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Models for Implementation of Linear, Non-Linear, and Parametrical Circuits in Traffic Safety Control Devices

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Abstract

The range of new approaches based on interconnected circuit theorems was considered to implementation, synthesis, and diagnostics of devices providing the traffic safety. The methodology for new devices implementation is based on the mathematical tools: theory of operators, Laplace transformation, modern methods for synthesis of the named classes of circuits and systems, possibility of excluding inductive elements use. It allows applying micro-electronic devices and hybrid systems together with computing machinery which makes it possible to decrease volume and weight, improve structures functionality and optimize the quantity of input elements as well as sensitivity functions which can be received with an accelerated method. An example of circuits' implementation without inductive elements is provided.

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1. Main text

Invention of new electric and radioelectronic devices partially or fully presupposes solving issues related to circuits: the necessity for creating mathematical models (macromodeling of various levels and requirements). Thereby, as a rule, preliminary complying with the set quality criteria (usually preliminary optimization of the elaborated solutions) requires elaboration of synthesis and implementation methods based on microelectronics — operating

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amplifier (OA), resistors, capacitors, signals multipliers, and newly-invented special active devices with set quantities [Korovkin et al. (2009)] including negative immittance converters (KOI) and multipole negative immittance converters (multi- KOI), gyrators and multigyrators, and other multipole multi-dimensional devices.

In general there are linear, non-linear, parametrical, non-linear parametrical, and hybrid elements among the used elements. For example, a tunable transistored non-linear amplifying converter contains either one of the elements or their combination. The respective operators as to implementation of these properties do not impose any essential constraints on possible structures of the implemented circuits. Henceforth we admit for the implemented systems that the clamp device inputs and outputs numbered as 1 ... *n* are inputs and outputs of the entire system; capacitive part is connected to clips (*n* + 1) … *m*; the non-linear elements — to the clips numbered as (*m* + 1) … *p* and, finally, the parametric ones — to (*p* + 1) … *q*.

To generalize the description henceforth we accept the following operator presentation for values in *C* blocks(the capacitive part) and *NP* (the non-linear parametrical part) (see Figure 1):

$$\begin{bmatrix}[P_L(s)]\\ [P_N(s)]\\ [P_\sim(s)]\end{bmatrix} = \mathrm{diag}\{[W_L(s)],[W_N(s)],[W_\sim(s)]\}\cdot\begin{bmatrix}[Q_L(s)]\\ [Q_N(s)]\\ [Q_\sim(s)]\end{bmatrix} = [P(s)] = \mathrm{diag}\{[W(s)]\}[Q(s)] \quad (1)$$

where $s=\sigma+j\omega$; *L*, *N*, ~ relate accordingly to the linear, non-linear, and parametrical circuits; $[W_k(s)], k\in\{L,N,\sim\}$ is the transformation operator of the vector of images of values $[Q_k(s)]$ to the vector $[P_k(s)]$, $[W_L(s)]\in L\{d^n/dt, \int(\ )dt\}\ n=\mathbf{0},\mathbf{1}$. In general, the multipole*AR* is difficult to be implemented for the likelihood of incompatible requirements.

Further, we address a random system which can be of the following type:

$$[[U(s)]^t,[I(s)]^t]^t = [T_o(s)][N(s)], \quad (2)$$

where $[U(s)]=\left[[U(s)]^t{}_n, [U(s)]^t{}_{q-n}\right]^t$, $[I(s)]=\left[[I(s)]^t{}_n, [I(s)]^t{}_{q-n}\right]^t$ are the block matrices of terminal source voltage numbered as 1 ... *n* and (*n* + 1) … *q*; $[T_o(s)]$ is some rectangular matrix with dimensions $\lambda\times(k-\lambda)$; $[N(s)]$ is the column vector of values with dimensions $(\lambda-k)\times\mathbf{1}$ (*k* is the number of constraints) also represented in block type $[N(s)]=\left[[N_1(s)]^t,[N_2(s)]^t\right]^t$ (index 1 points to the values appurtenance to the multitude {1, 2, …, *n*}, and index 2 — to {*n* + 1, *n* + 2, …, *q*}); *t* is the transposed matrix, λis the dimensionality of the accepted basis.

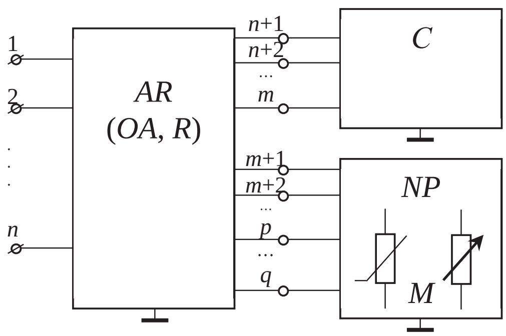

Fig. 1.The investigated system.