Besides this, these systems support the daily activities of troops for the purpose of maintaining them in a state of high combat readiness.

In accordance with a personnel training assignment formulated by the commander, an automated information system for teaching (ISO) carries out a sequential teaching process without the direct participation of a teacher. The simplest examples of such systems are different types of training equipment. More complicated ISO's contain digital computers with specially developed teaching programs.

Automated control systems are used to control processes and have different purposes. Such systems include, for example, control systems for complexes of weapons, troops, transportation and communication facilities, production process control systems, and so forth.

Finally, automated monitoring systems are classified according to their mode of operation: continuous action, periodic action and tolerance. Continuous- and periodic-action ASK's require no explanation. Tolerance ASK's provide for the transmission of an alarm signal whenever any parameter of the controlled process goes beyond a given limit.

The set of AIS, ASU, ASK, SAU and automaton subsystems insures integrated automation of weaponry control on a scale of the type encountered in the armed forces. Such a "system of systems" is called a "large system." The theory of "large systems" is being worked out and developed intensively at the present time and is intended for the solution of the problem of the efficient use of the systems involved.

Optimization of a cybernetic system is a central problem that is subject to solution during the creation of new complexes. The solution of this problem is based on two principles: Bellman's optimality principle and Pontryagin's maximum principle. The realization of these principles during the synthesis of specific SAU's is accomplished by the following methods:

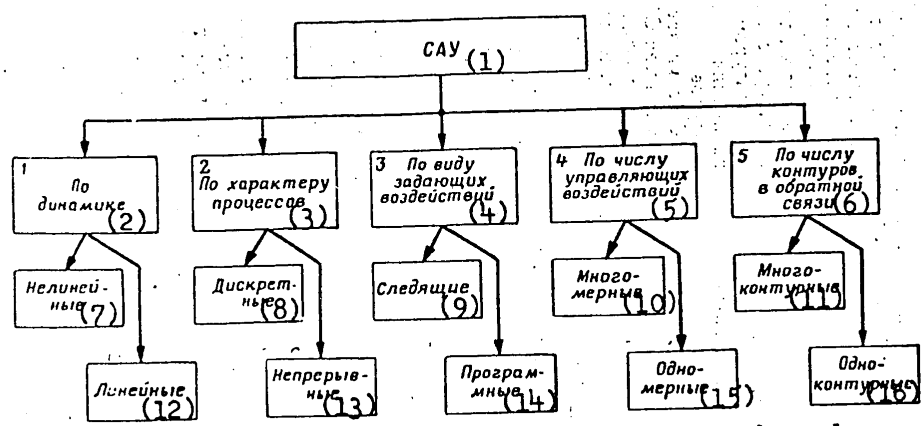

Figure 1.3. Classification of SAU's by dynamic and structural features.

Key:

1. SAU
2. By dynamics
3. By the nature of the processes
4. By the type of assigning actions
5. By the number of control actions
6. By the number of feedback circuits
7. Nonlinear
8. Discrete
9. Servo
10. Multidimensional
11. Multicircuit
12. Linear
13. Continuous
14. Programmed
15. Unidimensional
16. Single-circuit

frequency methods, dynamic programming, space of states, and others.

In order to use one method or another, it is necessary to present a clearcut classification of SAU's according to dynamic and structural features (Figure 1.3). This classification contains five characteristic features. The systems are divided into two mutually exclusive types for each feature.

According to the dynamic features, SAU's are subdivided into linear and nonlinear systems. It should be kept in mind that in view of the limitations that are imposed on control actions and the operating bands of sensors, all systems are nonlinear to some degree. However, if the deviations of the output coordinates during the process of SAU operation are within the given limits and the processes in the system are described by linear differential and nonlinear difference equations, the system can be considered to be linear.

SAU's are divided into continuous and discrete systems according to the nature of the processes taking place in them. In the first case the sensors measure the object's output coordinates continuously and the control system also generates the control actions on the object on a continuous basis. In the second case the system operates in an intermittent mode. The sensors measure the output coordinates periodically or the signals at the sensors' outlet are interrupted periodically, and the control signals at the control system's outlet are also of the intermittent type. Discrete systems include, for example, any SAU with a digital computer in the control circuit, since because of its operating principle a digital computer can receive and send out signals only at discrete points in time.

According to the nature of the assigning action that is generated, systems are subdivided into programmed systems and servosystems. This classification feature was discussed earlier.

On the basis of the number of independent control actions, SAU's are divided into uni- and multidimensional types. In the first case only one control signal can act on the object, whereas there can be several such signals in the second case.

According to the number of control circuits, systems are classified as single- or multicircuit. In the first case only one output coordinate is measured by a sensor and only a single feedback from the object to the control system is organized. In the second case the sensors measure several output coordinates and several feedbacks to the control system are organized. The number of circuits in the system is determined by the number of sensors. The circuits can be both internal and external. A multicircuit system with internal circuits frequently leads to a single-circuit structure with a single external circuit by way of shunting of the internal circuits.

From the viewpoint of analyzing and synthesizing SAU's, the upper row of the final classification in Figure 1.3 defines the more complicated system, while the lower row indicates the simpler SAU. In the first case the system is characterized as nonlinear, discrete, of the servo type, multidimensional and multicircuit, whereas in the second it is linear, continuous, programmed, unidimensional and single-circuit.

Although the classification presented above encompasses all types of SAU's, it still does not give a complete description of all their properties. In particular, using this classification it is difficult to give a full characterization of a system's degree of perf ction. Therefore, let us discuss a supplementary classification according to this feature (Figure 1.4).

Figure 1.4. Classification of SAU's according to degree of organization and perfection.

Key:
1. Self-organizing
2. Self-learning
3. Adaptive
4. Extreme
5. Self-adjusting
6. Closed-loop
7. Open-loop

As far as the degree of perfection is concerned, the simplest systems are open-loop SAU's, although they -- as has already been mentioned -- are frequently unable to function. Closed-loop systems (or systems with feedback) are an improvement. In them the control actions are generated according to deviations of the actual output coordinates from the required values. The operating principle of a closed-loop SAU was discussed in detail in Section 1.1.

The next higher level of organization belongs to self-adjusting SAU's, in which the control algorithm's parameters are reorganized without reorganizing the structure of the algorithm itself. The reorganization of the parameters takes place as the SAU operates in accordance with the change in the previously selected indicators for the quality of the work. The functional diagram of a self-adjusting SAU contains a monitoring system, while the block diagram is supplemented with a self-adjustment circuit.

In a self-adjusting SAU, if there is a search for the extreme value of the quality indicator and the processes are kept close to this extreme level under conditions where the system is acted on by external disturbances and interference, this system is called an extreme one.

Even more improved and more complexly organized is a self-adjusting SAU in which not only the control algorithm's parameters, but also its structure is reorganized. Such a system is adaptable to changing conditions in the external medium and is called adaptive.

At the sixth level of perfection and organization we find self-learning SAU's in which, in accordance with a selected learning strategy, optimal control algorithms are worked out according to given quality indicators. Of course, before such a system can operate effectively, it must spend some time on the development of the control algorithm; that is, on self-learning. At the same time, when there is an unforeseen change in the external operating conditions or the object's internal structure, the system "learns" anew, thus adapting to these changes. Let us mention here that the theory of such SAU's is not fully developed at the present time and that the systems themselves are far from being realized in practice.

The highest degree of perfection and organization is possessed by self-organizing SAU's, which not only generate the optimum algorithm during the process of operation, but also select the learning strategy according to the target function incorporated in it. However, technical systems of this type have apparently not yet been developed and will not be in the foreseeable future.

1.3. Examples of Cybernetic Systems

1.3.1. Flight Control System of an Intercontinental Ballistic Missile

As an example of a discrete, multicircuit SAU for military purposes, let us discuss the flight control system of a "Minuteman" missile [2]. As is known, the Minuteman is a three-stage intercontinental ballistic missile (MBR) with solid-fuel engines that has an inertial guidance system and an on-board digital computer (BTsVM) in the control circuit for the movement of the center of mass and stabilization relative to the center of mass.

