Integrating Robust Design and Multi-Response Optimization in Industrial Control Systems: A Multi-Disciplinary Approach

Vinayambika S Bhat

Department of Electronics & Communication Engineering,
Mangalore Institute of Technology & Engineering, Moodabidri, 574225, India,
vinayambika09@gmail.com

This article presents a new robust control system designed for industrial applications, specifically a Multivariable Proportional Integral (PI) controller. It uniquely integrates computational science, control engineering, chemical engineering, and statistical techniques for optimal resource utilization. The methodology employs Taguchi's robust design and multi-response optimization on a Two Input Two Output (TITO) model of a distillation column, focusing on Steady State Gain Matrix (SSGM), time constant (τ), and time delay (θ). Validation is achieved through simulations, statistical analysis, and real-time experiments on a pilot plant distillation column, comparing its performance with another control algorithm. Key findings include the more significant impact of Integral control parameters (Ki) over Proportional (Kp) for robustness, emphasizing the need to consider both control and noise parameters. The approach ensures optimal resource use and provides ideal parameter settings by balancing control and noise factors with multiple responses. This work is original in its comprehensive approach to control system design, considering controllable and uncontrollable factors for multi-response systems. It offers a template for robust process design in various industrial multi-input Output (MIMO) systems, demonstrating a significant field advancement. The key terms include Robust Design, Process Parameters, Distillation Column, PID Control, and Multi-response.

Keywords: Robust Design; Process Parameters; Distillation Column; PID Control; Multi-response Optimization; Computational Science; Control Engineering; Chemical Engineering; Statistical Techniques