Robust Fault Detection and Isolation Using a Parity Equation Implementation of Directional Residuals

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Abstract

This paper focuses on solving the failure detection and isolation (FDI) problem by developing a model-based approach using a parity equation implementation of directional residuals. This new approach is an extension of the generalized parity vector (GPV) technique based on the stable factorization approach.

The present work has improved the approach in Viswanadham, Taylor and Luce [1] in two important respects: (1) isolability has been increased, both in terms of the number of failures isolated and the quality of discrimination; and (2) the robustness of this technique has been increased by incorporating an adaptive fuzzy threshold to the decision-maker block. In the first instance, a novel transformation matrix computation is presented that enhances the isolation properties of the FDI algorithm, i.e., increases the maximum number of faults that can be isolated and the number of disturbances that can be decoupled, above the number of outputs of the system [2]. Robustness is also increased due to the fact that the adaptive fuzzy threshold takes into account the effects of disturbances and modeling errors, due to the deviations of the process from its operational point and possible nonlinear effects. Moreover, disturbance decoupling is implemented in the stable factorization framework to make the residuals immune to disturbance effects.

The efficacy and robustness of this technique is demonstrated by designing an FDI scheme for a continuous stirred tank reactor. Subsequently, its performance in a large-scale process will be tested using the actual model and data from one of the pilot plant facilities involved in the Petroleum Applications of Wireless Systems (PAWS) project, sponsored under the Atlantic (Canada) Innovation Fund (AIF).

References

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