Figure 1.5 depicts the design and functional diagram of this missile's flight control system. The inertial navigation unit consists of a gyrostabilized platform with pitch ($\Delta\Theta$), yaw ($\Delta\psi$) and rotation ($\Delta\varphi$) angle sensors. On the gyrostabilized platform there are three linear accelerometers that measure accelerations in three mutually perpendicular directions (x,y,z). On the basis of the signals from the accelerometers, a calculating and problem-solving unit determines the increments in the linear velocities ($\Delta V_x, \Delta V_y, \Delta V_z$) of the missile's center of mass in inertial space. In the second stage of the missile there is an additional angular accelerometer that measures deviations of the missile hull's angular velocities of rotation relative to the pitch ($\Delta\Theta_a$) and yaw ($\Delta\psi_a$) angles.

Signals from the accelerometers enter the VTsVM, which works out the output control signals for the purpose of stabilizing the missile's axes relative to the pitch, yaw and rotation angles and for controlling the center of mass's movement in the directions that are lateral and normal to the flight trajectory.

Thus, this system is a multicircuit and multidimensional discrete SAU. The system's distinctive feature is the use of a

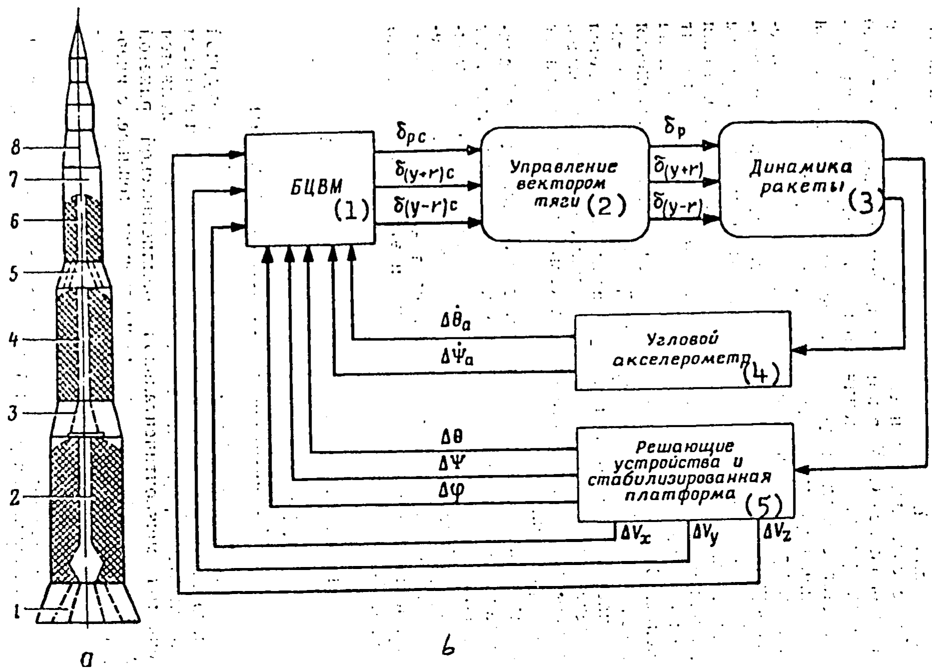

Figure 1.5. Minuteman intercontinental ballistic missile: a. missile; b. functional diagram of flight control system; 1. four rotating nozzles with angle of deflection sensors; 2. first stage; 3. transitional compartment between first and second stages; 4. second stage; 5. transitional compartment between second and third stages; 6. third stage; 7. instrument compartment (three accelerometers); 8. control and navigation systems' equipment compartment.

Key:

1. VTsVM
2. Thrust vector control
3. Missile dynamics
4. Angular accelerometer
5. Problem-solving units and stabilized platform

VTsVM with additional devices for converting analog (continuous) signals into discrete (digital) ones and vice versa. The VTsVM has a high operating speed and a memory that is adequate for controlling the missile with given quality indicators. The $\Delta\Theta$, $\Delta\psi$ and $\Delta\varphi$ output signals are quantified with respect to time, with a discreteness period $T_{01} = 0.03$ s, while the ΔV_x, ΔV_y and ΔV_z signals have a discreteness period $T_{02} = 0.45$ s. The output control signals enter the drive mechanisms with a period $T_{01} = 0.03$ s.

The use of the VTsVM provides the missile's control system with flexibility because the parameters of the algorithms for generating the stabilization and guidance signals, which are stored in the computer's memory, can be changed quite easily. For example, the missile can be retargeted and the flight assignment changed by entering new constants in the VTsVM's memory unit.

Thus, the integrated system for controlling the state and launching of the missile is automated and functions with the participation of an operator. After the launch command is transmitted, the system functions automatically.

1.3.2. Orientation and Stabilization System of an Orbital Space Station

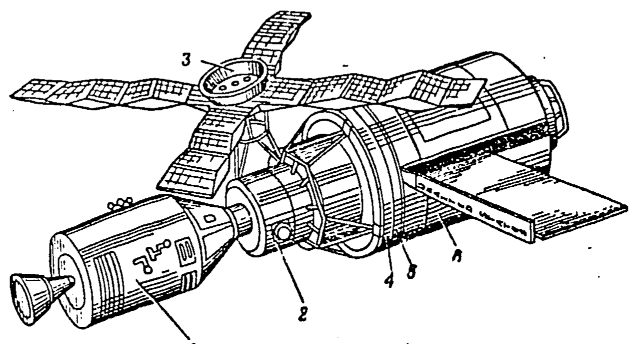

Figure 1.6. General view of the "Skylab" orbital station: 1. "Apollo" spacecraft; 2. docking unit (two docking assemblies); 3. astronomical instrument complex; 4. lock chamber; 5. instrument compartment; 6. basic station unit.

Let us discuss the purpose and operating principle of the orientation and stabilization system for the Skylab semipermanent, inhabited space station [9]. This station is not a military project, but from the viewpoint of the construction of the cybernetic system it can be regarded as an example of a modern SAU with a BTsVM in the control circuit. Figure 1.6 is a general view of the station with a docked Apollo spacecraft. In order to support the conduct of experiments requiring accuracy of orientation and stabilization on the order of several angular minutes, a special astronomical compartment (3) located in a separate structure is used. This compartment can rotate relative to the basic unit (6) of the orbital station.

Increased accuracy in the stabilization of the astronomical compartment is provided by vernier control of the compartment's

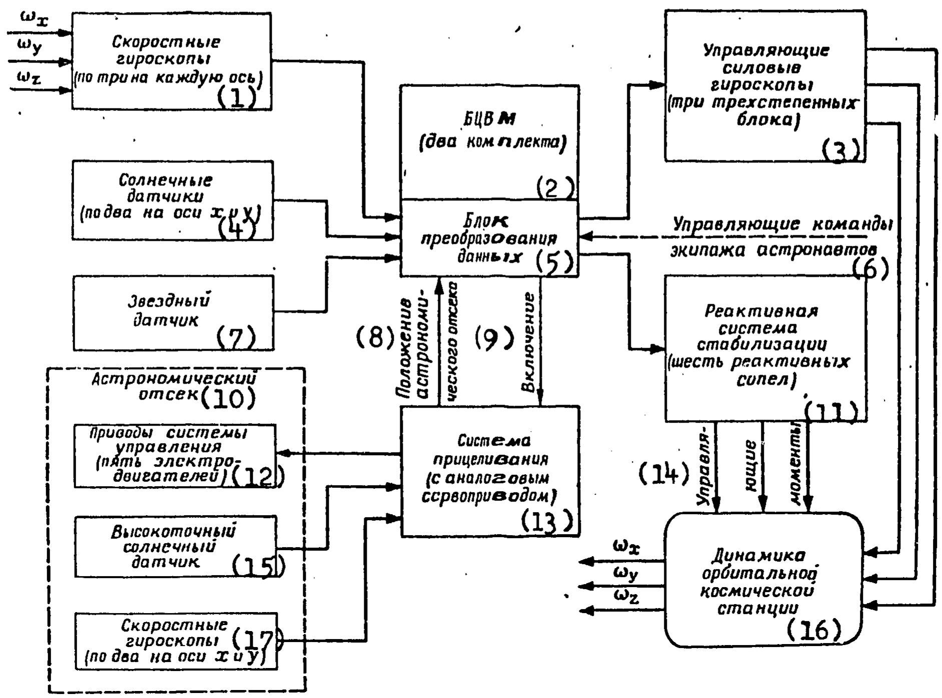

Figure 1.7. Functional diagram of orbital space station's orientation and stabilization system.

