INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
PhD-17 SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

This thesis presents data-driven and computationally efficient methodologies for intelligent fault diagnosis in industrial process control loops. The work focuses on three major aspects: oscillation detection and characterization, valve stiction detection, and root cause analysis (RCA) in interconnected process systems. A neural network-based approach using FFT and autocorrelation-derived features is proposed for oscillation detection, achieving high accuracy with significantly reduced computational complexity. Methods for estimating oscillation period and amplitude are also developed and validated using industrial data.

To identify oscillation sources caused by valve stiction, a heatmap-based data-driven technique analyzing controller output and process variable interactions is proposed. The method demonstrates good generalization across industrial loops and achieves reliable stiction detection performance. Further, a topology-independent RCA framework based on cross-correlation and weighted lag analysis is developed to identify the originating source of abnormalities in multivariable systems. The proposed τ-metric effectively captures relationships among process variables and shows high accuracy for both oscillatory and non-oscillatory faults.

Overall, the thesis contributes interpretable and practical tools for monitoring, diagnosis, and performance assessment of industrial control loops, supporting more reliable and autonomous process operations.