YAKUBOVICH, V.A.

16(1) PHASE I BOOK EXPLOITATION SOV/2660

Vsesoyuznyy matematicheskiy s"yezd. 3rd, Moscow, 1956

Trudy. t. 4: Kratkoye soderzhaniye sektsionnykh dokladov. Doklady inostrannykh uchenykh (Transactions of the 3rd All-Union Mathematical Conference in Moscow. vol. 4: Summary of Sectional Reports. Reports of Foreign Scientists) Moscow, Izd-vo AN SSSR, 1959. 247 p. 2,200 copies printed.

Sponsoring Agency: Akademiya nauk SSSR. Matematicheskiy institut.

Tech. Ed.: G.N. Shevchenko; Editorial Board: A.A. Abramov, V.G. Boltyanskiy, A.M. Vasil'yev, B.V. Medvedev, A.D. Myshkis, S.M. Nikol'skiy (Resp. Ed.), A.G. Postnikov, Yu. V. Prokhorov, K.A. Rybnikov, P. L. Ul'yanov, V.A. Uspenskiy, N.G. Chetayev, G. Ye. Shilov, and A.I. Shirshov.

PURPOSE: This book is intended for mathematicians and physicists.

COVERAGE: The book is Volume IV of the Transactions of the Third All-Union Mathematical Conference, held in June and July 1956. The book is divided into two main parts. The first part contains summaries of the papers presented by Soviet scientists at the Conference that were not included in the first two volumes. The second part contains the text of reports submitted to the editor by non-Soviet scientists. In those cases when the non-Soviet scientist did not submit a copy of his paper to the editor, the title of the paper is cited and, if the paper was printed in a previous volume, reference is made to the appropriate volume. The papers, both Soviet and non-Soviet, cover various topics in number theory, algebra, differential and integral equations, function theory, functional analysis, probability theory, topology, mathematical problems of mechanics and physics, computational mathematics, mathematical logic and the foundations of mathematics, and the history of mathematics.

Starzhinskiy, V.M. (Moscow). On the problem of the boundedness of solutions of a system of linear differential equations with periodic coefficients 37

Tamarkin, S.A. (Moscow). Asymptotic solution of linear non-homogeneous differential equations and its applications to the design of shells and blades 39

Chechik, V.A. (Voronezh). Singular differential equations 40

El'sgolts, L.E. (Moscow). Periodic solutions of quasilinear differentail equations with delayed argument 41

Yakubovich, V.A. (Leningrad). Extension of certain studies of A.M. Lyapunov on a differential equation of the second order to canonical systems with periodic coefficients 41

Yasenko, K.M. (Moscow). On discontinuities in solutions of quasilinear equations 42

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YAKUBOVICH, V. A.: Doc Phys-Math Sci (diss) -- "A system of linear differential equations in canonic form with periodic coefficients". Leningrad, 1959. 21 pp (Leningrad Order of Lenin State U im A. A. Zhdanov), 150 copies (KL, No 14, 1959, 117)

YAKUBOVICH, V.A. (Leningrad)

Small-parameter method for canonical systems with periodic coefficients. Prikl. mat. i mekh. 23 no.1:15-34 Ja-F '59. (MIRA 12:2)

(Differenital equations)

16(1) SOV/20-124-3-10/67

AUTHOR: Yakubovich, V.A.

TITLE: Oscillation Properties of the Solutions of Linear Canonical Systems of Differential Equations (Ostsillyatsionnyye svoystva resheniy lineynykh kanonicheskikh sistem differentsial'nykh uravneniy)

PERIODICAL: Doklady Akademii nauk SSSR, 1959, Vol 124, Nr 3, pp 533-536 (USSR)

ABSTRACT: The author considers the system

$$\frac{dx}{dt} = JH(t)x,$$ where x is a 2k-dimensional vector, $H(t) = \begin{pmatrix} \alpha & \beta \\ \beta' & \gamma \end{pmatrix}$, $\alpha = \alpha'$, $\gamma = \gamma'$,

$J = \begin{pmatrix} 0 & I_k \\ -I_k & 0 \end{pmatrix}$, I_k unit matrix, $H(t) = H(t)^*$ a real symmetric matrix. The author uses results of I.M. Gel'fand, V.B. Lidskiy, I.M. Glazman, L.D. Nikolenko etc, in order to formulate seven theorems after having introduced many definitions; these theorems overlap with well-known results of Sternberg [Ref 5]

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Oscillation Properties of the Solutions of Linear Canonical Systems of Differential Equations SOV/20-124-3-10/67

and others or, however, already implicitly occur in other investigations.
There are 10 references, 7 of which are Soviet, 2 American, and 1 Portuguese.

ASSOCIATION: Nauchno-issledovatel'skiy institut matematiki i mekhaniki Leningradskogo gosudarstvennogo universiteta imeni A.A.Zhdanova (Scientific Research Institute for Mathematics and Mechanics of the Leningrad State University imeni A.A. Zhdanov)

PRESENTED: September 22, 1958, by V.I. Smirnov, Academician

SUBMITTED: September 15, 1958

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16(1) SOV/20-124-5-9/62

AUTHOR: Yakubovich, V.A.

TITLE: Conditions for the Oscillation and Nonoscillation for Linear Canonical Systems of Differential Equations (Usloviya kolebatel'nosti i nekolebatel'nosti dlya lineynykh kanonicheskikh sistem differentsial'nykh uravneniy)

PERIODICAL: Doklady Akademii nauk SSSR, 1959, Vol 124, Nr 5, pp 994-997 (USSR)

ABSTRACT: The author considers the system

$$(1) \qquad \frac{dx}{dt} = JH(t)x,$$

where x is a 2k-dimensional vector, $H(t)=\begin{pmatrix}\alpha & \beta \\ \beta^* & \gamma\end{pmatrix}$, $\alpha=\alpha^*$, $\gamma=\gamma^*$, $J=\begin{pmatrix}0 & I_k \\ -I_k & 0\end{pmatrix}$, $H(t)=H(t^*)$ real symmetric $2k\times 2k$ matrix. Let $x_1,\dots,x_k$ be linearly independent solutions of (1), where it is $(Jx_j,x_h)=0$. Let $\binom{U}{V}$ be a $k\times 2k$ matrix, the columns of which are the vectors $x_1,\dots,x_k$. Let $X(t)$ be the matricant of (1), see [Ref 1]; $\mathrm{Arg}\,X(t)=\mathrm{Arg}\det[U(t)-iV(t)]$. The equation (1) is called oscillating, if $\mathrm{Arg}\,X(t)$ for $t\to\infty$ is not bounded;

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Conditions for the Oscillation and Nonoscillation for Linear Canonical Systems of Differential Equations SOV/20-124-5-9/62

(1) is called nonoscillating, if Arg X(t) is bounded. In eight theorems the author gives several conditions for the oscillation and nonoscillation in the above sense, e.g.: Theorem: If starting from $t_0 > 0$ it is almost everywhere $\alpha \leq 0$, $\gamma \geq 0$ (or conversely), then (1) is nonoscillating. The results overlap or generalize the results of I.M.Glazman, V.A.Kondrat'yev, L.D.Nikolenko.

There are 7 references, 5 of which are Soviet, and 2 American.

ASSOCIATION: Nauchno-issledovatel'skiy institut matematiki i mekhaniki Leningradskogo gosudarstvennogo universiteta imeni A.A. Zhdanova (Scientific Research Institute of Mathematics and Mechanics of the Leningrad State University imeni A.A.Zhdanov)

PRESENTED: September 22, 1958, by V.I.Smirnov, Academician

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AUTHOR: Yakubovich, V.A.

TITLE: On Nonlinear Differential Equations of Automatic Control Systems With One Control Unit

PERIODICAL: Vestnik Leningradskogo universiteta, Seriya matematiki, mekhaniki i astronomii, 1960, No.2, pp 120-153

TEXT: This is a detailed representation of the results on the method of A.I.Lur'ye (Ref.1) announced by the author in (Ref.4,5). There are overlappings with the books of A.M.Letov (Ref.2) and P.V.Bromberg (Ref.3). The author mentions V.M.Popov, V.A.Pliss, Ayzerman, Professor D.K.Faddeyev, A.B.Konstantinova, Ye.A.Barbashin and N.N.Krasovskiy.
There is 1 figure and 17 references: 15 Soviet and 2 German.

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YAKUBOVICH, V.A.

Nonlinear differential equations of automatic control systems with one regulating element. Vest.LGU 15 no.7:120-153 '60. (MIRA 13:4)
(Automatic control) (Differential equations)

S/043/60/000/13/09/016
C111/C222

AUTHOR: Yakubovich, V.A.

TITLE: On Radius of Convergence of Series in the Small Parameter Method for the Linear Differential Equations With Periodic Coefficients

PERIODICAL: Vestnik Leningradskogo universiteta, Seriya matematiki, mekhaniki i astronomii, 1960, No. 13, pp. 81 - 89

TEXT: If the solution of a linear system of differential equations with periodic coefficients is sought in the form $X(t, \varepsilon) = P(t,\varepsilon)e^{K(\varepsilon)t}$, where the matrix $K(\varepsilon)$ and the periodic matrix $P(t,\varepsilon)$ are series in ε, where $K(\varepsilon) = \ln X(1,\varepsilon)$, then in general there can appear different radii of convergence for $K(\varepsilon)$ because of the nonuniqueness of the logarithm. The author proves a theorem which is partially known (compare (Ref. 10)) which together with some qualitative considerations permits to make the calculations in the above mentioned method so that there results the greatest radius of convergence.

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On Radius of Convergence of Series in the Small Parameter Method for the Linear Differential Equations With Periodic Coefficients

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The author mentions N.N. Bogolyubov, Yu.A. Mitropol'skiy, N.A. Artem'yev, I.Z. Shtokalo, N.P. Yerugin, and M.G. Kreyn.
There are 2 figures and 13 references : 12 Soviet and 1 Italian.

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S/020/60/135/001/006/030
C111/C222

AUTHOR: Yakubovich, V.A.

TITLE: Stability Conditions in the Large for Some Non-Linear Differential Equations of Automatic Control

PERIODICAL: Doklady Akademii nauk SSSR, 1960, Vol. 135, No. 1, pp 26-29

TEXT: The author considers the system

(1) $$\frac{dx}{dt} = Ax + a\varphi(\sigma), \quad \frac{d\sigma}{dt} = (b, x) - \varrho\varphi(\sigma),$$

where x, a and b are vectors, A - matrix, (b,x) - scalar product and $\varphi(\sigma)$ is a real continuous function ; $\varrho > 0$; $0 < \mu_1 \leq \frac{\varphi(\sigma)}{\sigma} \leq \mu_2 < +\infty$ $(\sigma \neq 0)$. Furthermore it is assumed that the eigenvalues of the matrix

(2) $$K = \frac{1}{\varrho}\left(A^* + \frac{1}{\varrho} ba^*\right)$$

lie in the left halfplane. For an arbitrary matrix H let $H > 0$ mean that H is

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symmetric and positive definite.

