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The Extension of Mitrovic's Method and Its Application to the Design of Compensation Networks

Toyomi OHTA*

The author first investigated the relation between roots and coefficients of n-th order algebraic equation with constant coefficients, and then showed new methods of design of compensation networks to be inserted in automatic control systems using these results.

In order to analyze the transient phenomena of linear automatic control systems, it is rather common to derive the characteristic equations from the fundamental differential equations of these systems and then locate the roots to discuss the dynamic behavior of the systems. It may be said that the essence of the analysis lies in the estimation of these roots.

Mitrovic, in 1959, found a new relation between the roots of n-th order algebraic equation and its coefficients of zero-th and first degree terms, and thus developed a new method for estimation of roots.

There are many approximate methods of finding roots of polynomials in existence, but very few of them may be applied for the design of compensation networks In addition, both the frequency response method and the root locus method have many disadvantages, as the former is indirect and inaccurate and the latter too complex to become accurate in estimating the dynamic behavior of complex systems.

The method developed by Mitrovic is a graphical one and is available in the design.

Considering these, the author made detailed and individual investigations of the relationships between the roots and other combinations of two coefficients selected from the network design point of view, and then rigorously difined the stable domain in the respective graphs.

On the process, the atthor found it is rather inadequate to use only two coefficients to discuss the stable domain in certain cases, and proposed three parametric theory to use in such occasions.

The author also formulated those simultaneous equations for the coefficient combinations most frequently appear in the design process, and showed systematic procedure of sketching them in details. In addition a program is prepared for the

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digital computer with the FORTRAN programming to analyze the higher order systems.

The author, utilizing the above results in the stability analysis, discussed the design of compensation networks of automatic control systemf, and developed a new method which can quantitatively improve the damping ratio and the time constant of any system. This method implies a systematic way of bringing a point defined by the two coefficients into a stable domain with a specified damping ratio. This method doesn't need trial probings of several times, and yet in relocating the representative roots no additional considerations are required to see the variation of the sites of other roots.

By the author's present paper, for the first time the quantitative improvement of the dynamic behavior of control systems has become practical in the design of compensation networks with damping ratio and time constant specified. Also it seems there are many applications in relation to the stability analysis, and accordingly the method seems to have great influences in the design of more common usual networks.