Key:

1. Rate gyroscopes (three on each axis)
2. VTsVM (two complexes)
3. Powered control gyroscopes (three three-stage units)
4. Solar sensors (two each on x and y axes)
5. Data conversion unit
6. Astronaut crew control commands
7. Stellar sensor
8. Position of astronomical compartment
9. Engage
10. Astronomical compartment
11. Jet-powered stabilization system (six jet nozzles)
12. Control system drive mechanisms (five electric motors)
13. Aiming system (with analog servomotor)
14. Control moments
15. High-precision solar sensor
16. Orbital space station dynamics
17. Rate gyroscopes (two each on x and y axes)

position with the help of a special servomotor. The stabilization system's sensors serve three rate gyroscopes that measure the station's angular velocities relative to the ω_x, ω_y and ω_z axes.

Powered control gyroscopes and jet nozzles are used to maintain the required orientation of the station's axes. The basic stabilization equipment consists of three-stage powered gyroscopes, the rotors of which spin at a speed of 9,000 r/min. The functional diagram of the orientation and stabilization system is shown in Figure 1.7.

The VTsVM uses the angular velocity sensors' readings to determine the station's position relative to the inertial space's fixed axes and generate the control signals to control the velocity vector. However, as the result of the accumulation of errors in the computation of the angles, such a system cannot insure the preservation of the required angular position of the station's axes for an extended period of time. Therefore, solar sensors and star trackers are used to supplement the system. The special feature of this system is its use of a centralized BTsVM that solves all the basic station control problems.

The BTsVM has the following specifications: time for a single cycle -- 3 μs; memory -- 16,000 sixteen-bit words; temperature range for normal operation -- from -40 to +75°C; data presentation -- with fixed decimal and parallel processing of individual bytes of information.

In order to insure its operational reliability, the BTsVM is duplicated: in the case of failure of the basic complex, a coupling unit provides for automatic switching of all circuits to the reserve complex. The BTsVM's memory has already had entered in it the programs for computing the orientation and stabilization control signals that are sent to the powered gyroscopes and, when necessary, to the jet nozzles' drive mechanisms. The command signals first pass through a digital filter in order to eliminate the undesirable effect of tones from elastic vibrations of the station's hull on the dynamics of the stabilization system. The discreteness period during the transmission of the control signals to the powered gyroscopes is 0.2 s.

Thus, this system is a multicircuit, multidimensional, discrete SAU with a variable structure and a single BTsVM in the control circuit.

1.3.3. Automatic Flight and Weapons Control System for a Strategic Bomber

Let us discuss the realization and operation of an integrated system, using the control system of the United States' multipurpose FB-111 aircraft as an example [5]. This aircraft's complex of on-board data equipment (Mk. 2) is intended to

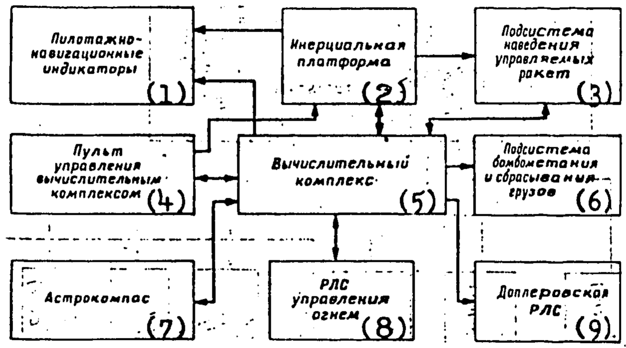

Figure 1.8. Functional diagram of the on-board equipment complex of the FB-111A airplane.

Key:

1. Pilot's navigation display
2. Inertial platform
3. Guided missile guidance subsystem
4. Computer complex control center
5. Computer complex
6. Bombing and cargo-dropping subsystem
7. Astrocompass
8. Fire-control radar
9. Doppler radar

provide semiautomatic and automatic aircraft flight modes and to control the launching and guidance of guided missiles of the air-to-ground type.

The bomber can carry six SRAM missiles [22]. They are launched at a distance of 60-160 km from the target, after which the airplane turns to the opposite heading.

Figure 1.8 is the functional diagram of the FB-111A aircraft's complex of on-board equipment. On the airplane there are also terrain-following radar, a radio altimeter, a unit for detecting enemy radar in operation, electronic countermeasures devices and other auxiliary equipment. The distinctive feature of this complex is the presence of two BTsVM's of the 4Pi (AN/AYK-6) type and a conversion unit that links the BTsVM's to the sensors and the other on-board equipment. One of the BTsVM's is used to make navigation calculations and, in particular, to insure the generation of signals to correcto the position of the inertial platform during flight, while the other generates weapons control commands and signals.

The BTsVM is based on integrated circuits. In order to insure the operational reliability of the digitual computation complex in case of failure of one of the BTsVM's, an auxiliary operating mode with switching in of the second computer is provided. If one of the BTsVM's fails, the conversion unit and the couplings insure that the signals from the sensors are switched to the one that is in good working order.

Specifications of 4Pi BTsVM

Weight	21.3 kg
Volume	22 dm^3
Required power	240 W
Word length	16-32 binary digits
Capacity of main memory	8,448-33,792 words
Operation execution time:	
Addition	5 μs
Multiplication	19.4 μs
Division	46.3 μs

The SRAM supersonic guided missile (Figure 1.9) is used to arm existing and prospective strategic bombers (FB-111A, B-52G/H, B-1) and has the purpose of suppressing radar and antiaircraft weapons when breaking through an enemy's air defenses, as well as that of destroying the main target. The missile can carry a nuclear warhead. Flight control is exercised by an inertial guidance system consisting of an autopilot, a computer and a radar altimeter.

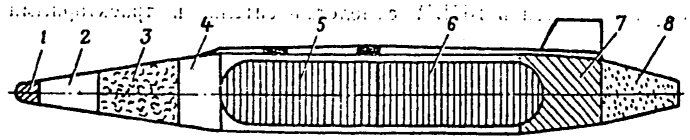

Figure 1.9. Layout of SRAM missile: 1. impact detonator; 2. compartment for guidance system; 3. nuclear warhead; 4. guidance and control system compartment; 5. solid-fuel propellant; 6. solid-fuel launching charge; 7. tail section with actuating equipment of control system; 8. tail cone.

The method for guiding the missile to the target, which provides a flexible flight trajectory with maneuvering in the vertical and horizontal planes, is called "guidance to an imaginary target." The spatiotemporal coordinates of the imaginary target in the missile's guidance section are generated in the on-board computer and changed in accordance with the previously chosen trajectory that passes through the actual target. The principle of guidance according to the imaginary target's trajectory is explained in Figure 1.10.

Beginning with the moment of its launch from the airplane, the missile is guided to the actual target by the method of pursuit

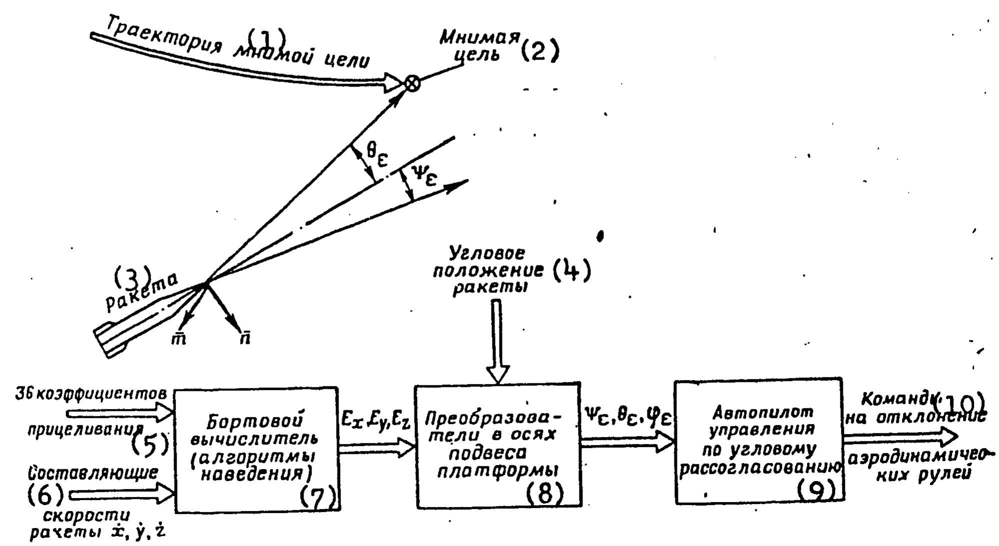

Figure 1.11. Functional diagram of missile flight navigation and control system.