Theorem 1: Take an arbitrary matrix $G_0 > 0$ and define the matrices $H_0 > 0$, $M(\sigma)$ and the vectors a_0 and $m(\sigma)$ by

$$K H_0 + H_0 K^* = - G_0 , \quad a_0 = H_0 a , \quad M(\sigma) = \int_0^{\sigma} \exp\left[K \int_{\tau}^{\sigma} \frac{d\sigma_1}{\varphi(\sigma_1)}\right] d\tau ,$$

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$$m(\sigma) = \frac{1}{\varrho^2 \varphi(\sigma)} K M(\sigma) a_0$$

Assume that for an $\varepsilon_0 > 0$ and all σ it holds

$$(3) \quad 1 - (G_0^{-1} m(\sigma), b) - \sqrt{(G_0^{-1} m(\sigma), m(\sigma)) \cdot (G_0^{-1} b, b)} \geqslant \varepsilon_0 > 0$$

For the stability of (1) in the large it is necessary and sufficient that

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Stability Conditions in the Large for Some Non-Linear Differential Equations of Automatic Control

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for all σ, $-\infty < \sigma < +\infty$ it holds

(4) $$2\int_0^{\sigma} (a, M(\sigma)a_0)d\sigma \geqslant (H_0^{-1} M(\sigma)a_0, M(\sigma)a_0) .$$

Let $K^{-1}(Ha - \frac{b}{2\varrho} = -u$, where H is the real solution of the inequation

$$-\varrho(KH + HK^*) - \mu_0^2 K^{-1} (Ha - \frac{b}{2\varrho})(Ha - \frac{b}{2\varrho})^* K^{*-1} + \frac{1}{\varrho}(ba^*H + Hab^*) - - \frac{1}{\varrho^2} bb^* > 0$$

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with

(8) $\mu_0^2 = \max \varphi'(\sigma)^2$, $-\infty < \sigma < +\infty$.

Theorem 2: Assume that the conditional equations (cf. (Ref.6))

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(9) $-\varsigma(KU + UK^{*}) = \mu_o^2\, uu^{*} + \frac{1}{\varsigma}(Kub^{*} + bu'K^{*})$

$$U^{a} + Ku + \frac{b'}{2\varsigma} = 0 ,$$

where μ_o^2 is given by (8), have real solutions u, $U = U^{*}$ for all vectors b' being sufficiently neighboring to b. For the stability of (1) in the large it is sufficient and necessary that

(10) $U > 0 \quad , \left[\varsigma + 2(u,a)\right] \int_0^{\sigma} \varphi(\tau)d\tau \geqslant (U^{-1}u,u)\,\varphi(\sigma)^2$

is satisfied.

Theorem 3: contains stability conditions for the case where the coefficients of (1) depend on a parameter.

Theorem 4 is a rougher modification of theorem 3 which is more convenient for stability control.

The assumptions of the theorems 1 - 4 are always satisfied if ς is sufficiently large.

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Stability Conditions in the Large for Some Non-Linear Differential Equations of Automatic Control

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The author mentions Ayzerman, Ye.A. Barbashin, N.N. Krasovskiy and Lyapunov. There are 6 Soviet references.

ASSOCIATION: Leningradskiy gosudarstvennyy universitet imeni A.A. Zhdanova (Leningrad State University imeni A.A. Zhdanov)

PRESENTED: June 6, 1960, by V.I. Smirnov, Academician

SUBMITTED: May 23, 1960

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Card 5/5

YAKUBOVICH, V. A., and KREYN, M. G.

"Hamiltonian systems of linear differential equations with periodic coefficients."

report submitted for the Intl. Symposium on Nonlinear Vibrations, IUPAM Kiev 12-18 Sep 1961

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AUTHOR: Yakubovich, V. A.

TITLE: Systems of linear differential equations of canonical form with periodic coefficients (Autoreview of the dissertation)

PERIODICAL: Uspekhi matematicheskikh nauk, v. 16, no. 1, 1961, 223-234

TEXT: The dissertation has been maintained on June 11, 1959 at the session of the Uchenyy sovet matematiko-mekhanicheskogo fakul'teta Leningradskogo universiteta (Scientific Council of the Mathematical-Mechanical Faculty of the Leningrad University). Opponents: V. J. Smirnov, Academician; M. G. Kreyn, Corresponding Member of the Academy of Sciences, UkrSSR; G. Yu. Dzhanelidze, Doctor of Physico-mathematical Sciences; M. A. Krasnosel'skiy, Doctor of Physicomathematical Sciences.

The results have been published by the author in (Ref. 17: Otsenka kharakteristicheskikh pokazateley sistemy lineynykh differentsial'nykh uravneniy s periodicheskimi koeffitsientami [Estimates of characteristic exponents of a system of linear differential equations

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with periodic coefficients], PMM 18, vyp. 4 (1954)); (Ref. 18: Rasprostraneniye metoda Lyapunov opredeleniya organichennosti resheniy uravneniya y" + p(t) y = 0, p(t+w) = p(t)na sluchay znakoperemennoy funktsii p(t) [Extension of Lyapunov's method of determining boundedness of solutions of the equation y"+p(t) y = 0, p(t+w) = p(t) to the case of a function p(t) of variable sign] PMM 18, vyp. 6 (1954)); (Ref. 19: O sistemakh differentsial'nykh uravneniy kanonicheskogo vida s periodicheskimi koeffitsientami poryadka bol'she dvukh [On systems of differential equations of canonical form with periodic coefficients of order > 2] DAN 103, No.6 (1955)); (Ref. 20: O zavisimosti sobstvennykh znacheniy samosopryazhennykh krayevykh zadach dlya sistemy dvukh differentsial'nykh uravneniy ot krayevykh usloviy [On the dependence of the eigenvalues of the boundary problem for the system of two differential equations on boundary conditions] Vestn. LGU, ser. matem. mekh. i astr., No. 1, vyp. 1 (1957)); (Ref. 21: Rasprostraneniye nekotorykh rezul'tatav Lyapunova na lineynyye kanonicheskiye sistemy s periodicheskimi koeffitsientami [Extension of some results of Lyapunov to linear canonical systems with periodic coefficients,] PMM 21, vyp. 4 (1957)); (Ref. 22: Zamechaniye k nekotorym

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rabotam po sistemam lineynykh differentsial'nykh uravneniy s periodicheskimi koeffitsientami [Remarks on some papers on linear systems of differential equations with periodic coefficients], PMM 21, vyp. 5 (1957)); (Ref. 23: Stroyeniye gruppy simplekticheskikh matrits i i struktura mnozhestva neustoychivykh kanonicheskikh sistem differentsial'nykh uravneniy s periodicheskimi koeffitsientami [Structure of the group of symplectic matrices and of the set of unstable canonical systems with periodic coefficients], Matem. sb. 44 (86): 3(1958)); (Ref. 24: Kriticheskiye chastoty kvazikanonicheskikh sistem [Critical frequencies of quasicanonical systems], Vestn. LGU 13, vyp. 3 (1958)); (Ref. 25: Ostsillyatsionnyye svoystva resheniy lineynykh kanonicheskikh uravneniy [Oscillation properties of solutions of linear canonical equations], DAN 123, No. 3 (1959)); (Ref. 26: Method malogo parametra dlya kanonicheskikh sistem s periodicheskimi koeffitsientami [Method of the small parameter for canonical systems with periodic coefficients], PMM 23, vyp. 1 (1959)); (Ref. 27: Voprosy ustoychivosti resheniy sistemy dvukh lineynykh differentsial'nykh uravneniy kanonicheskogo vida s periodicheskimi koeffitsientami [Questions of the stability of solutions of a

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system of two linear differential equations of canonical form with periodic coefficients], Matem. sb. 37 (79), vyp. 1 (1955)).

A report on the results was given among others in the seminaries of V. J. Smirnov, Academician (Leningrad); N. G. Chetayev, Corresponding Member of the Academy of Sciences USSR, Institut mekhaniki AN SSSR (Institute of Mechanics AS USSR); L. S. Pontryagin, Academician (MJAN); V. V. Nemytskiy, Professor (MGU).

The author considers the systems

$$\frac{dx}{dt} = JH(t)\,x \qquad (2)$$

where x is a column vector with the components $p_1, \ldots, p_k, q_1, \ldots, q_k$

$$H(t) = \begin{pmatrix} \|\alpha_{jh}\| & \|\beta_{hj}\| \\ \|\beta_{jh}\| & \|\gamma_{jh}\| \end{pmatrix} \quad j,h = 1, \ldots, k), \quad J = \begin{pmatrix} 0 & I_k \\ -I_k & 0 \end{pmatrix}$$

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I_k -- unit matrix. The α, β, γ are real functions of t and integrable according to Lebesgue; $\alpha_{jh}(t) = \alpha_{hj}(t)$, $\gamma_{jh}(t) = \gamma_{hj}(t)$ almost everywhere.

Chapter I considers the structure of the space $L = \{H(t)\}$ of all $H(t) = H(t+\tau)$, to which there correspond solutions of (2) which have certain properties. E. g. let $\mathfrak{M}$ be the set of the H(t) for which (2) possesses a certain number of bounded solutions for $t \to \infty$, while the other solutions are estimated by $|x(t)| < C e^{\alpha t}$; these properties are said to be stable with respect to small variations of H(t). It is stated that the sets $\mathfrak{M}$ thus defined are either domains or are decomposed into at most denumerably many domains. The author gives clear models of the space L for k = 1 and = 2.

In chapter II the author considers the convex properties of the stability domains in L; here $\mathfrak{M}$ is a stability domain, if the solutions of (2), the H(t) of which belongs to $\mathfrak{M}$, are stable. $\mathfrak{M} \subset L$ is called convex in the direction of growth, if from

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$H_1 \in \mathfrak{M}_1$, $H_2 \in \mathfrak{M}$, $H_1 \leq H_2$ it follows $H \in \mathfrak{M}$, if $H_1 \leq H \leq H_2$. It is stated that all stability domains are convex in this sense for $k = 1, 2$. Under certain assumptions the stability domains can be subdivided into convex subdomains for $k > 2$. These properties are used for obtaining sufficient stability conditions for (2).

In chapter III the author extends the Lyapunov method for the investigation of the Hill equation

$$\frac{d^2y}{dt^2} + p(t)\, y = 0, \quad p(t + \tau) = p(t) \qquad (4)$$

to more general classes of canonical equations.

