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Comparative analysis of controller tuning methods for first-order inertia object model with astatism and non-minimum phase

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Abstract

This paper presents a comparative analysis of controller tuning procedures for first-order inertia object models with astatism and non-minimum phase, using methods such as the maximum stability degree with iterations and polynomial method. The procedure for tuning the controller for first-order inertia object model with astatism and non-minimum phase is developed using the maximum stability degree method with iterations. Analytical expressions for controller tuning parameters as nonlinear functions of the stability degree and known object parameters are derived. The stability degree is varied, and these functions are graphically constructed. Sets of controller parameter values are selected on these curves for the same argument value through iteration procedures, and simulation is used to determine the highest performance and robustness of the system. A controller synthesis procedure is developed using the modified polynomial method. To verify and compare the results, an example is studied using the proposed methods, as well as by applying pole-zero, Ziegler-Nichols, and parametric optimization methods. System simulations with performance analysis are conducted by varying object model parameters from nominal values by ±50 %, verifying the system's robustness. The advantages of the maximum stability degree method with iterations, with reduced calculations and minimal time, are highlighted, along with the benefits of the modified polynomial method, which simplifies the controller tuning procedure for these object models.

Keywords: *automatic system, control algorithm, controller tuning, system response, system performance, system robustness*

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