Key:
1. Imaginary target's trajectory
2. Imaginary target
3. Missile
4. Missile's angular position
5. 36 aiming factors
6. Missile's velocity components $\dot{x}, \dot{y}, \dot{z}$
7. On-board computer (guidance algorithms)
8. Converters in platform suspension system's axes
9. Autopilot control by angular mismatch
10. Commands for deflection of aerodynamic rudders

be mentioned that the algorithms incorporated in the missile's on-board computer are quite simple, since the most complicated calculations to insure the orientation of the missile's inertial platform and determine the guidance parameters are done by the carrier aircraft's BTsVM.

Specifications of the SRAM Missile's On-Board Computer

Weight	2.3 kg
Volume	2.26 dm^3
Required power	45.5 W
Number of commands	11
Memory capacity	2,048 8-bit binary words
Length of information word	18 binary bits
Addition operation execution time	24 μs
Digital configuration of analog-to-code and code-to-analog converters	9

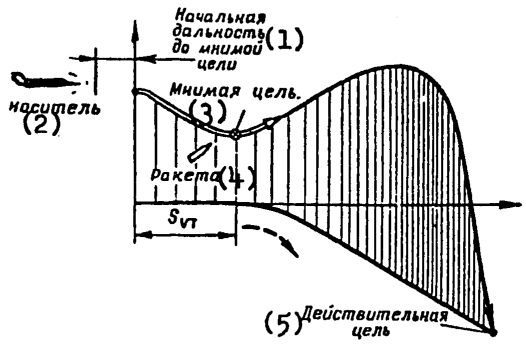

Figure 1.10. Missile guidance trajectory according to the method of pursuit of an imaginary target.

Key:
1. Initial range to imaginary target
2. Carrier
3. Imaginary target
4. Missile
5. Actual target

of the imaginary target. The imaginary target's trajectory is determined by 36 aiming constants that are stored in the carrier aircraft's BTsVM, as well as the trajectory algorithms that are incorporated in the missile's on-board computer. The missile's inertial platform is set up before it is launched, as the carrier aircraft is in flight, by singals from the airplane's reference bloc of inertial measuring units. The Kalman filter method is used to insure accurate orientation of the platform according to a 10-dimensional vector of state. Figure 1.11 depicts the functional diagram of the missile's flight guidance and control system.

On the basis of sensor signals and in accordance with the guidance algorithms, from the moment of the missile's launch its on-board computer determines the three orthogonal components of the mismatch between the position of the missile's center of mass and the point representing the imaginary target's location in the navigational system of coordinates ($\Delta x, \Delta y, \Delta z$). These values are filtered and converted into direct-current analog signals in accordance with the directing cosines. The analog signals are distributed among the channels of the connected system of coordinates with the help of angular sine-cosine converters that are oriented on the axes of the inertial platform's suspension system. As a result, signals are generated that are proportional to the angular errors Θ_ε, ψ_ε and φ_ε in the missile's orientation. These signals enter the autopilot's input as programmed signals; the autopilot then provides the necessary orientation of the missile's axes and guides its center of mass along the imaginary target's trajectory. It should

Thus, the integrated flight control system of the FB-111A carrier aircraft with a SRAM guided missile is a compex, multi-circuit and multidimensional discrete SAU with digital computers on board both the airplane and the missile.

1.3.4. Automated Weapons Control System for a Ship

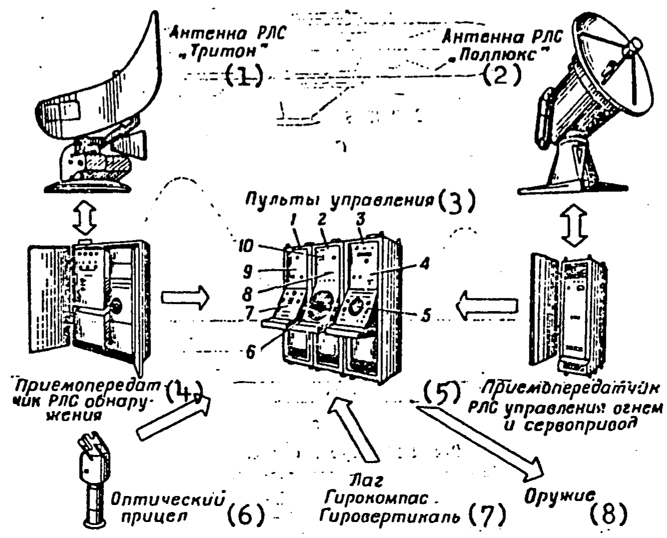

Figure 1.12. The "Vega" system: 1. missile and torpedo control panel; 2. target detection and acquisition panel; 3. artillery fire-control panel; 4. artillery unit control computer; 5. target tracking screen; 6. tactical situation screen; 7. weapon control panel; 8. unit for input of target movement and attacking ship's parameters into computer; 9. guided missile and torpedo fire-control computer; 10. automatic target-tracking unit.

Key:

1. "Triton" radar antenna
2. "Pollux" radar antenna
3. Control panels
4. Acquisition radar transceiver
5. Fire-control radar transceiver and servomotor
6. Optical sight
7. Log; gyrocompass; vertical gyroscope
8. Weapons

As an example of a modern ASU intended for the control of a ship's weapons, let us discuss the Vega system [12]. Eleven variants of this system are known, each of which is intended to control a certain, specific complex of weapons on board a ship. Figure 1.12 is a diagram of the Vega system. Each of the system's variants contains: a Triton radar for target acquisition and tracking and navigation; a Pollux or "Castor" radar for controlling the ship's weapons; a control panel combined with a TsVM [digital computer].

The shipborne TsVM in the Vega system processes the data needed to "capture" targets for the weapon-control radar, track them, and control the different weapon systems. For example, in the "Vega-Pollux-PCOT" system the TsVM generates the necessary data for controlling the fire of a ship's conventional artillery, launching "Ekzoset" [translation unknown] or "Automat" missiles, and firing guided torpedoes. The TsVM has a single central processor that operates in the multiprogram mode. The TsVM's operating is sufficiently fast (addition, multiplication and division of two 16-bit binary words require 2, 5 and 4 s, respectively) so as to enable it to operate in the control circuits in real time.

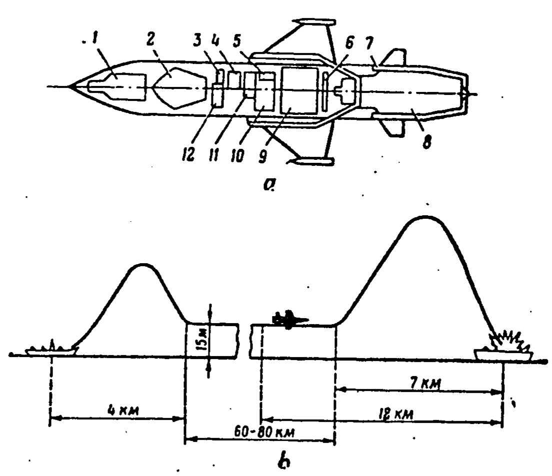

Figure 1.13. The Automat missile: a. layout; b. flight trajectory; 1. active radar homing head; 2. semi-armor-piercing warhead; 3. regulator; 4. control system bloc; 5. converter; 6. oil tank; 7. aerodynamic rudder servomotor; 8. turbojet cruise engine; 9. fuel tank; 10. computer and radar altimeter; 11. electronic equipment bloc; 12. inertial system bloc.