In chapter IV the author considers systems (2), the coefficients of which are not periodic. He investigates oscillation properties of the solutions and degenerated self-adjoint boundary value problems. A geometric definition of the oscillation character of the equation (2) is given, where results of J. M. Gel'fand and V. B. Lidskiy

(Ref. 10: O strukture oblastey ustoychisvoski kanonicheskikh line-ynykh sistem differentsial'nykh uravneniy s periodicheskimi koeffitsien-tami [On the structure of the regions of stability of linear canonical systems of differential equations with periodic coefficients], UMN 10, vyp. 1 (63), (1955), 3-40) are essentially used. Degenerated self-adjoint boundary value problems are investigated for the equation

$$\frac{dx}{dt} = J(H_o(t) + \lambda H_1(t))\,x \quad . \qquad (6)$$

The author gives necessary and sufficient conditions for the existence of at least one and of an infinite number of eigenvalues tending to infinity.

Chapter V and VI have applied character. The author investigates the equation

$$\frac{dx}{dt} = J\left[H_o + \varepsilon H(\theta t, \varepsilon)\right] x \qquad (8)$$

where θ is the exciting frequency and $H(s, \varepsilon) = H_1(s) + \varepsilon H_2(s) + \ldots$;

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especially the case of resonance is considered, where JH_0 possesses eigen values which are congruent mod i θ. The author describes parameter resonance and the construction of the dynamical instability domains of (8).

In a longer footnote the author rejects the objections of N. P. Yerugin who criticizes in (Ref.38: Metody issledovaniya sistem lineynykh differentsial'nykh uravneniy s periodicheskimi koeffitsientami [Methods of investigation of linear systems of differential equations with periodic coefficients], Inzh.-fiz. zhurn. AN BSSR 3, No. 2 (1960) that the author uses results of other authors without reference in chapter 5 of his dissertation.

A. M. Lyapunov, L. D. Nikolenko, J. M. Glazman, N. N. Bogolynhov, Yu. A. Mitropol'skiy, J. Z. Shtokalo, J. G. Malkin and K. A. Breus are mentioned.

There are 44 Soviet-bloc and 2 non-Soviet-bloc references. The reference to English-language publication reads as follows:

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R. Sternberg, Variational methods and non-oscillation theorems for systems of differential equations, Duke Math. Journ. 19, No. 2 (1952), 311-312.

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Card 9/9

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16.3400

AUTHOR: Yakubovich, V.A.

TITLE: Unbounded-stability conditions for a second-order differential equation

PERIODICAL: Leningrad. Universitet. Vestnik. Seriya matematiki, mekhaniki i astronomii, no. 4, 1961, 83 - 91

TEXT: Several theorems on unbounded stability of dynamical systems are proved. The equation

$$\frac{d^2x}{dt^2} + \nu\frac{dx}{dt} + \varphi(\theta t)x = 0 \qquad (1.1)$$

is considered, where $\nu > 0$, $\theta > 0$, $\varphi(s + 2\pi) = \varphi(s)$, the function φ being either continuous on the interval $[0, 2\pi]$ or having a finite number of singularities and

$$\int_0^{2\pi} |\varphi(s)| ds < \infty .$$

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Unbounded-stability conditions ...

In the following, such functions are called 2π-periodic, piecewise linear and integrable. According to M.A. Ayzerman (Ref. 1: Dostatochnoye usloviye ustoychivosti odnogo klassa dinamicheskikh sistem s peremennymi parametrami. PMM, v. 15, no. 3, 1951), a dynamic system described by Eq. (1.1) has unbounded stability if for any positive θ, the condition

$$x(t) \longrightarrow 0, \ \frac{dx}{dt} \longrightarrow 0 \text{ for } t \longrightarrow +\infty \qquad (1.2)$$

is satisfied. Another author considered Eq. (1.1) with piecewise-constant functions

$$\varphi(s) = \begin{cases} M^2 & \text{for } 0 < t < \pi, \\ m^2 & \text{for } \pi < t < 2\pi; \end{cases}$$

he arrived at the conditions

$$\nu^2 > \frac{M^2}{2} \left(1 - \frac{\sigma}{M} \sqrt{2 - \frac{\sigma^2}{M^2}}\right) \qquad (1.3)$$

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where $$\sigma^2 = \frac{1}{2}(m^2 + M^2).$$

A more general result can be derived from the author (Ref. 3: DAS SSSR, 87, 3, 1952). This result is formulated as Theorem 1: Denote by $\Phi_{M,\sigma}$ the set of 2π-periodic piecewise-linear, integrable functions $\varphi(s)$ for which

$$\max \varphi(s) = M^2, \quad \frac{1}{2\pi}\int_0^{2\pi}\varphi(s)ds = \sigma^2 \geqslant 0$$

are preassigned numbers. For unbounded stability of Eq. (1.1) with any function $\varphi(s) \in \Phi_{M,\sigma}$, it is necessary and sufficient that inequality (1.3) hold. Below, a very simple direct proof of theorem 1 is given. An analogous result is formulated in a more elaborate way, when min $\varphi(s)$ is pre-assigned instead of max $\varphi(s)$, viz. Theorem 2: Denote by $\Psi_{m,\sigma}$ the set of functions $\varphi(s)$ for which

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$$\min \varphi(s) = m^2, \quad \frac{1}{2\pi}\int_0^{2\pi} \varphi(s)ds = \sigma^2$$

are pre-assigned. In order that Eq. (1.1) have unbounded stability for any function $\varphi(s) \in \Psi_{m,\sigma}$, it is necessary and sufficient that 1) for $\nu < m$, inequality

$$\operatorname{ch} \frac{\nu \xi}{\sqrt{m^2 - \nu^2}} + \cos\xi - \frac{1}{2}\left(\frac{\sigma^2 - m^2}{m^2 - \nu^2}\right) \xi \sin\xi > 0 \qquad (1.4)$$

should hold for any ξ, $0 < \xi < \pi$; 2) for $\nu = m$, inequality

$$\nu^2 \geqslant \frac{y_0}{1 + y_0}\sigma^2 = 0.50547 \ldots \sigma^2 \qquad (1.5)$$

should hold, where $y_0 = 2x_0^2\sqrt{x_0^2 - 1}(x_0 - \sqrt{x_0^2 - 1})$ and $x_0 = 1.1996 \ldots$, is the solution of equation $x = \operatorname{cth} x$; 3) for $\nu > m$ inequality

$$\mathrm{ch}\,\frac{\nu\xi}{\sqrt{\nu^2 - m^2}} + \mathrm{ch}\ - \frac{1}{2}\left(\frac{\sigma^2 - m^2}{\nu^2 - m^2}\right)\xi\ \mathrm{sh}\,\xi > 0 \qquad (1.6)$$

holds for any $\xi > 0$. Further, the analogous problem of evaluating the characteristic exponents of equation (1.1) which belong to the classes of functions $\Phi_{M,\sigma}$ and $\psi_{m,\sigma}$, is considered. As this problem is equivalent to evaluating the characteristic ecponents for Hill's equation

$$\frac{d^2y}{dt^2} + p(\theta t)y = 0, \qquad (1.7)$$

the latter equation is considered, whereby the function p can also take negative values. Two theorems are formulated. Theorem 3: In order that for any positive θ and p(s), the approximation

$$y = O(e^{\mu t}),\ t \to +\infty \qquad (1.8)$$

to the solution of Eq. (1.7) should hold ($\mu > 0$ being a pre-assi-

29024

Unbounded-stability conditions ... S/043/61/000/004/002/008
D274/D302

gned number). it is necessary and sufficient that

$$\mu \geqslant \begin{cases} \dfrac{p_{max} - p_{cp}}{2\sqrt{p_{max}}} & \text{for } p_{max} + p_{cp} > 0 \\ \sqrt{-p_{max}} & \text{for } p_{max} + p_{cp} < 0 \end{cases} \quad (1.9)$$

hold. Theorem 4 is analogous to theorem 2. In the following, the 4 theorems are proved. There are 10 references: 9 Soviet-bloc and 1 non-Soviet-bloc.

Card 6/6

LIN[illegible]IN, Yu.V.; LYAPIN, Ye.S.; YA[illegible]VICH, V.A.

Vladimir Abramovich Tartakovskii on his 60th birthday. Usp. mat. nauk 16 no.5:225-230 S-O '61. (MIRA 14:10)
(Tartakovskii, Vladimir Abramovich, 1901-)

YAKUBOVICH, V.A.

Conditions of unlimited stability for a certain differential equation of the second order. Vest.LGU 16. no.19:83-92 '61. (MIRA 14:10)

(Differential equations)

16.3400

31906
S/039/61/055/003/002/004
D299/D304

AUTHOR: Yakubovich, V.A. (Leningrad)

TITLE: Arguments on a group of simplectic matrices

PERIODICAL: Matematicheskiy sbornik, v. 55, no. 3, 1961, 255-280

TEXT: The group of simplectic matrices is related to the linear system of canonical differential equations

$$p_j = \frac{\partial H}{\partial q_j}, \quad q_j = -\frac{\partial H}{\partial p_j} \quad (j = 1, \ldots, k) \qquad (0.1)$$

where H is a quadratic form of p_j, q_j, with real coefficients. The concept of argument on a group of simplectic matrices was introduced by I.M. Gel'fand and V.B. Lidskiy in connection with the structure of stability regions of Eq. (0.1) with periodic coefficients (Ref. 1: O strukture oblastey ustoychivosti lineynykh kanonicheskikh sistem differentsial'nykh uravneniy s periodicheskimi koeffitsiyentami, Uspekhi matem. nauk, v. 10, no. 1 (63), 1955, 3

Card 1/6

- 40). Various definitions of the argument are given, each of the definitions leading to some new interpretation of the number of stability- and instability regions of Eq. (0.1) with periodic coefficients. The main application of the arguments consists in studying the oscillatory properties of the solutions to Eq. (0.1); this however, is the subject of a later article by the author. The present article is devoted to defining the various arguments, their properties and their equivalence. Let ArgX be a real function (of even sign) of the matrix $X \in G$, satisfying the conditions: 1) The function ArgX is defined for any matrix $X \in G$, 2) If $(\mathrm{Arg}X)_0$ denotes one of the values of ArgX, then the other values are

$$(\mathrm{Arg}X)_m = (\mathrm{Arg}X)_0 + 2m\pi \quad (m = \pm 1, \pm 2, \ldots);$$

3) Each of the values $(\mathrm{Arg}X)_m$ is a continuous function of $X \in G$;

