USE OF COMPLEX OPTIMIZATION FOR SENSITIVITY DETERMINATION IN DISTRIBUTED-LUMPED-ACTIVE NETWORKS

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Abstract

A method of applying complex optimization techniques to determine various sensitivity coefficients for distributed-lumped-active networks is presented.

1. INTRODUCTION

The DLA (Distributed-Lumped-Active) network is one composed of distributed elements (modeled by partial differential equations), lumped elements (modeled by ordinary differential equations and algebraic relations), and active elements (modeled by algebraic relations). The DLA network has many advantages over its purely lumped counterparts, however, the presence of transcendental irrational functions of the complex frequency variable in the network functions describing such circuits make the analysis and synthesis computations associated with this class of networks considerably more difficult than corresponding computations having to do with comparable LA (Lumped-Active) networks. An especially important example of the difficulty of such computations occurs in the determination of sensitivity information for a given DLA network configuration. Such a determination is greatly facilitated by the use of complex optimization techniques implemented on a digital computer.

2. SENSITIVITY DETERMINATION

Complex optimization is a powerful technique which may be used in the application of optimization theory to the synthesis and analysis of DLA networks. In this technique, the magnitude of some desired transfer function is maximized at a given point in the complex plane corresponding to a desired location for a pole of the network function. Correspondingly, the function may be simultaneously minimized at a point at which a zero is desired. Thus the network parameters may be considered as defining a vector $\underline{x}$ which is optimized while the pole and zero positions form a requirement vector $\underline{r}$. The optimization problem may be stated as the determination of some $\hat{\underline{x}}$ such that $f(\hat{\underline{x}},r) < \varepsilon$, where $f(\underline{x},\underline{r}) = \Sigma\, T(z_i) + \Sigma\, 1/T(p_i)$, T is the network function magnitude, the z_i are the desired zero locations and the p_i are the desired pole locations. The same digital computational techniques which determine such a minimum may be applied to the determination of sensitivity information by interchanging the roles of $\underline{x}$ and $\underline{r}$. Thus we seek a vector $\hat{\underline{r}}$ which satisfies the relation $f(\underline{x},\tilde{\underline{r}}) < \varepsilon$ for a given specified $\underline{x}$. When such a computation is made for a series of values of $\underline{x}$ which represent perturbations of the individual component variables x_i from some nominal solution vector $\underline{x}_0$, the result is a complete sensitivity analysis of the specified network. If such sensitivity information is included with the original scalar functional, i.e., if we seek an $\hat{\underline{x}}$ such that $f(\hat{\underline{x}},\underline{r},\underline{s}) < \varepsilon$ where $\underline{s}$ is a sensitivity vector, then sensitivity minimization may be achieved simultaneously with the determination of the network parameters.

3. CONCLUSION

In this paper a digital computer algorithm for the determination of sensitivity information of DLA networks using complex optimization is described. The results obtained from applying this algorithm to several well known DLA networks are discussed.