Let us discuss an automatic antiship missile control system, using an Automat missile [21] as an example. The missile's basic purpose is to destroy mobile surface targets at quite long ranges. The Automat missile's layout is shown in Figure 1.13a. The missile has five compartments: nose cone, warhead, instrument compartment, fuel tank and engine. The missile flies on a calculated trajectory. During the final section of its flight a radar homing system is engaged. The control system consists of an inertial unit, a radar altimeter, a computer, an active radar homing head, electronic equipment, and servomotors for the aerodynamic rudders.

The missile is launched from a container that is mounted stationarily on board a ship. The target is "captured" with the help of the ship's acquisition and tracking radar. Data on the target's parameters are sent from the radar to a TsVM, which simultaneously receives data on the carrier ship's speed, course and list and the wind parameters. In accordance with the algorithm previously incorporated in it, the TsVM works out the parameters of the missile's maneuver trajectory and calculates when the homing head should be turned on. These data are sent to the on-board computer in the missile's guidance system. A possible missile flight trajectory is shown in Figure 1.13b.

A standardized missile of the Automat type can be fired not only from ships, but also from airplanes, helicopters and even from coastal launching units. Analyzing the composition and purpose of the Vega system, we can conclude that modern automated and automatic control systems for shipborne weapons are multicircuit and multidimensional cybernetic systems with TsVM's on the ship and computing systems in the guided missiles.

1.3.5. Antiaircraft Missile Complex Control System

Let us discuss the purpose, composition and operating principle of an automated control system for an antiaircraft missile complex (ZRK), using the SAM-D system [13] as an example. The missiles in this complex are intended to destroy airplanes of the FB-111 type at different altitudes, air-to-ground rockets of the SRAM type, and tactical ground-to-ground missiles of the Lens type.

The complex consists of a control point, a multifunction radar with a phased antenna array (FAR), and launchers (Figure 1.14). The control point receives and processes all the initial information needed to operate the SAM-D system. Its equipment consists of a TsVM, a display unit, and a data transmission system.

The TsVM's operating speed is about 1 million operations per second and its memory has a capacity of 750,000 binary digits.

The XMIM-104 missiles in the SAM-D complex are guided by a combined method: in the initial stage of the flight they are controlled by commands from the radar, and in the final stage by semiactive guidance. In the final stage, the guidance commands are determined with the help of the radar's TsVM and then transmitted to the missile.

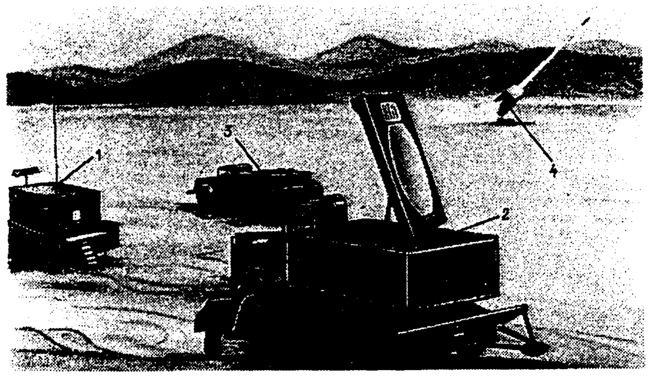

Figure 1.14. Placement of elements of SAM-D ZRK at the firing site (sketch): 1. control point; 2. multifunction radar with FAR; 3. military vehicle with launching containers; 4. launcher.

Thus, the ZRK automated fire control system is a complex multicircuit and multidimensional system with a digital computer that provides for both the operation of the radar with the FAR and the generation of commands for guiding the missiles to the target.

1.4. Models of Automatic Control Systems

1.4.1. Continuous, Unidimensional Systems

Let us discuss the techniques for formulating the structural diagram of an SAU according to its functional diagram, using a system for pitch angle stabilization of a rocket as an example. Figure 1.15 is a functional diagram of such a system. When the system is in operation, a pitch-angle sensor mounted on a gyrostabilized platform measures the deviation of this angle's actual value from the required value and converts the given deviation into a proportional voltage u_d, the polarity of which corresponds to the sign of the angle's deviation $\Delta\vartheta$. In order to insure the stability and quality of the entire stabilization system, voltage u_d is fed into an equalizer that is a component part of the amplifier-converter. From the equalizer's outlet, voltage u_k is fed into the amplifier, which -- in turn -- generates the control signals in the form of currents i_{II}, i_{IV}. These currents enter the control windings of steering actuators II and IV. The latter set the control elements in action by turning the rudder chambers through angles δ_{II} and δ_{IV}.

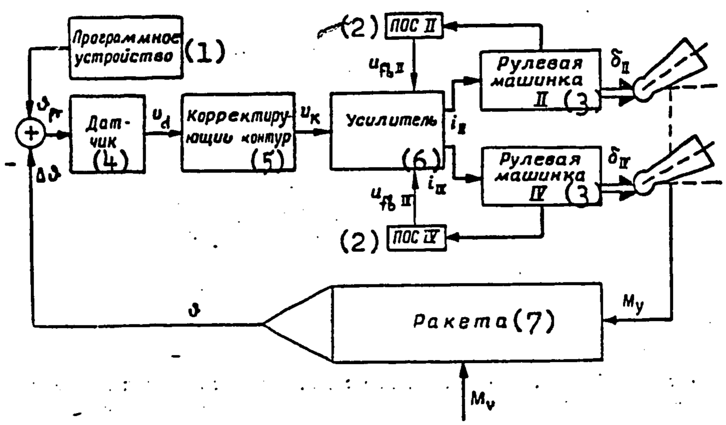

Figure 1.15. Functional diagram of a rocket's pitch angle stabilization system.

Key:
1. Programming unit
2. POS
3. Steering actuator
4. Sensor
5. Equalizer
6. Amplifier
7. Rocket

Thus, there appears a control action in the form of pitch control moment M_y. This moment insures the turning of the rocket with respect to the pitch angle so as to obtain the small deviation $\Delta\vartheta = \vartheta_{pr} - \vartheta$. The adduced signals and the actions form the basic closed-loop feedback circuit. However, it is not hard to see that in the system there also exist additional internal circuits from feedback potentiometers POS_{II} and POS_{IV}, which are mounted on the steering actuators' shafts. These additional negative feedback circuits insure the generation of the control voltage u_y. It can be assumed that the amplifier, the steering actuators and the feedback potentiometers form a servodrive. Therefore, after the inner circuit is rolled up and replaced with the servodrive, we reduce the two-circuit system to a single-circuit one.

Let us mention here that a previously unknown external disturbing moment acts on a rocket in flight. Besides this, the steering actuators have some creep; that is, a slow drift of their shafts from the zero position when there is a zero input signal i_y. It can be assumed that this drift appears because of an additional disturbance signal i_v.

The programming unit assigns the programmed value ϑ_{pr} of the pitch angle. In order to formulate the system's structural diagram, let us write the equations that describe the operation of the individual units and define the relationships between each unit's input and output signals:

$$\left.\begin{array}{l}
1.\ u_d = k_d(\vartheta_{pr} - \vartheta) = k_d\Delta\vartheta; \\
2.\ a_2\frac{d^2u_\kappa}{dt^2} + a_1\frac{du_\kappa}{dt} + u_\kappa = b_0\left(T_1^2\frac{d^2u_d}{dt^2} + 2T_1\xi_1\frac{du_d}{dt} + u_d\right); \\
3.\ i_y = k_y(u_\kappa - u_{fb}) = k_y\Delta u; \\
4.\ \frac{d\delta}{dt} = k_\delta(i_y + i_v); \\
5.\ u_{fb} = k_{fb}\delta; \\
6.\ \frac{d^2\vartheta}{dt^2} + c\frac{d\vartheta}{dt} + d\vartheta = e\delta + m_v.
\end{array}\right\} \quad (1.1)$$

In this system we have: 1 -- the sensor's equation; 2 -- the equalizer's equation; 3 -- the amplifier's equation; 4 -- the steering actuators' equation; 5 -- the feedback potentiometers' equation; 6 -- the pitch angle moment's equation. The coefficients of the following units have been defined in terms of k_d, k_y, k_δ and k_{fb}: the sensor, the amplifier, the sterring actuator and the feedback potentiometer. Coefficients a_2, a_1, b_0, T_1 and ξ_1 characterize the equalizer's properties. Coefficients c, d and e characterize the object's (rocket's) properties.