4) There exists a closed curve $U(t) \in G$ with index unity, so that $\Delta\,\mathrm{Arg}U(t) = 2\pi$. Any function which satisfies the above 4 conditions is called argument on the group of simplectic matrices. This defi-

nition can be rephrased: Assume a continuous mapping is given of the group G on a circle, whereby a closed curve $U(t) \in G$, $0 \leqslant t \leqslant 1$, of index unity exists, so that if t varies from 0 to 1, the corresponding point traverses the circle once in the positive sense; by definition, ArgX is the argument (in the ordinary sense of the word) of the point on the circle, onto which the matrix X is mapped. A theorem is proved which shows that the various arguments defined above are equivalent in a topological sense. Assume, further

$$\mathrm{Arg}_* X = \sum_{j=1}^{k} \mathrm{Arg}\ \rho_j^{(+)}; \qquad (1.7)$$

the matrix X is divided into 4 k x k -matrices:

$$X = \begin{pmatrix} U_1 & U_2 \\ V_1 & V_2 \end{pmatrix}; \qquad (1.8)$$

the notations

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$$\left.\begin{aligned} \mathrm{Arg}_1 X &= \mathrm{Arg}\ \det\ (U_1 - iV_1), \\ \mathrm{Arg}_2 X &= \mathrm{Arg}\ \det\ (U_2 - iV_2), \\ \mathrm{Arg}_3 X &= \mathrm{Arg}\ \det\ (U_1 + iU_2), \\ \mathrm{Arg}_4 X &= \mathrm{Arg}\ \det\ (V_1 + iV_2), \end{aligned}\right\} \qquad (1.9)$$

are introduced. It is also possible to take as arguments the functions X

$$\left.\begin{aligned} \mathrm{Arg}'_{AB} X &= \mathrm{Arg}\ \det\ (U' - iV'), \\ \mathrm{Arg}''_{AB} X &= \mathrm{Arg}\ \det\ (U'' + iV''). \end{aligned}\right\} \qquad (1.11)$$

Theorem 3. Each of the functions defined by formulas (1.7), (1.9) and (1.11), satisfies the conditions of the definition and can, therefore, be considered as an argument on the group of simplectic matrices. The equivalence of various definitions is then examined. Let Arg'X and Arg"X be two different arguments, i.e. two functions on G which satisfy the 4 conditions of the definition. The arguments Arg'X and Arg"X are called equivalent if a positive constant

C exists, so that for any continuous curve $X(t) \in G$, the inequality

$$/\Delta \operatorname{Arg}'X(t) - \Delta \operatorname{Arg}''X(t)/ < C$$

holds. Further, a model is constructed which shows that various arguments, both equivalent and non-equivalent can be introduced which satisfy the 4 conditions of the definition. Theorem 4. The above-introduced arguments

$$\operatorname{Arg}_j X \ (j = 0,\ 1,\ 2,\ 3,\ 4),\ \operatorname{Arg}'_{AB}X,\ \operatorname{Arg}''_{AB}X,\ \operatorname{Arg}_* X,$$

are equivalent. This theorem is important for studying the oscillatory properties of the solution to Eq. (0.1). Its proof is complicated and involves several lemmas. There are 3 figures and 20 references: 14 Soviet-bloc and 6 non-Soviet-bloc, (including 3 translations). The references to the English-language publications read as follows: R.L. Sternberg, Variational methods and non-oscillation theorems for systems of differential equations, Duke Math. Journ. 19, no. 2, 1952, 311-322; W.T. Reid, The theory of the second variation for non-parametric problem of Bolza, Amer.

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S/039/61/055/003/002/004
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Arguments on a group of ...

Journ. Math., 57, 1935, 573-586; W.T. Reid, A matrix differential equation of Riccati type, Amer. Journ. Math., 68, 1946, 237-246.

SUBMITTED: January 7, 1960

Card 6/6

YAKUBOVICH, V.A.

Structure of the functional space of complex canonical equations with periodical coefficients. Dokl. AN SSSR 139 no.1:54-57 Jl '61. (MIRA 14:7)

1. Leningradskiy gosudarstvennyy universitet im. A.A Zhdanova. Predstavleno akademikom V.I. Smirnovym.
(Differential equations) (Groups, Theory of)

YAKUBOVICH, V.A.

Convex properties of the stability domains of linear Hamiltonian systems of differential equations with periodic coefficients. Vest. LGU 17 no.13:61-86 '62. (MIRA 15:7)
(Differential equations, Linear)

GEL'FOND, A.O.; LINNIK, Yu.V.; CHUDAKOV, N.G.; YAKUBOVICH, V.A.; LINNIK, IU.V.; CHUDAKOV, N.G.; IAKUBOVICH, V.A.

An incorrect work of N.I.Gavrilov. Usp.mat.nauk 17 no.1:265-267 Ja-F '62. (MIRA 15:3)

(Functions, Zeta)
(Gavrilov, N.I.)

31909
S/039/62/056/001/001/003
B112/B138

16.3400

AUTHOR: Yakubovich, V. A. (Leningrad)

TITLE: Oscillation properties of the solutions of canonical equations

PERIODICAL: Matematicheskiy sbornik, v. 56(98), no. 1, 1962, 3-42

TEXT: The author studies the oscillation properties of the solutions of the canonical system Jdx/dt = H(t)x, where

$$J = \begin{pmatrix} 0 & -I_k \\ I_k & 0 \end{pmatrix}$$

and H(t) = H*(t). The method applied is a geometric rather than an analytic one. It is based on the fact that each fundamental solution matrix X(t) is a symplectic matrix: X*JX = J. The symplectic group G = {X} has the topological structure of a multi-dimensional torus. This result is due to I. M. Gel'fand and V. B. Lidskiy (Uspekhi matem. nauk, t. X, vyp. 1(63) (1955), 3- 40.). The canonical system considered is said

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Oscillation properties of the ... B112/B138

to be of the oscillation type if the fundamental matrix X(t) "rotates" without limitation on the torus G for $t \to +\infty$. The equivalence of different definitions of oscillation is shown. A series of criteria are derived for whether a given canonical system is of the oscillation type or not. G. A. Bliss (Lektsii po variatsionnomu ischisleniyu, Moscow, IIL, 1950.), I. M. Glazman (DAN SSSR, t. 118, No. 3 (1958), 423 - 426., t. 119, No. 3 (1958), 421 - 424.), V. A. Kondrat'yev (Uspekhi matem. nauk, t. XII, vyp. 2 (75) (1957), 159 - 160., Trudy Mosk. matem. o-va, t. 8 (1959), 259 - 282.), L. D. Nikolenko (Avtoreferat dissertatsii, Kiyev, 1956., DAN SSSR, t. 110, No. 6 (1956), 929 - 931.), M. G. Kreyn (DAN SSSR, t. 73, No. 3 (1950), 445 - 448.), V. B. Lidskiy (DAN SSSR, t. 102, No. 5 (1955), 877 - 880.) are referred to. There are 4 figures and 34 references: 26 Soviet and 8 non-Soviet. The four most recent references to English-language publications read as follows: R. L. Sternberg, Variational methods and non-oscillation theorems for systems of differential equations, Duke Math. Journ., 19, No. 2 (1952), 311 - 322; J. H. Barrett, A Prüfer transformation for matrix differential equations, Proc. Amer. Math. Soc., 8, No. 3 (1957), 510 - 518; W. T. Reid, The theory of the second variation for non-parametric problem of Bolza, Amer. Journ. Math., 57 (1935), 573 - 586; W. T. Reid, A matrix differential equation of
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S/039/62/056/001/001/003
B112/B138

Oscillation properties of the ...

Riccati type, Amer. Journ. Math., 68 (1946), 237 - 246.

SUBMITTED: January 7, 1960

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16.1500

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S/020/62/143/006/007/024
B125/B112

AUTHOR: Yakubovich, V. A.

TITLE: Solution of a few matrix inequalities in the automatic control theory

PERIODICAL: Akademiya nauk SSSR. Doklady, v. 143, no. 6, 1962, 1304-1307

TEXT: The author derives a necessary and sufficient condition under which a Hermitean matrix $H = H^*$ exists for a given matrix A and for given vectors a and b, so that the matrix $G - gg^*$, where $G = -(A^*H + HA)$, and $g = -(Ha+b)$, is positive definite. This condition reads $1 + 2\mathrm{Re}\,((A-i\omega)^{-1}a,b) > 0$ for $-\infty < \omega < +\infty$. The formulation of the problem is connected with problems concerning the optimum conditions of stability for nonlinear differential equations. The most important English-language reference is: S. Lefschetz, RIAS technical report 60-9, 1960.

PRESENTED: December 11, 1961, by V. I. Smirnov, Academician

SUBMITTED: December 11, 1961

Card 1/1

L 15573-63 EWT(d)/FCC(w)/BDS AFFTC IJP(C)
ACCESSION NR: AT3002555 S/2944/63/000/001/0030/0044

AUTHOR: Yakubovich, V. A.

53

TITLE: Two-sided estimates of the solution of a homogeneous second order differential equation 16

SOURCE: Leningrad. Universitet. Kafedra vychislitel'noy matematiki i Vychislitel'nyy tsentr. Metody vychisleniy, no. 1, 1963, 30-44

TOPIC TAGS: differential equation, inequality, upper bound, lower bound, region of parameter value

ABSTRACT: The author considers the equation

$$\frac{d^2x}{dt^2}+P(t)\frac{dx}{dt}+Q(t)x=0 \qquad (1)$$

subject to the initial conditions $x(0) = x_0$, $\dot{x}(0) = \dot{x}_0$, where the coefficient functions in (1) depend upon parameters $\alpha_1, \ldots, \alpha_m$. He wishes to find a set of parameter values for which

$$x(T)<x' \quad \text{or} \quad x(T)>x''. \qquad (2)$$

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He also would like to find an increasing sequence of such sets whose union is the set of all such parameter points. By the usual reduction, he transfers (1) and (2) to

$$\frac{d^2y}{dt^2}+p(t)y=0. \quad (3)$$

$$y(0)=a, \quad \dot{y}(0)=b \quad (4)$$

He attempts to accomplish the desired result by the natural use of sequences $v^{(n)}$, $w^{(n)}$, satisfying

$$\text{(I)} \quad v^{(n)}(t)<y(t)\leqslant w^{(n)}(t),$$
$$\text{(II)} \quad v^{(1)}(t)<v^{(2)}(t)\leqslant\ldots, \quad w^{(1)}(t)>w^{(2)}(t)>\ldots, \quad (5)$$

(III) for $n\to\infty$ uniformly in $t\in(0, T)$ the following is satisfied $v^{(n)}(t)\to y(t)$, $w^{(n)}(t)\to y(t)$.

