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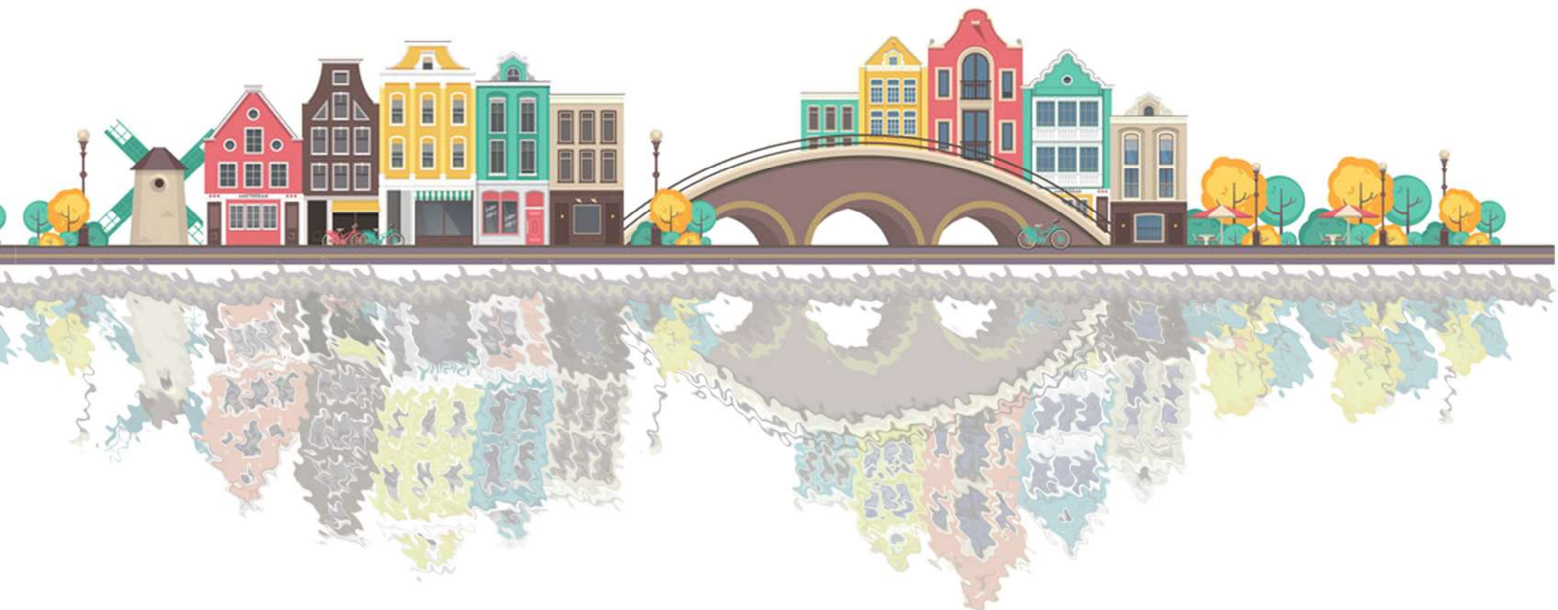

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CONTENT

SECTION II. ENGINEERING AND IT

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EVALUATION OF THE PARAMETER'S SENSITIVITY OF DYNAMIC SYSTEMS MODELS OBTAINED BY THE PROJECTION METHODS

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Solving the problems of complex dynamic systems control optimizing and their identification with partially observable output signals becomes much more complicated and can be solved under certain assumptions regarding the system matrices structure. Let us apply a generalized approach to solving the problem of controlling a multidimensional system with coordinates inaccessible to observation. In this case, only the output signals can be measured directly. When investigating the possibility of optimal control, we proceed from the fact that the system is described by the vector-matrix differential equation [1, 2, 3]

$$\vec{x} = \mathbf{A}(t)\vec{x}(t) + \mathbf{B}(t)\vec{u}(t) + \vec{n}(t)\,, \qquad (1)$$

where: $\vec{x}(t)$ *– n-dimensional vector representing state variables;* $\vec{u}(t)$ *– k-dimensional vector representing control actions;* $\vec{n}(t)$ *– s- dimensional vector representing external random influences;* $\mathbf{A}(t)$ *– coefficients matrix of the processes occurring in the system;* $\mathbf{B}(t)$ *– control matrix.*

The solution to equation *(1)* has the form

$$\vec{x}(t) = \mathbf{\Theta}(t,t_0)\vec{x}(t_0) + \int_{t_0}^{t}\left[\mathbf{\Theta}(t,\tau)\mathbf{B}(\tau)\vec{u}(\tau) + \vec{n}(\tau)\right]d\tau\,, \qquad (2)$$

where: $\mathbf{\Theta}(t,\tau) = e^{\mathbf{A}(t)\cdot(t-\tau)}$ *– system transition matrix.*

The constructing optimal controls principle for a dynamic system is determined by the quality index with constraints, under which the physical implementation of the dynamic system optimal control is guaranteed. While implementing digital control systems, the quality indicator is determined by the quadratic form:

$$J_N = \sum_{k=1}^{N}\left\{[\vec{x}^{\,d}(k) - \vec{x}(k)]'\mathbf{Q}(k)[\vec{x}^{\,d}(k) - \vec{x}(k)] + \lambda\vec{u}'(k-1)\mathbf{H}(k-1)\vec{u}(k-1)\right\}, \qquad (3)$$

where: $\vec{x}^{\,d}(k)$ *– the desired state vector;* **Q**, **H** *– positive definite symmetric matrices;* λ *– constant multiplier.*

The first term in *(3)* gives a deviation from the given process at any time, the second term takes into account the limitation of the control action energy [1, 3, 5, 6]. By appropriate choice of the matrix **Q**, any coordinate of the process state can be made more important and effective for assessing the quality of the system in comparison with another variable. By choosing the elements of the matrix **H**, it is possible to impose the desired constraints on the control actions energy. Optimal control consists of determining a sequence of control vectors $\vec{u}'(0), \vec{u}'(1), \ldots, \vec{u}'(N-1)$ that minimize the expected average value of the quality indicator [1, 3, 4].

The aggregate of the initial mathematical model *(1)* and quality criteria *(3)* that determine the sensitivity functions are called the sensitivity model of the system under study.

Conclusions. Projection techniques for studying dynamic systems allow, with a certain selection of matrices **Q** and **H**, to solve the problem of finding a quasi-optimal control with a certain accuracy with incomplete observation of the system output signals. Investigation of the obtained models dynamic's systems for sensitivity makes it possible to determine critical changes in the eigenvalues of the system operator and to predict unstable operating modes of the system. The solution of the stability problem for the model of a dynamical system *(1)* is determined by the structure of the matrix **A**, its rank, type and multiplicity of the roots of the characteristic polynomial and is solved by the method of perturbation theory different orders of eigenvalues and eigenvectors based on Gershgorin's theorems. The stability of the dynamic system model is determined by the location of the eigenvalues on the complex plane.

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