This system of equations can be regarded as a mathematical model of the stabilization system. In order to obtain a structural diagram, we should perform a Laplace transform operation on the left and right sides of all the equations that are part of the system for zero initial conditions. Allowing for the fact that in general form the representation of the derivative $(d^nx/dt) \to p^nX(p)$, where p = the Laplace variable and X(p) = the representation, we obtain

$$\left.\begin{array}{l}
1.\ u_d(p) = k_d\Delta\vartheta(p); \\
2.\ u_\kappa(p) = \frac{b_0(T_1^2p^2 + 2T_1\xi_1p + 1)}{a_2p^2 + a_1p + a_0}u_d(p); \\
3.\ i_y(p) = k_y\Delta u(p); \\
4.\ \delta(p) = \frac{k_\delta[i_y(p) + i_v(p)]}{p}; \\
5.\ u_{fb}(p) = k_{fb}\delta(p); \\
6.\ \vartheta(p) = \frac{e\delta(p) + m_v(p)}{p^2 + cp + d}.
\end{array}\right\} \quad (1.2)$$

On the basis of system of equations (1.2) it is not difficult to construct a structural diagram (Figure 1.16), where the operator transfer functions (OPF) of the system's separate components are located inside the rectangles. Where all the OPF parameters are known, this structural diagram serves as a basis for analyzing the processes in the SAU. However, if any of the OPF parameters of the components of the regulator are unknown

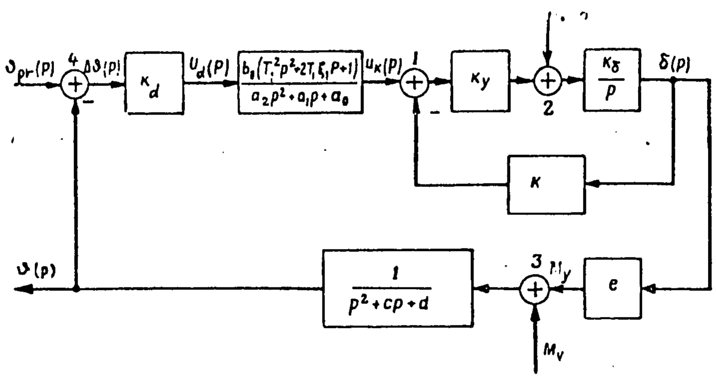

Figure 1.16. Structural diagram of a pitch angle stabilization system for a rocket.

beforehand, it is possible to formulate and solve the problem of synthesizing the SAU for a given form of the structural diagram; that is, the problem of selecting the regulator's parameters according to the given requirements for the system (as far as accuracy, operating speed and other quality indicators are concerned). If the form of the equalizer's OPF is not given, the more general problem of synthesizing the system according to a given quality indicator can be formulated and solved; that is, the problem of determining not only the parameters of the regulator's structure, but also the form of the OPF of the structure itself. In accordance with the classification given in Section 1.2, such a system can be regarded as linear, continuous, programmed, unidimensional, and double-circuited. In the case of convolution of the inner circuit, such a system is reduced to a single-circuit one.

1.4.2. Single-Circuit and Unidimensional Discrete Systems

Let us discuss a discrete, single-circuit object stabilization system, the distinctive feature of which is the presence of a TsVM in the control circuit. The use of a TsVM makes it possible to unitize and standardize the control equipment and provide self-monitoring both before and during operation. These properties are particularly important for military systems, where it is necessary to insure a high degree of combat readiness, accuracy and reliability.

Figure 1.17 is a functional diagram of a discrete SAU. In the diagram there are two switches that are closed in a short time interval with discreteness period T_0. The sensors are connected to the digital control unit (TsUM) by signal converters of the voltage-to-code type (N/K), while the TsUM is connected to

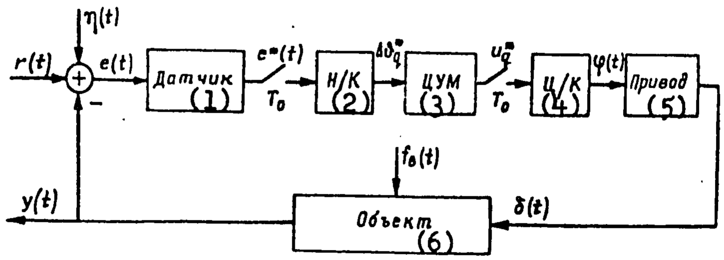

Figure 1.17. Functional diagram of a discrete, single-circuit stabilization system.

Key:
1. Sensor
2. N/K
3. TsUM
4. Ts/K
5. Drive
6. Object

the drives by a reverse converter of the digit-to-code type (Ts/K). The control signal that actuates the drive is read at this converter's outlet. For discrete systems, signals marked with the symbol * are discrete in time sequence. Figure 1.18

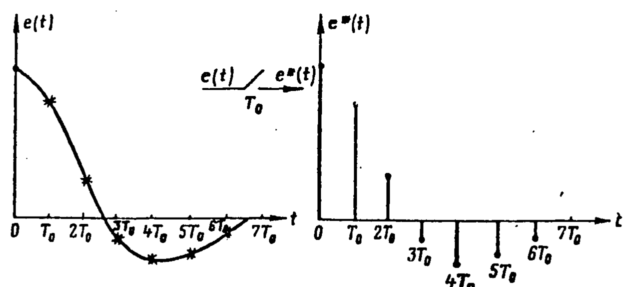

Figure 1.18. Conversion of continuous signal into a discrete sequence.

shows the principle of the conversion of a continuous, changing signal e(t) into a discrete sequence e*(t). It should be mentioned here that in connection with such a conversion, information on the input signal inside period T_0 is lost. It should also be kept in mind that the TsUM's and converters' input registers have a finite number of binary digits, so in addition to quantization of the input signal with respect to time, there is also signal quantization by level. In many cases, however, this conversion error is small and can be ignored in practical calculations. Therefore, we will henceforth limit ourselves to a discussion of only SAU's with time quantization of the signals. In the literature, such SAU's are frequently called pulse SAU's.

When analyzing and synthesizing SAU's with TsUM's, there is no need to discuss the layout of the regulator's equipment in detail. It is sufficient to determine the equations that connect the TsUM's output temporal sequences with the input sequences. Since the TsUM has memory cells, it can remember the values of the input and output signals during preceding moments relative to a given moment. In accordance with the previously selected algorithm, the TsUM can calculate the control signal's values according to the relationship

$$\begin{aligned} u[kT_0] = \psi\{e[(k-i)T_0],\ e[(k-i+1)T_0],\ \ldots,\ e[kT_0], \\ u[(k-j-1)T_0],\ u[(k-j)T_0],\ \ldots,\ u[(k-1)T_0]\}; \\ 0 \leqslant i \leqslant k;\ 0 \leqslant j < k-1;\ k = 0, 1, 2, 3, \ldots, \end{aligned} \tag{1.3}$$

where ψ = some function of the arguments on the right side.

If this function is nonlinear, it can be written in the form of a difference equation:

$$\begin{aligned} u[kT_0] = a_n e[(k-n)T_0] + a_{n-1} e[(k-n+1)T_0] + \ldots + a_0 e[kT_0] - \\ - b_m u[(k-m)T_0] - b_{m-1} u[(k-m+1)T_0] - \ldots - b_1 u[(k-1)T_0]. \end{aligned} \tag{1.4}$$

If we use a z-transform [3] on the right and left sides of this equation after having obtained $z = e^{T_0 p}$ (where p = Laplace variable), we obtain the TsUM's z-OPF:

$$D[z] = \frac{u[z]}{e[z]} = \frac{a_n z^{-n} + a_{n-1} z^{-(n-1)} + \ldots + a_1 z^{-1} + a_0}{b_m z^{-m} + b_{m-1} z^{-(m-1)} + \ldots + b_1 z^{-1} + 1}. \tag{1.5}$$

The z-OPF is analogous to the equalizer's OPF for a continuous system, it being the case that $m \leqslant n$. However, the essential difference in this OPF is that it gives only the relationship between the discrete values of the TsUM's input and output signals. In this respect, the expression $z^{-n} = e^{-nT_0 p}$ can be regarded as a lag in the signal's discrete value by n discreteness periods T_0.