Such sequences are constructed typically by the use of Theorem 1. Assume p(t) to be the form

$$p(t)=p_0(t)+p_1(t), \quad (6)$$

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where $p_0(t)$, $p_1(t) \in L_2(0,T)$, and such that the following conditions are satisfied:

a) $p_1(t) \geq 0$ for $0 \leq t \leq T$ and the measure of the set $\{t: 0 \leq p_1(t) < \varepsilon\}$ tends to 0 as $\varepsilon \to 0$;

b) we know the fundamental system of solutions $u_1(t)$, $u_2(t)$ of the equation

$$\frac{d^2u}{dt^2} + p_0(t)u = 0 \quad (7)$$

with initial conditions

$$\begin{pmatrix} u_1 & u_2 \\ \dot{u}_1 & \dot{u}_2 \end{pmatrix}_{t=0} = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}; \quad (8)$$

c) within the given interval $(0,T)$ the function $u_2(t)$ has no zero.

If

$$p(t) > c_0 \quad \text{for} \quad 0 \leqslant t < T, \quad (9)$$

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then the conditions (a), (b), (c) can be satisfied, taking, for example, as $p_0(t)$, any function $p_0(t) = c$, where the constant c is subject to the condition

$$c \leqslant \min[c_0, \pi^2/T^2]. \quad (10)$$

As the "zero approximation" the author takes the solution $u = y_0(t)$ of equation (7) with initial conditions (4).

Theorem 1. Assume that (a), (b) and (c) are satisfied and that $y_0(t) > 0$ on $(0,T)$. Sequentially define the functions $y_1(t), y_2(t), \ldots$ from the equations

$$\frac{d^2y_{n+1}}{dt^2} + p_0(t)\,y_{n+1} = p_1(t)\,y_n,\ y_{n+1}(0) = 0,\ y'_{n+1}(0) = 0,$$
$$n = 0, 1, 2, \ldots \quad (11)$$

and set

$$y^{(n)}(t) = y_0(t) - y_1(t) + \ldots + (-1)^n y_n(t). \quad (12)$$

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Then for $0 < t < T$:

1) all $y_n(t) > 0$, $n = 1, 2, \ldots$,

$$\frac{y_{n+1}(t)}{y_n(t)} < \frac{n}{n+1} \frac{y_n(t)}{y_{n-1}(t)} \qquad (13)$$

3) there exists an integer $m = m(t) \geq 0$ such that

$$y_0(t) < y_1(t) < \ldots < y_m(t), \quad y_m(t) > y_{m+1}(t) > y_{m+2}(t) > \ldots \qquad (14)$$

4) if $t' < t''$, then $m(t') \leq m(t'')$

5) for the solution $y(t)$ of (3) with initial conditions (4)

$$\left.\begin{aligned} y(t) &< y^{(n)}(t) \quad \text{for even} \quad n > m(t) - 1, \\ y(t) &> y^{(n)}(t) \quad \text{for odd} \quad n > m(t) - 1, \end{aligned}\right\} \qquad (15)$$

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ACCESSION NR: AT3002555

6) if for even n, $y^{(n)}(t) \leq y_0(t)$ or for odd n, $y^{(n)}(t) \geq -y_0(t)$, then $n \geq m(t)$.

7) as $n \to +\infty$ uniformly in $t \in [0, T]$

$$y^{(2n)}(t) \to y(t), \quad y^{(2n+1)}(t) \to y(t). \tag{16}$$

Orig. art. has: 34 formulas and 3 figures.

ASSOCIATION: none

SUBMITTED: 00 DATE ACQ: 28Jun63 ENCL: 00

SUB CODE: MM NO REF SOV: 005 OTHER: 001

Card 6/6

ACCESSION NR: AT4008597 S/2944/63/000/002/0095/0131

AUTHOR: Yakubovich, V. A.

TITLE: Machines learning to recognize images

SOURCE: Leningrad. Universitet. Kafedra vy*chislitel'noy matematiki i vy*chislitel'ny*y tsentr. Metody* vy*chisleniy, no. 2, 1963, 95-131

TOPIC TAGS: image recognition machine, selflearning computer, computer, perceptron, character recognition machine, vowel recognition machine, linear perceptron

ABSTRACT: The characteristics of image recognizing machines (perceptrons), (the basic elements of which are identified as the retina, the associative element, the summing element, and the logical element), are described by methods of set theory with mathematical rigor, but the treatment is made understandable to the non-mathe-

ACCESSION NR: AT4008597

matician. The subject headings are: Introduction. 1. Schematic diagram of the perceptron. 2. Diagram of the recognition block. Linear perceptron. 3. Perceptron with one summing element. 4. Concepts that can be distinguished by a perceptron with a single summing element. 5. Concerning one algorithm for the separation of convex sets. 6. Separation of an arbitrary number of generally nonconvex sets. Learning block of a perceptron with many summing elements. 7. Description of the experiments performed. These cover the recognition of convex and concave functions, recognition of handwritten numbers, recognition of profiles, and recognition of vowel phonemes. "The author is grateful to the students M. Persiyanov, T. Bogdarin, and N. Belyayev for much work done in the experiments, and to Prof. G. V. Gershuni and Prof. L. A. Chistovich, who supplied the graphs for the vowels." Orig. art. has: 14 figures and 47 formulas.

ASSOCIATION: Leningradskiy gosudarstvenny*y universitet (Leningrad

Card 2/3

ACCESSION NR: AT4008597

State University)

SUBMITTED: 00 DATE ACQ: 27Dec63 ENCL: 00

SUB CODE: CP NO REF SOV: 008 OTHER: 004

Card 3/3

YAKUBOVICH, V.A. (Leningrad)

Absolute stability of nonlinear control systems in critical cases. Part 1. Avtom.i telem. 24 no.3:293-303 Mr '63.
(MIRA 16:4)

(Automatic control)

APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001962010019-2"

L 10322-63 EWT(d)/BDS--AFFTC/APGC/ASD--
Pg-4/Pk-4/Pl-4/Po-4/Pq-4--BC
ACCESSION NR: AP3001081 S/0103/63/024/006/0717/0731

12

AUTHOR: Yakubovich, V. A. (Leningrad)

TITLE: Absolute stability of nonlinear controlled systems in critical cases. 2

SOURCE: Avtomatika i telemekhanika, v. 24, no. 6, 1963, 717-731

TOPIC TAGS: stability of controlled systems, nonlinear controlled systems, Lyapunov's functions in automation

ABSTRACT: A theorem is proved that yields effective, necessary, and sufficient conditions for the existence of the Lyapunov's function -- "quadratic form plus an integral of nonlinearity" -- with a least degenerated derivative. Possibilities are explored of using such Lyapunov's functions in the problems with fixed nonlinearity. Pertinent formulas are given in Enclosure 1. Orig. art. has: 60 formulas.

ASSOCIATION: none

SUBMITTED: 03May62 DATE ACQD: 01Jul63 ENCL: 01

SUB CODE: 00 NO REF SOV: 015 OTHER: 001

Card 1/2

L 10322-63
ACCESSION NR: AP3001081 ENCLOSURE: 1

Automatic control system is described by these equations:

$$\frac{dx}{dt} = Ax + a\varphi(\sigma), \qquad \frac{d\sigma}{dt} = b^*x - \rho\varphi(\sigma),$$

where the matrix A has eigenvalues in the left closed semiplane; any number of them can be on the imaginary axis. The continuous function satisfies the inequality

$$0 < \frac{\varphi(\sigma)}{\sigma} < \mu_0 \quad (\sigma \neq 0,\ 0 < \mu_0 < +\infty)$$

The fundamental problem is to find the conditions of absolute stability which would encompass all conditions expressed by a Lyapunov function of this type

$$V = (Hx, x) + 2(h, x)\sigma + \chi\sigma^2 + \vartheta\int_0^\sigma \varphi(\sigma)\,d\sigma$$

with a least degenerated derivative. Here H, h, χ, ϑ are some parameters.

Card 2/2

S/020/63/149/002/008/028
B112/B180

AUTHOR: Yakubovich, V. A.

TITLE: Frequency conditions for absolute stability of controllable systems with hysteresis non-linearities

PERIODICAL: Akademiya nauk SSSR. Doklady, v. 149, no. 2, 1963, 288-291

TEXT: Hysteresis operators $\mathcal{Y}[\sigma, \xi_0]_t$ are considered which satisfy the following conditions: (1) For any σ_0 there exists a set $\mathcal{L}(\sigma_0)$ of initial values of hysteresis function. (2) The set $\mathfrak{M}_{\sigma_0}(t_0, t_1)$ of the continuous functions $\sigma(t)$ with $\sigma(t_0) = \sigma_0$ is mapped into the set $C(t_0, t_1)$ by the operator

$$\mathcal{Y}\left[\cdot\Big|_{t_0}^{t_1}, \xi_0\right].$$

The equation

Card 1/2

$$dz/dt + Pz + q\varphi[\sigma, \varphi_0]_{t_0}, \quad \sigma = (z, r) \qquad (1)$$

is shown to be solvable if $\varphi[\sigma, \varphi_0]$ is a continuous operator. The case where $\varphi[\cdot, \varphi_0]$ is discontinuous is an unsolved mathematical problem. Conditions of absolute stability of Eq. (1) are derived: One of them is the following: $0 \leqslant \sigma(t)\,\varphi[\sigma, \varphi_0]_t \leqslant \mu_0 \sigma(t)^2$, $\varphi[\sigma, \varphi_0]_t = 0$ for $\sigma(t) = 0$, $\xi(\omega) = 1/\mu_0 + \mathrm{Re}\,\chi(i\omega) > 0$ for $0 \leqslant \omega < \infty$ $(\chi(\lambda) = ((P - \lambda I)^{-1} q, r))$, $+\infty \geqslant \lim_{\omega \to \infty} \omega^2 \xi(\omega) > 0$. There is 1 figure.

PRESENTED: September 18, 1962, by V. I. Smirnov, Academician

SUBMITTED: September 15, 1962

DERGUZOV, V.I.; YAKUBOVICH, V.A.

