

Observer-based fault detection with fuzzy variable gains and its application to industrial servo system

ABSTRACT

In this paper, an adaptive high-accurate observer-based fault detection approach for industrial applications is proposed. The proposed fault detection algorithm employs a fuzzy logic-based approach with the objective of finding the appropriate observer gains that could cope with the different working conditions. The flexibility and adaptability represent the main objectives of the proposed observer. This work is interested in proposing an observer with fuzzy variable gains for a general nonlinear system. Furthermore, a linear model has been built to facilitate the accomplishment of the fault detection of the industrial servo system by using the proposed observer. In order to evaluate the proposed approach, eleven realistic sensor fault scenarios are created under varying conditions: fault parameters (e.g., multiple fault profiles, location, and magnitudes), unknown inputs (e.g., disturbers and sensor noises) for performance testing. Also, a scoring algorithm has been implemented, to evaluate the classification ability of the algorithm and the early fault detection ability. The experimental results demonstrate the effectiveness of the proposed observer approach in detecting sensor faults in the industrial servo systems, with 88.8% classification accuracy. Furthermore, the obtained results confirm the proposed algorithm superiority when compared to classical Luenberger observer with constant gains.

Keyword: Observers; Fault detection; Mathematical model; Servomotors; Stability analysis; Fault diagnosis; Employee welfare