The Ts/K converter carries out the reverse conversion of the signal's sequence of digital values at the TsUM's outlet into the drive control signal $\varphi(t)$. The specific form of this signal depends on the type of drive.

The following types of drives are known at the present time: continuous, pulsed, step and digital. For a continuous drive, the sequence of digits at the TsUM's outlet is converted -- with the help of the Ts/K unit -- into a signal that is piecewise-continuous and constant over the discreteness period T_0 (Figure 1.19). If the drive has a sufficiently fast operating speed, it generates an input signal during each discreteness period T_0, as is shown in the figure.

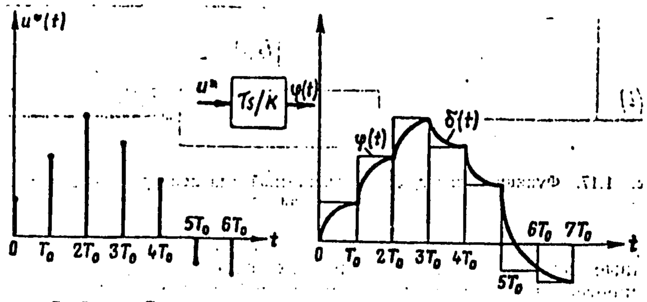

Figure 1.19. Conversion of discrete signal into a piecewise-continuous one.

The nature of the change in the drive's output coordinate has the form of curve $\delta(t)$. The operation of obtaining a constant control signal in the period T_0 is called recall of the signal's discrete value, while the component that performs this operation is the zero-order fixing component. For this component the OPF has the form

$$W_{fc}(p)=\frac{1-e^{-T_0 p}}{p}. \quad (1.6)$$

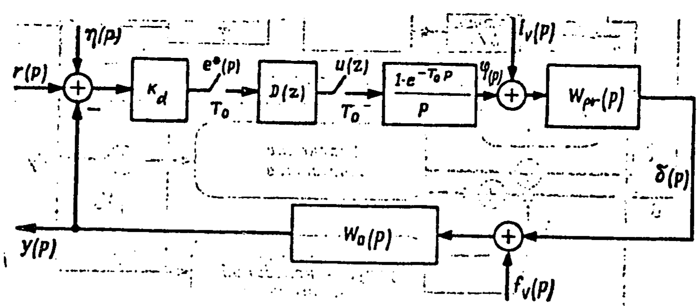

Figure 1.20. Structural diagram of a linear, discrete, single-circuit SAU.

The controlled object and the continuous drive are described by normal differential equations in the same manner as for a continuous SAU. Therefore, the structural diagram of a linear, discrete, single-circuit SAU has the form shown in Figure 1.20. If the discreteness period and the coefficients of the object's, drive's and regulator's OPF's are known, this structural diagram gives exhaustive information for investigating and evaluating the properties of the discrete SAU. If the D[z] coefficients are not given, then for the purpose of determining the TsUM's optimum algorithm for generating the control signal they are found by methods developed in the theory of discrete SAU's.

1.4.3. Multicircuit and Multidimensional Systems

In contrast to single-circuit SAU's, it is irrational to represent complex multicircuit and multidimensional SAU's in the form of a normal structure with an OPF. Let us examine, for example, the functional diagram of a solid-fuel rocket's pitch angle control system that allows for the effect on the system's dynamics of elastic tones from the vibration of the hull [8]. In the object equations we will take into consideration the deviation of the rocket's center of mass in the direction of the normal to the trajectory. In this case the object of control is described by moment and force equations and the equations of the tones from the hull's elastic vibrations. Let us assume that the system has three sensors of generalized output coordinates: a pitch angle sensor, an angular pitch velocity sensor and a sensor of linear velocity along the normal to the trajectory. The functional diagram of such a system is shown in Figure 1.21. The mathematical model of the object contains the following deviation equations:

$$\left.\begin{aligned} &1.\ \Delta\dot{V}_y + C_{VV}\Delta V_y + C_{V\vartheta}\Delta\vartheta + C_{V\delta}\Delta\delta = \frac{F_V}{m};\\ &2.\ \Delta\ddot{\vartheta} + C_{\vartheta V}\Delta V_y + C_{\vartheta\vartheta}\Delta\vartheta + C_{\vartheta\delta}\Delta\delta = \frac{M_\vartheta}{J};\\ &3.\ \Delta\ddot{q}_j + C_{q_j\dot{q}_j}\Delta\dot{q}_j + C_{q_jq_j}\Delta q_j = C_{q_j\delta}\Delta\delta;\ \ j = 1, 2, \ldots, m, \end{aligned}\right\} \qquad (1.7)$$

where ΔV_y = deviation of the rocket's velocity along the normal to the trajectory; $\Delta\vartheta$ = pitch angle deviation; Δq_j = deviation of the axis's angles of inclination for the j-th tone of the rocket hull's elastic vibrations; $\Delta\delta$ = deviation of the control element's angle of rotation with respect to pitch; F_V = disturbing force along the normal to the trajectory; M_ϑ = disturbing moment; C = differential equation coefficients that are temporally variable.

Let it be noted that the components caused by the hull's elastic vibrations are not taken into consideration in the force and moment equations. These vibrations can exert a significant influence on the readings of the pitch angle and pitch angular velocity sensors, so it is necessary to allow for them in these sensors' equations. Let us introduce into the discussion the steering gear's differential equation:

$$\Delta\ddot{\delta} + a_{\dot{\delta}\dot{\delta}}\Delta\dot{\delta} + a_{\delta\delta}\Delta\delta = k_{pr}\Delta u_1, \qquad (1.8)$$

where Δu_1 = the amplifier-converter's control signal.

An analysis of the system of differential equations that takes into consideration a single tone of the flexible vibrations (m = 1) shows that the object (including the drive) can be described by a system of seven first-order differential equations.

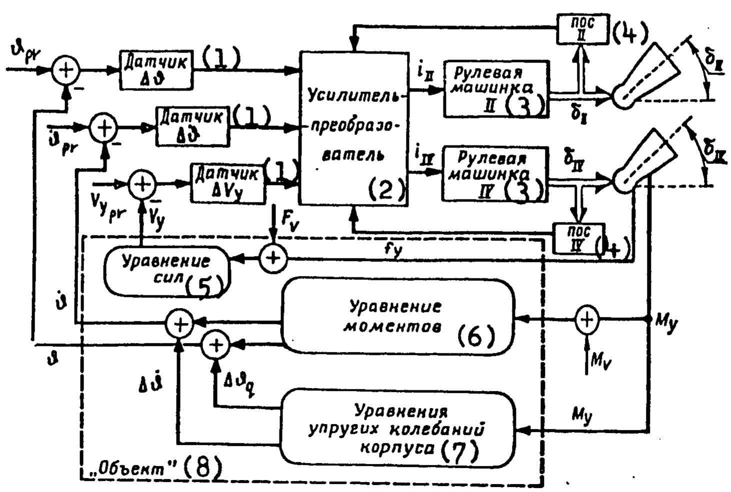

Figure 1.21. Functional diagram of a multicircuit flight control system for a solid-fuel rocket.