Existence of solutions to linear Hamiltonian equations with unbounded operator coefficients. Dokl. AN SSSR 151 no.6:1264-1267 Ag '63. (MIRA 16:10)

1. Predstavleno akademikom V.I.Smirnovym.

YAKUBOVICH, V.A. (Leningrad)

Absolute stability of nonlinear controlled systems in critical cases. Part 3. Avtom. i telem. 25 no.5:601-612 My '64.
(MIRA 17:9)

ACCESSION NR: AP4042487 S/0103/64/025/007/1017/1029

AUTHOR: Yakubovich, V. A. (Leningrad)

TITLE: Method of matrix inequalities in the theory of stability of nonlinear controlled systems. Part 1 — Absolute stability of forced oscillations

SOURCE: Avtomatika i telemekhanika, v. 25, no. 7, 1964, 1017-1029

TOPIC TAGS: automatic control, nonlinear automatic control, automatic control theory, automatic control stability

ABSTRACT: The existence and absolute stability of forced periodic and quasi-periodic oscillations in a controlled system having one nonlinearity are analyzed. This set of equations is considered:

$$dx/dt = Px + q\varphi(\sigma) + f(t), \quad \sigma = r^*x, \qquad (1)$$

where f(t) is a vector function limited within $(-\infty + \infty)$; $\varphi(\sigma)$, generally a discontinuous function, has only isolated points of discontinuity of the first kind. Any function x(t) can be a solution of the above set (1) provided a function $\psi(t)$ satisfies these conditions:

ACCESSION NR: AP4042487

$$dx/dt = Px + q\psi(t) + f(t),$$

$$\varphi_-[\sigma(t)] \leqslant \psi(t) \leqslant \varphi_+[\sigma(t)], \quad \sigma(t) = r^*x(t).$$

Under certain assumptions regarding the roots (Theorem 1), the solution $x_0(t)$ is exponentially stable im grossen with the exponent exceeding α, i.e., such numbers $\beta > 0$ $\varepsilon > 0$ exist, that for any $t \geqslant t_0$ and any solution $x(t)$, this inequality holds true:

$$|x(t) - x_0(t)| \leqslant \beta e^{-(\alpha+\varepsilon)(t-t_0)} |x(t_0) - x_0(t_0)|.$$

Further, forced oscillations are investigated assuming that the solution $x_0(t)$ is known. Among other things, it is found that, in the absence of external influences, the condition of absolute stability with a specified decrement is similar to V. M. Popov's condition. Orig. art. has: 50 formulas.

ASSOCIATION: none

SUBMITTED: 04Nov63 ENCL: 00

SUB CODE: DP, IE NO REF SOV: 025 OTHER: 008

Card 2/2

STARZHINSKY, V.M. (Moscow); YAKUBOVICH, V.A. (Leningrad)

"Contribution to the Lyapunov method of determining periodic solutions"

Report presented at the 2nd All-Union Congress on Theoretical and Applied Mechanics, Moscow 29 Jan - 5 Feb 64.

GANTMAKHER, F.R. (Moscow); YAKUBOVICH, V.A. (Leningrad):

"Absolute stability of non-linear controls."

report presented at the 2nd All-Union Congress on Theoretical and Applied Mechanics, Moscow, 29 Jan - 5 Feb 64.

ACCESSION NR: AP4036716 S/0020/64/156/002/0278/0281

AUTHOR: Yakubovich, V. A.

TITLE: A solution for certain matrix inequalities encountered in a nonlinear control theory

SOURCE: AN SSSR. Doklady, v. 156, no. 2, 1964, 278-281

TOPIC TAGS: matrix inequality, nonlinear control, Lyapunov function, matrix spectrum, closed halfplane, absolute stability, Lurie method, quadratic form

ABSTRACT: This paper deals with special systems of differential equations (e.g., for automatic control) and a bounded class of the Lyapunov function (e.g., quadratic forms). The existence of this function was converted into a purely algebraic problem involving the existence of a solution to certain specialized matrix inequalities. Through a series of mathematical arguments and the construction of theorems, a solution was presented. In his third theorem, the author assumes that $\mu_0 \neq \infty$. Therefore, in order to have a matrix $H = H^*$ in which $F(\mu,H) > 0$ when $0 \leq \mu \leq \mu_0$, it is necessary that in the case of a certain $\tau \geq 0$ and all $\omega \geq 0$, the following equation be carried out:

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$$\pi_1(\omega) \equiv \gamma + 2\mathrm{Re}\, p^* (P - i\omega I)^{-1} q + \tau [\mu_0^{-1} + \mathrm{Re}\, r^* (P - i\omega I)^{-1} q] > 0 \quad (4)$$

Orig. art. has: 6 equations, 4 theorems, and 1 lemma.

ASSOCIATION: none

SUBMITTED: 15Jan64 DATE ACQ: 03Jun64 ENCL: 00

SUB CODE: MA NO REF SOV: 004 OTHER: 002

Card 2/2

ACCESSION NR: AP[illegible] [illegible]

SOURCE: Ref. zh. Mekhanika, Abs. [illegible]

AUTHOR: Yakubovich, V. A.

TITLE: Frequency conditions for the absolute stability of nonlinear automatic control systems

CITED SOURCE: Tr. Mezhvuz. konferentsii po prikl. mekhan., 1962. Kazan', 1964, 135-142

TOPIC TAGS: nonlinear automatic control system, absolute stability, stability condition, Lyapunov function

TRANSLATION: The controlled system is studied: $x = Px + q\varphi(\sigma)$, where $\sigma = r^*x$, P is a constant Hurwitz matrix, q and r are constant columns, and the function φ satisfies the condition $0 \leqslant \varphi(\sigma)\sigma \leqslant \mu_0\sigma^2$, $\mu_0 < +\infty$. The solution of [illegible] matrix [illegible] formulated, on the basis of which the sufficient [illegible] V. M. Popov for the absolute stability of the investigated system are derived by analysis of the Lyapunov function $[illegible]\, x^*Hx\ [illegible]\ \int_0^{\sigma} \varphi(\sigma)\,d\sigma$ (H is a positive-definite

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ACCESSION NR: AR5016489

It is shown that the obtained results are valid even in the case when
matrix). It is shown that the obtained results are valid even in the case when
φ (6) is a piecewise-continuous function. The third matrix problem is cited, and
It is shown that it is now solved. It follows from its solution that the "weak"
[illegible] necessary for the existence of the Lyapunov function
condition of [illegible] is derived [illegible]
with $U \leqslant 0$. The frequency condition for absolute stability
the case when φ is a continuous hysteresis function. A system with the piecewise-
continuous function φ(σ), $d\varphi/d\sigma \geqslant 0$ is also considered. A sufficient frequency
condition for absolute system stability, broader than the condition of V. M. Popov,
is obtained by analysis of the Lyapunov function. A. Kh. Gelig

SUB CODE: IE, MA

ENCL: 00

Card 2/2

L 08829-67 EWT(d)/EWP(1) IJP(c) BB/GG

ACC NR: AT6022616 (A) SOURCE CODE: UR/3040/65/000/004/0003/0071

35

AUTHOR: Yakubovich, V. A.

ORG: none

TITLE: Some general theoretical principles for the construction of learning perception systems. I

SOURCE: Leningrad. Universitet. Kafedra vychislitel'noy matematiki i Vychislitel'nyy tsentr. Vychislitel'naya tekhnika i voprosy programmirovaniya, no. 4, 1965, 3-71

TOPIC TAGS: information theory, perceptron, automaton

ABSTRACT: General principles are given for the construction of automatic systems which model human perception and identification processes. A large class of models of the perceptron type is discussed. A general introduction is given, describing the general properties of a perception system. The general formula for such a system is

$$s(x) \approx \sum_{j=1}^{N} x_j a_j(x),$$

where x_j are certain numerical coefficients, $s(x)$ is an elementary "concept" resulting from the perception of image x, and a_j are certain so-called "a-elements"--functional

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L 08829-67

ACC NR: AT6022616

elements which react on incoming images. The method for choosing these a-elements is discussed. It is shown that the collection of functions representing a-elements is complete in the field of images under certain sufficiently general assumptions regarding the functions given on the receptor field ("retina"). It is shown also that for an optimal choice of coefficients x_j the probability of error in perception will become arbitrarily small providing the number N of a-elements is sufficiently large, along with the number m of elements of the learning sequence. The requirements for an algorithm of learning and perception are discussed. Systems are studied which are based on the defined notions of L- and C-optimality. The L-algorithm is shown to be theoretically superior but extremely unwieldy and hence unsuitable for circuit form; while algorithms satisfying C-optimal requirements, converging only with sufficiently great values of N, are quite simple and can be circuit-programmed. These algorithms are recurrence solutions of linear inequalities and equations. Orig. art. has: 225 formulas, 9 figures, 1 table.

SUB CODE: 09,12/ SUBM DATE: 01Aug64/ ORIG REF: 017/ OTH REF: 006

Card 2/2 nst

EWT(d)/EWP(k)/EWP(h)/EWP(l) Po-4/Pq-4/Pf-4/Pg-4/Pk-4/Pl-4

ACCESSION NR: AP5011900 UR/0103/65/026/004/0577/0590

AUTHOR: Yakubovich, V. A. (Leningrad)

TITLE: The method of matrix inequalities in the theory of stability of nonlinear controlled systems. II. Absolute stability in a class of nonlinearities with derivative condition

SOURCE: Avtomatika i telemekhanika, v. 26, no. 4, 1965, 577-590

TOPIC TAGS: control system stability, nonlinear class stability, derivative condition, absolute nonlinear system stability, matrix inequality

ABSTRACT: The author studied the system

$$\frac{dx}{dt} = Px + q\varphi(\sigma), \qquad \sigma = r^*x, \qquad (1)$$

where $\varphi(\sigma)$ is a function differentiable at every point and satisfying

$$0 \leqslant \sigma\varphi(\sigma) \leqslant \mu_0\sigma^2 \quad (\mu_0 \leqslant +\infty), \qquad (2)$$

and either

$$\varphi'(\sigma) \leqslant \alpha_1, \qquad (3)$$

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or

$$\varphi'(\sigma) \geqslant \alpha_2. \quad (4)$$

and derived a new frequency condition for the absolute stability of the nonlin-
and derived a new frequency condition for the absolute stability of the nonlin-
earity classes satisfying (2) and (3), or (2) and (4) and an additional condition
[illegible] equation (1), Latin ca[illegible] denote matrices, small letters [illegible]
[illegible]
consideration, all the conditions [illegible] nonlinearity [illegible]
[illegible] based [illegible]
integral over the nonlinearity [illegible] earlier (Dokl. AN SSSR, v. 143, no. 6, 1962). An
matrix inequalities discussed earlier (Dokl. AN SSSR, v. 143, no. 6, 1962). An
appendix contains the proof of four theorems used in the text. Orig. art. has:
86 formulas and 1 figure.

