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ANALYSIS OF ACCELERATION EFFECT IN NETWORK DESIGN BY THE CONTROL THEORY METHODS

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Based on the generalized theory of electronic network design, the effect of additional acceleration of the design process has been revealed and analyzed. This effect arises due to different behavior of design trajectories with change in the vector of the controlling functions. The effect is noticeable for all networks analyzed and permits to additional reduction in the computer time.

The problem of reduction of computation time is one of important tasks aimed at improvement of quality of large systems design. Apart from traditional approaches such as sparse matrices and decomposition techniques, some new concepts, based on the control theory methods, have been developed by the author in a number of works [1–3]. The idea to abandon exact observance of Kirchhoff's laws, proposed in [4], was generalized due to application of the optimal control theory. As shown in [1–3], this leads to a whole number of different design strategies and, as a result, to an opportunity to set up (based on these variants) a strategy quasioptimal in terms of its speed. This approach generalizes the design process and permits us to formulate the task of seeking the fastest algorithm as the control theory problem. On the other hand, this approach permits us to analyze thoroughly the motion of the current point of the design process in the phase space of variables. The main concept of the new approach consists in introducing some controlling functions, which generalize the design process and make it possible to control it in such a way as to attain the objective function optimum for a minimum of machine time. This opportunity appears because of a practically unlimited number of various design strategies existing within the framework of the approach suggested. According to this conception, the traditional design strategy is one of possible representatives among the variety of different design strategies.

As shown in the works mentioned above, the possible gain in the computation time, attainable with the optimal design strategy as compared to the traditional one, increases with size and complexity of electronic networks. However, this expected gain can become reality only if we manage to generate the algorithm making it possible to determine the optimal trajectory of the design process. Thus the problem of establishment and investigation of major intrinsic properties and restrictions of the optimal trajectory of design is the principal task to be resolved in creation of the optimal algorithm.

Based on the concepts suggested, in this work we analyze new effects arising in the process of network design by the control theory methods. The inquiries started from a simplest nonlinear circuit with a single node and two parameters ($N = 2$), which has no practical applications but serves as a good illustration for comprehension of the processes in the network design based on the new methodology. After that an N-dimensional problem will be considered. All the examples included demonstrate some phenomenon, which may be called the effect of acceleration of design process. The latter arises because of different behavior of design trajectories having different controlling functions. We also assume that the vector X of the mathematical model parameters of a network can be divided in two parts: $X = (X', X'')$, where $X' \in R^K$ is the vector of independent variables, K is the number of independent variables, $X'' \in R^M$ is the vector of dependent variables, M is the number of dependent variables, and $N = K + M$.

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