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AN ALGORITHM FOR PARAMETRIC OPTIMIZATION OF ELECTRONIC NETWORKS BASED ON NUMERICAL INTEGRATION METHODS

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An efficient algorithm is suggested for solving the general nonlinear programming problem based on the Adams-Bashfort method of numerical integration. The paper contains comparative estimates of efficiency of the new method performed after solving several test problems and problems of parametric optimization of electronic networks.

With advances in integral technologies the opportunities for full-scale experiments become more limited, and their cost increases. Moreover, reduction of the time for designing imposes strict requirements to the network CAD software — not only to perform comprehensive network analysis but also help in treatment of more complex problems of design. One of such problems, whose solution usually takes the main bulk of time allotted for the design implementation, is the parametric optimization problem. Thus, development and modernization of the approaches, methods, and algorithms of parametric optimization is the matter of importance.

Many problems of the parametric optimization of electronic circuits can be represented as the general nonlinear programming problem

$$\min_x \Phi(x) \tag{1}$$

provided that $A_i(x) \le 0, i = 1(1)N, B_j(x) = 0, j = 1(1)M$, where $\Phi(x)$ is some objective function (OF) establishing the relation between the network's parameters and the specified requirements; $x = [x_1, x_2, \dots, x_n]^{\mathrm{T}}$ is the vector of variable parameters; while $A_i(x)$ and $B_j(x)$ are the functions-constraints imposed on the variable parameters.

The number of methods for treatment of the general problem of nonlinear programming is large enough, but most efficient are quasi-Newton methods [1] and the generalized variable-order method [2]. The principle of operation of these methods consists in using the procedures of resolving the systems of nonlinear algebraic equations, when the objective function $\Phi(x)$ is expanded in Taylor's series with a finite number of expansion terms. Since the problems of parametric optimization of electronic networks are characterized with a large number of ravines (curved narrow valleys), in order to improve efficiency of these algorithms, various accelerating techniques (semi-empirical for the most part) are applied. However, even the use of such techniques does not guarantee the result desired. Because of this, the more preferable strategy consists in continuously tracking the behavior of the OF and constraints — to obtain at each step the coordinates of a new point $x^{(k)}$, which satisfies most appropriately the Kuhn-Tucker conditions of problem (1).

For alternative we can use the method proposed in [3], where formulation of the problem of constrained minimization is equivalent to treatment of the system of nonlinear differential equations of the first order

$$\dot{x}(t) = -H(x(t))g(x(t)), \quad x(0) = x^{(0)}, \tag{2}$$

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