ASSOCIATION: None

SUBMITTED: 23Sep63 ENCL: 00 SUB CODE: IE, MA

NO REF SOV: 013 OTHER: 005

Card 2/2

AUTHOR: Yakubovich, V. A. (Leningrad)

TITLE: Method of matrix inequalities in the theory of stability of nonlinear controlled systems. Part 3 — Absolute stability of systems having hysteresis-type nonlinearities

SOURCE: Avtomatika i telemekhanika, v. 26, no. 5, 1965, 753-763

TOPIC TAGS: nonlinear automatic control, automatic control, automatic control design, automatic control system, automatic control theory

ABSTRACT: The article proves that the V. M. Popov frequency condition holds true in the case of a hysteresis-type nonlinearity if the parameter that enters the above condition has a definite sign that depends on the direction of following the hysteresis loop. An automatic-control system is considered which can be described by these equations: $\frac{dx}{dt} = Px + q\varphi[\sigma, \varphi_0]_t$, $\sigma = r^*x$, where P — $\nu \times \nu$ is a

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ACCESSION NR: AP5013832

constant matrix; q, r − ∂ x 1 are constant vectors ($q \neq 0$, $r \neq 0$); r^*x is a scalar product; $\varphi[\sigma, \varphi_0]_t$ is a hysteresis function. For a backlash-type nonlinearity, the condition of absolute stability is determined. Orig. art. has: 3 figures and 55 formulas.

ASSOCIATION: none

SUBMITTED: 17Jul63 ENCL: 00 SUB CODE: DP, IE

NO REF SOV: 011 OTHER: 000

Card 2/2

AUTHOR: Yakubovich, V. A.

TITLE: Frequency criteria for absolute stability and dissipativity of control systems with one differentiable nonlinearity

SOURCE: AN SSSR. Doklady, v. 160, no. 2, 1965, 298-301

TOPIC TAGS: absolute stability criterion, dissipativity criterion, nonlinear control system, global asymptotic stability

ABSTRACT: A study is made of the stability of nonlinear control systems described by the system of differential equations

$$dx/dt = Px + q\varphi(\sigma). \quad (1)$$

where $\sigma = r^*x$, P is a Hurwitz matrix, q is a vector, and $\varphi(\sigma)$ is a differentiable function satisfying the following conditions:

$$\text{a) } 0 \leqslant \sigma\varphi(\sigma) \leqslant \mu_0\sigma^2; \quad \text{б) } -\alpha_1 \leqslant \varphi'(\sigma) \leqslant \alpha_2 \quad (2)$$

L 25383-65

ACCESSION NR: AP5004585

where u_0, α_1, and α_2 are finite numbers. An expression $\pi(\omega)$ containing certain parameters τ_1, τ_2, θ, and the transfer function of the linear part of the system $\chi(i\omega)$ is introduced which is used for defining criteria of the absolute stability of the system (1). Conditions which parameters $\tau_1 \geq 0$, $\tau_2 \geq 0$, θ and $\pi(\omega)$ must satisfy that the solution $x \equiv 0$ of system (1) be asymptotically stable in the large are presented in the form of two theorems. For the control system described by equations

$$dx/dt = Px + q\varphi(\sigma) + f(t, x); \quad \sigma = r^* x \qquad (3)$$

where $f(t, x)$ is a continuous function of x and t and

$$\lim_{|x| \to \infty} |f(t, x)| / |x|$$

converges toward zero uniformly with respect to t, and under the same assumptions as for system (1) except for condition (2a) which is replaced by a weaker one

$$\lim \frac{\varphi(\sigma)}{\sigma} \left[\lim \frac{\varphi(\sigma)}{\sigma} \right] \geq 0 \quad \text{at } |\sigma| \to \infty,$$

[illegible] established. If for certain parameters [illegible]

... there exists a bounded closed set F such that all f(x) ... ∈ F,

has ... formulas

... Leningrad State University)

SUBMITTED: 26Jun64 ENCL: 00 SUB CODE: IE, MA

NO REF SOV: 006 OTHER: 001 ATD PRESS: 3182

Card 3/3

L 24596-66 EWT(d) IJP(c)

ACC NR: AP6009415 SOURCE CODE: UR/0020/66/166/006/1308/1311

28
27
B

AUTHOR: Yakubovich, V. A.

ORG: Leningrad State University im. A. A. Zhdanov (Leningradskiy gosudarstvennyy universitet)

TITLE: Recurrence finitely convergent algorithms for solving systems of inequalities

SOURCE: AN SSSR. Doklady, v. 166, no. 6, 1966, 1308-1311

TOPIC TAGS: algorithm, Euclidean space, Hilbert space, set theory, vector, real function

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ABSTRACT: The infinite system of inequalities

$$\varphi(x, a_j) > 0 \quad (j = 1, 2, \ldots),$$

is examined, where x is the unknown vector of the euclidean or real Hilbert space R_1; a_j are arbitrary vectors of some set M of a euclidean or real Hilbert space R_2; and $\varphi(x, a)$ is a real function. The derived algorithms have a number of common characteristics with relaxation algorithms. Besides being simple, they

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have high reliability. Five theorems are proved. Superposition of the algorithms $x_{j+1} = f_j[x_j, c_j(x_j, a_j), \gamma_j(x_j, a_j)]$ for $x_1 \in G$ will be a finitely convergent algorithm for solution of the inequalities $\varphi(x, a_j) > 0$. Simple finitely convergent algorithms for solution of the inequalities $\chi_j + 2(h_j, x) + (H_j x, x) > 0$, where $H_j = H_j^* > 0$, can be easily obtained by this method. "The author thanks V. I. Smirnov for a number of valuable comments." This paper was presented by V. I. Smirnov, academician, on 11 June 1965. Orig. art. has: 4 equations.

SUB CODE: 12/ SUBM DATE: 06Jun65/ ORIG REF: 005/ OTH REF: 004

Card 2/2 BK

L 27783-66 EWT(d)/T/EWP(1) IJP(c) GG/BB/JXT(CZ)

ACC NR: AP6012911 SOURCE CODE: UR/0020/66/167/005/1008/1011

57

AUTHOR: Kozinets, B. N.; Lantsman, R. M.; Yakubovich, V. A.

56

ORG: Lithuanian Scientific Research Institute for Forensic Examinations, Vilnius (Litovskiy Nauchno-issledovatel'skiy institut sudebnoy ekspertizy)

B

TITLE: Criminalistic examination of similar handwriting by means of electronic computers

SOURCE: AN SSSR. Doklady, v. 167, no. 5, 1966, 1008-1011

TOPIC TAGS: computer application, adaptive pattern recognition, electronic computer, digital computer

ABSTRACT: One of the most difficult tasks in criminalistic examination is the identification of similar handwriting. The present authors developed a program for a learning digital computer which bases the recognition process on learning according to the algorithm which follows a training sequence. The graphical object is first converted into digital form by means of characteristic features. The processing of data is carried out by associating to the stereotype of the handwriting of a given person a sampling of convex sets. Computer recognition of true and forged signatures of the personnel of the Lithuanian Scientific Research I[illegible] Examinations (Litovskiy nauchno-issledovatel'skiy institut sudebnoy ekspertizy) was compared with the results of identifications by experts of the Leningrad Scientific Research Laboratory of Forensic Examinations (Leningradskaya nauchno-issledovatel'skaya laboratoriya sudebnoy ekspertizy), of the scientific technical department

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ACC NR: AP6012911

of the UM UOOPLO (nauchno-tekhnicheskiy otdel), and the scientific-technical group of the highway department of the militia MOOP RSFSR (nauchno-tekhnicheskaya gruppa dorozhnogo otdela militsii). Results are shown in Table 1.

Table 1 Handwriting recognition

Signature	Recognition, percent	
	Experts	Machine
Metsyavichyus	58.3; 68.3; 70	88
Shtromas	75.4; 78.9; 80.7	91.2
Chyapas	75.0; 80	84.2
Poshkyavichyus	90.0; 92	100

A more detailed account of the investigation will appear in Symposium No. 2 of the Lithuanian Scientific-Research Institute for Forensic Investigation which planned the study in conjunction with the Computer Center of Leningrad University (Vychislitel'nyy tsenter Leningradskogo universiteta). The authors express their gratitude to the experts of abovementioned institutions. The paper was presented by Academician Smirnov, V. I., 20 Jul 65. Orig. art. has: 1 table.

SUB CODE: 05, 09 / SUBM DATE: 17Jul64 / ORIG REF: 001

Card 2/2

L 04900-67 EWT(d)/EWP(1) IJP(c) GG/BB/JXT(BF)/GD

ACC NR: AT6022670 SOURCE CODE: UR/0000/66/000/000/0021/0028

AUTHOR: Kozinets, B. N.; Lantsman, R. M.; Sokolov, B. M.; Yakubovich, V. A.

52

ORG: none

B+1

TITLE: Handwriting recognition and discrimination by means of electronic computers

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SOURCE: Moscow. Institut avtomatiki i telemekhaniki. Samoobuchayushchiyesya avtomaticheskiye sistemy (Self-instructing automatic systems). Moscow, Izd-vo Nauka, 1966, 21-28

TOPIC TAGS: pattern recognition, automaton, character recognition, computer application

ABSTRACT: The general problem of machine recognition and discrimination of handwriting, the development of the necessary algorithms, and the theoretical principles underlying the process of teaching an automaton handwriting analysis are discussed. The discussion is based primarily on certain theoretical work in this area that has been carried out at the VTs LGU. A detailed explanation is given of the manner in which the handwriting or "graphic" material is converted into a system of numbers suitable for computer processing, and several different metrization techniques are described. The principle of the "dynamic stereotype of writing" (a fundamental assumption of the method proposed) is introduced as a means of neutralizing

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ACC NR: AT6022670

random or deliberate handwriting deviations from an established and quantized standard. The necessary and sufficient conditions for the validity of this hypothesis are stated, and it is shown that algorithms based on this assumption are in all cases much simpler than those which disregard it. Examples are given and an analysis is made of the results of certain machine experiments using the general techniques outlined, including a comparison of the algorithm adopted with others founded on different approaches. The theoretical considerations and experiments described substantiate the possibility in principle of employing computers for the differentiation of similar handwriting styles. Orig. art. has: 8 figures.

SUB CODE: 09,06/ SUBM DATE: 02Mar66/ ORIG REF: 003

Card 2/2

L 00451-67 EWT(d) IJP(c)
ACC NR: AT6024067 SOURCE CODE: UR/2944/66/000/003/0051/0059

AUTHOR: Yakubovich, V. A.