Key:
1. Sensor
2. Amplifier-converter
3. Steering actuator
4. POS
5. Force equation
6. Moment equation
7. Equations of the elastic vibrations of the hull
8. "Object"

The system has three sensors and a single independent control action, so it can be placed in the class of unidimensional, multicircuit SAU's. For the mathematic description of this system it is realistic to use vector-matrix equations of the system's spatial states. For this purpose, let us introduce some new designations for the generalized output coordinates and the additional variables (for the hull's elastic vibrations)

$$y_1 = \Delta V_y;\ y_2 = \Delta\vartheta;\ y_3 = \Delta\dot{\vartheta};\ y_4 = \Delta\delta_y;\ y_5 = \Delta\dot{\delta}_y;\ y_6 = \Delta q_1;\ y_7 = \Delta\dot{q}_1.$$

System of equations (1.7) and equation (1.8) can then be reduced to the following form:

$$\left.\begin{aligned} \dot{y}_1 &= b_{11}y_1 + b_{12}y_2 + \ldots + b_{17}y_7 + a_{11}u_1 + c_{11}f_1 + c_{12}f_2; \\ \dot{y}_2 &= b_{21}y_1 + b_{22}y_2 + \ldots + b_{27}y_7 + a_{21}u_1 + c_{21}f_1 + c_{22}f_2; \\ &\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ \dot{y}_7 &= b_{71}y_1 + b_{72}y_2 + \ldots + b_{77}y_7 + a_{71}u_1 + c_{71}f_1 + c_{72}f_2. \end{aligned}\right\} \quad (1.9)$$

In vector-matrix form this system is written as

$$\dot{Y} = BY + Au_1 + CF, \quad (1.10)$$

where Y = vector of state of the object with dimensionality

$n = 7$; u_1 = control action with dimensionality $\ell = 1$; F = vector of external disturbances with dimensionality $g = 2$; B = = matrix of coefficients of the object, with dimensionality (7 x 7); A = vector of the coefficients affiliated with the control action, with dimensionality $n = 7$; C = matrix of the coefficients affiliated with the disturbances, with dimensionality (7 x 7).

Let us write the system of equations for generating the control action as:

$$\dot{U}_1 = Ku_1 + M'\Delta X, \tag{1.11}$$

where ΔX = vector of the deviations of the output coordinates, with dimensionality $m = 3$, as measured by the sensors; M = vector of the coefficients affiliated with the deviations; K = coefficient affiliated with the control action.

The equation of the system's sensors has the form

$$X = DY + V, \tag{1.12}$$

where D = matrix of the sensor's coefficients, with dimensionality (3 x 7); V = vector of interference at the sensors' outputs, with dimensionality $m = 3$; X = vector of the output coordinates, as measured by the sensors, with dimensionality $m = 3$.

The equation of the deviations of the output coordinates' actual values from the required ones is written as

$$\Delta X = X_{pr} - X, \tag{1.13}$$

where X_{pr} = vector of the output coordinates' programmed values, with dimensionality $m = 3$.

In the general case, for a multicircuit and multidimensional linear SAR it is possible to write vector-matrix equations similar to expressions (1.10)-(1.13), where when $\ell > 1$ we will have, instead of scalar u_1, vector U with dimensionality ℓ and matrices $A_{(n \times \ell)}$, $K_{(\ell \times \ell)}$ and $M_{(\ell \times m)}$.

A structural-matrix diagram of a multicircuit and multidimension SAU constructed in accordance with equations (1.10)-(1.13) is shown in Figure 1.22, where in terms of I_1 and I_2 we define the diagonal matrices with integration operators of the form

$$I = \begin{Vmatrix} \frac{1}{p} & 0 & 0 \ldots 0 \\ 0 & \frac{1}{p} & 0 \ldots 0 \\ \ldots & \ldots & \ldots \\ 0 & 0 & 0 \ldots \frac{1}{p} \end{Vmatrix}. \tag{1.14}$$

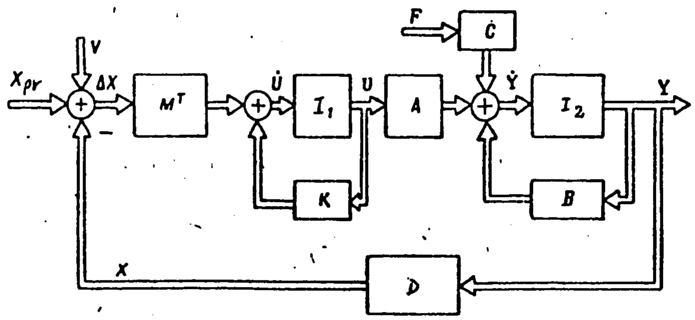

Figure 1.22. Structural-matrix diagram of a continuous multicircuit and multidimensional SAU.

Matrix I_1 has dimensionality $(\ell \times \ell)$, while for matrix I_2 it is $(n \times n)$. The double arrows designate vectors. The structural-matrix diagram in Figure 1.22 fully defines all the properties of a continuous multicircuit and multidimensional SAU if its matrices and initial conditions Y_i and U_i are known. In the case of a system with a TsUM in the control circuit, the structural-matrix diagram undergoes changes. Instead of a system of differential equations of the form

$$\dot{U} = KU + M^{*}\Delta X \qquad (1.15)$$

we write the difference vector-matrix equation corresponding to the control signal generation algorithm:

$$U[kT_0] = \sum_{i=0}^{n} B_i \Delta X[(k-i)T_0] - \sum_{i=1}^{m} C_i U[(k-i)T_0], \qquad (1.16)$$

where B_i = matrices with coefficients of the control signal generation algorithm, with dimensionality $(\ell \times n)$; C_i = matrices of the feedback coefficients affiliated with the control signals, with dimensionality $(\ell \times \ell)$.

If we take the z-transform of both parts of equation (1.16), we obtain the z-OPF matrix in the form

$$D[z] = \begin{Vmatrix} d_{11}[z] & d_{12}[z] \ldots d_{1n}[z] \\ d_{21}[z] & d_{22}[z] \ldots d_{2n}[z] \\ \ldots & \ldots \\ d_{l1}[z] & d_{l2}[z] \ldots d_{ln}[z] \end{Vmatrix}, \qquad (1.17)$$

where $d_{ij}[z]$ is the z-OPF relationship of the z-representation of the i-th control output signal $u_i[z]$ to the z-representation of the j-th output deviation $\Delta x_j[z]$ in the form

$$d_{ij}[z] = \frac{a_{nj}z^{-n} + a_{n-1j}z^{-(n-1)} + \ldots + a_{0j}}{c_{mj}z^{-m} + c_{m-1j}z^{-(m-1)} + \ldots + 1}. \qquad (1.18)$$

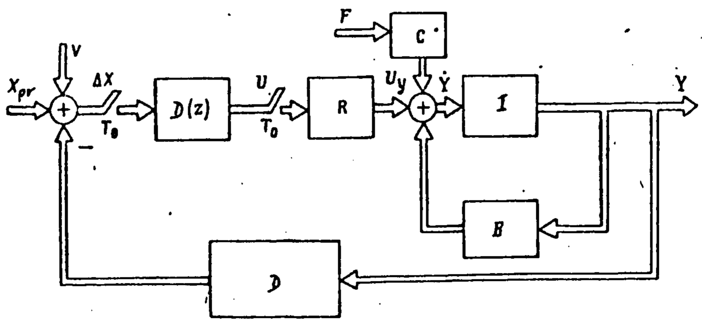

Figure 1.23. Structural-matrix diagram of a discrete multicircuit and multidimensional SAU.

Figure 1.23 is a structural-matrix diagram of such a system, where R designates the diagonal matrix with the OPF of the zero-order fixing components:

$$R = \left\| \begin{matrix} \frac{1-e^{-T_0 p}}{p} & 0 & 0 \ldots & 0 \\ 0 & \frac{1-e^{-T_0 p}}{p} & 0 \ldots & 0 \\ \cdots & \cdots & \cdots & \cdots \\ 0 & 0 & 0 \ldots & \frac{1-e^{-T_0 p}}{p} \end{matrix} \right\|. \qquad (1.19)$$

It should be kept in mind that all the switches in this layout must be triggered simultaneously, with discreteness period T_0. If this is not done and other discreteness periods $T_{10} \neq T_0$ occur for some channels, the SAU will be multiperiodic. The analysis and synthesis of multiperiodic SAU's poses a considerably more complex problem than for uniperiodic ones.

In succeeding chapters we will first discuss methods of analyzing synthesizing linear continuous and discrete SAU's, and then methods for investigating nonlinear SAU's.

The solution of the analysis and synthesis problem is illustrated by examples from the area of military systems, such as guided missiles, aircraft and radar stations.

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