ORG: none

TITLE: Regions of dynamic instability in Hamiltonian systems

SOURCE: Leningrad. Universitet. Kafedra vychislitel'noy matematiki i Vychislitel'nyy tsentr. Metody vychisleniy, no. 3, 1966, 51-59

TOPIC TAGS: linear differential equation, Hamilton equation, dynamic stability

ABSTRACT: The system studied is:

$$J\frac{dx}{dt}=[C(\theta)+\varepsilon H(t,\varepsilon,\theta)]\,x. \qquad (0.1)$$

where x is a vector solution, J is a non-degenerate real skew-symmetric matrix, and matrices C and H are real-valued, symmetric for real ε, θ, and depend analytically on the parameters in the region

$$-\infty<\theta_1\leqslant\theta<\theta_2<+\infty,\ |\varepsilon|<\varepsilon_0<\infty. \qquad (0.2)$$

A point of instability is defined as follows: a point $(\varepsilon_0, \theta_0)$ in region (0.2) is a point of instability if for $\varepsilon = \varepsilon_0$, $\theta = \theta_0$ equation (0.1) has solutions unbounded on $(0,\infty)$. Regions on the plane (ε,θ) into which an open set, obtained from the set M of all instable points by discarding boundary points, falls are called regions of dynamic

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L 09451-67

ACC NR: AT6024067

instability of equation (0.1). The value θ_0 is called critical for equation (0.1) if points of instability can be found arbitrarily close to the point $(0,\theta_0)$. The general form of such regions of instability is studied, and an algorithm is given for calculating the boundaries of regions of dynamic instability for small values of ε. Orig. art. has: 76 formulas, 5 figures.

SUB CODE: 12/ SUBM DATE: 16Apr63/ ORIG REF: 011

Card 2/2

L 09441-67 EWT(d)/EWT(m)/EWP(w)/EWP(1) IJP(c) EM
ACC NR: AT6024069 SOURCE CODE: UR/2944/66/000/003/0076/0104

AUTHOR: Fomin, V. N.; Yakubovich, V. A.

ORG: none

TITLE: The computation of characteristic exponents for linear systems having periodic coefficients

SOURCE: Leningrad. Universitet. Kafedra vychislitel'noy matematiki i Vychislitel'nyy tsentr. Metody vychisleniy, no. 3, 1966, 76-104

TOPIC TAGS: linear differential equation, dynamic stability, approximate solution

ABSTRACT: An equation is derived for determining the characteristic exponents of the system

$$\frac{dx}{dt}=[C+\varepsilon D(t,\varepsilon)]\,x.$$

For $\varepsilon = 0$, they reduce to a given characteristic exponent α_0 of the unperturbed equation

$$\frac{dx}{dt}=Cx.$$

Formulas are also derived for the calculation by successive approximations of characteristic exponents for perturbed systems with periodic coefficients, for a vector equation of degree m, and for systems with multi-parametric perturbations. Some conclusions

L 09441-67

ACC NR: AT6024069

are made concerning the effect of combinatory resonance on the stability of elastic systems. Orig. art. has: 175 formulas.

SUB CODE: 12/ SUBM DATE: 16Apr63/ ORIG REF: 011/ OTH REF: 006

Card 2/2

ACC NR: AP7001539 SOURCE CODE: UR/0020/66/171/003/0533/0536

AUTHOR: Yakubovich, V. A.

ORG: Leningrad State University im. A. A. Zhdanov (Leningradskiy gosudarstvennyy universitet)

TITLE: Periodic and nearly periodic limiting states of control systems with certain, generally speaking, discontinuous nonlinearities

SOURCE: AN SSSR. Doklady, v. 171, no. 3, 1966, 533-536

TOPIC TAGS: control system, automatic control system, system analysis, differential equation

ABSTRACT: Consider the differential equations of a control system with $\varkappa$ nonlinear units $\varphi_j = \varphi_j(\sigma_j)$

$$dx/dt = Px + q\varphi(\sigma) + f(t), \quad \sigma = r^*x.$$

The matrices $P, q, r, x, f(t), \varphi(\sigma) = \|\varphi_j(\sigma_j)\|$ are real and have respective orders $\nu\times\nu, \nu\times\varkappa, \nu\times\varkappa, \nu\times 1, \nu\times 1, \varkappa\times 1$, $\varkappa \times 1$, and $\sigma = \|\sigma_j\|$ is $\varkappa \times 1$. It is assumed that $\varphi_j(\sigma_j)$ is a piecewise continuous function having only first-order points of discontinuity and that

$$0 \leqslant \Delta\varphi_j/\Delta\sigma_j \leqslant \mu_j, \quad j = 1, 2, \ldots, \varkappa,$$

where $\Delta\varphi_j = \varphi_j(\sigma_j + \Delta\sigma_j) - \varphi_j(\sigma_j)$, $-\infty < \sigma_j < +\infty$, $-\infty < \Delta\sigma_j < +\infty$ and $\sigma_j, \sigma_j + \Delta\sigma_j$

ACC NR: AP7001539

are points of discontinuity of the function $\varphi_j(\sigma_j)$. Subject to other definitions and constraints, it is shown that the solution of this system is an arbitrary, absolutely continuous $\nu \times 1$ matrix function x(t). Then for a certain $\varkappa \times 1$ matrix function $\psi(t) = \|\psi_j(t)\|$ (summed at each interval) and also for the function $\varphi[\sigma(t)]$, the relationship $dx/dt = Px + \bar{q}\psi(t) + f(t)$, $\varphi_j[\sigma_j(t) - 0] \leqslant \psi_j(t) \leqslant \varphi_j[\sigma_j(t) + 0]$, where $\sigma(t) = \|\sigma_j(t)\| = r^*x(t)$, is nearly always satisfied. Four theorems are stated and proved in demonstration of the existence of an exponential convergence of the system solution. Parts of the proof were presented by the author in an earlier paper (Avtomatika k telemekh., 25, No. 7, 1964). This paper was presented by Academician L. S. Pontryagin on 24 January 1966. Orig. art. has: 5 equations.

SUB CODE: 12/ 13/ SUBM DATE: 24Jan66/ ORIG REF: 006/ OTH REF: 004

Card 2/2

ACC NR: AT6022669 SOURCE CODE: UR/0000/66/000/000/0009/0020

AUTHOR: Yakubovich, V. A.

ORG: none

TITLE: Some basic principles of the design of cognitive learning systems

SOURCE: Moscow. Institut avtomatiki i telemekhaniki. Samoobuchayushchiyesya avtomaticheskiye sistemy (Self-instructing automatic systems). Moscow, Izd-vo Nauka, 1966, 9-20

TOPIC TAGS: intelligent machine, speech recognition, pattern recognition, character recognition, adaptive pattern recognition, sound recognition computer, artificial intelligence

ABSTRACT: The author describes a mathematical basis for the development of learning, pattern recognition machines. In addition, the results of certain experiments carried out using a machine constructed in accordance with the proposed theory are reported. A learning machine functions by association of the stimulae presented with previously acquired and stored information. The training process therefore consists of feeding into the machine the inputs to be recognized, as well as the corresponding correct outputs (responses). The amount of required information can be substantially reduced and performance improved by giving the machine the ability to recognize the inputs by

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classifying them as belonging to a set of similar, familiar inputs. An input can be considered in mathematical terms to be a set *S*. This set can have certain general properties which can be used for its classification as a preliminary to its recognition. The set *S* may be open, connected, and in many cases, convex. The author does not postulate that biological systems function in accordance with this principle; he suggests, however, that during the process of evolution, living organisms sensed and utilized the general properties of sets. Consequently, the proposed method appears reasonable. A mathematical basis for systems designed to differentiate between various types of convex and non-convex sets is given and related to some olfactory, auditory, and visual stimulae. An artificial retina of 10 × 10 cm was constructed and operated in conjunction with a computer. The inputs were in terms of coordinates for 25 points of an image. The experiment of recognition of handwritten numbers consisted in presenting the retina with five numbers "2" and five numbers "3". All numbers were different in shape, size, and their location on the retina. This constituted the training phase. Thereafter fourteen images (seven "two's" and seven "three's") were presented, of which the machine correctly identified twelve. The experiment of human profile recognition had the criterion of classifying a profile either as an "upturned nose" or as a "long nose". After an initial training phase the machine correctly recognized all forty-two profile images presented. Two other experiments dealing with recognition of sounds and random terms are also described. The sounds were translated into curves of spectral densities and presented to the retina. The author expresses his gratitude to Prof. G. V. Gershuni and Prof. L. A. Chistovich for the use of spectral density recordings. Orig. art. has: 11 figures.

SUB CODE: 06,05/ SUBM DATE: 02Mar66/ ORIG REF: 007/ OTH REF: 004

Card 2/2

ARTEMOV, Yu.V.; KOZINETS, B.N.; YAKUBOVICH, V.A.

Effect of impact on a multimass system. Metod. vych. no.2:75-90 '63. (MIRA 18:11)

YAKUBOVICH, V.A.

Teaching a machine to perceive an image. Metod. vych. no.2:95-131 '63. (MIRA 18:11)

L 00592-66

ACCESSION NR: AR5010350

UR/0124/65/000/007/A011/A012
531.36+531.391.3

SOURCE: Ref. zh. Mekhanika, Abs. 7A97

AUTHOR: Yakubovich, V. A.; Starzhinskiy, V. M.

TITLE: A parametric resonance system with multiple degrees of freedom

CITED SOURCE: Tr. Mezhvuz. konferentsii po prikl. teorii ustoychivosti dvizheniya i analit. mekhan., 1962. Kazan', 1964, 123-134

TOPIC TAGS: canonic equation system, frequency order, forced oscillation stability, resonant system, instability area boundary

TRANSLATION: The authors analyze the equation system $\frac{dx}{dt} = [C + \varepsilon A(\theta t)]x$ where C is a constant 2k x 2k matrix with pure imaginary eigenvalues $i\omega_\nu (\nu = \pm 1, \ldots, \pm k)$.

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L 00592-66

ACCESSION NR: AR5019350

while A (s) is a 2π = periodic matrix. All critical frequencies are given for some classes (i.e. t-invariant, canonical) of systems of type (1). These assume the form

$$\theta_0 = |\omega_j \pm \omega_h|/m \quad (j, h = \pm 1, \ldots, \pm k, \; m = 1, 2, \ldots).$$

A formulation of the M.G. Krein theorem for canonic systems is presented, employing the concepts of first and second order frequencies. Formulas are given for canonic equation systems to define boundaries of instability areas in plane $\varepsilon\theta$ with an accuracy ranging to small O (ε) inclusive. The importance of a study of combination resonances in system (1) are emphasized and the feasibility of expanding combination resonance regions by introducing minor friction is indicated. Calculation results are cited to clarify the failure of the Takomskiy bridge. Formulas are given for first approximations of characteristic exponents of systems similar to canonic. The results derived are applied in a study of the stability of forced periodic oscillations in the quasilinear system

$$M\ddot{v} + Q_0\dot{v} + P_0 v = f(t) + \varepsilon g(t, v, \dot{v}, \varepsilon) =$$
$$f(t+T) \equiv f(t), \quad g(t+T, v, \dot{v}, \varepsilon) \equiv g(t, v, \dot{v}, \varepsilon)$$

for resonant and nonresonant formulations. K.G. Valeyev

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