

THE DEVELOPMENT AND INVESTIGATION ANALYSIS OF AN ARX-BASED GENERALIZED LIKELIHOOD RATIO (GLR) STICTION DETECTION METHOD

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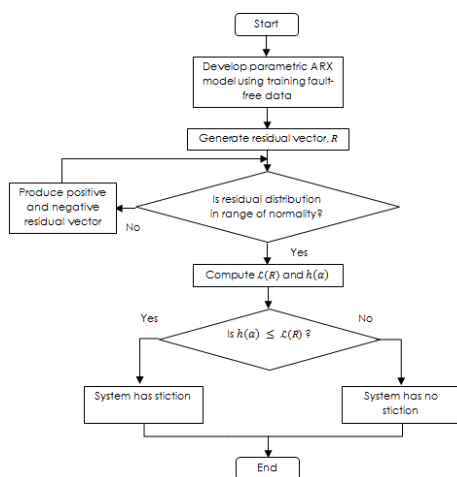
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Graphical abstract



Abstract

Control valve stiction is one of the main sources of nonlinearity which can result in many deleterious effects on the control loop performance of a process. The study of stiction detection methods has now becoming one of the essential research areas in process control. In this present work, an ARX-based Generalized Likelihood Ratio (GLR) stiction detection method is proposed and its effectiveness is analyzed. The implementation of the proposed method involves three main stages; 1) ARX model identification, 2) GLR test, and 3) statistical hypothesis testing. The proposed detection method was applied to two benchmark simulated case studies. Results showed that the method effectively detect stiction. The presence of stiction is declared if the GLR test statistics, $\mathcal{L}(R)$ exceeds the decision threshold limit, $h(\alpha) = 3.841$, and the null hypothesis is rejected at 5% significance level. On the other hand, if $\mathcal{L}(R)$ value lies below $h(\alpha) = 3.841$, the null hypothesis is accepted and the absence of stiction is confirmed. In addition, it is also observed that the proposed method is reasonably insensitive and robust to the changes in the process gain, K and time constant, τ as it generally allows up to $\pm 10\%$ changes in the two parameters for both case studies.

Keywords: Control valve, stiction detection, ARX, GLR test, statistical hypothesis testing

Abstrak

Geseran statik injap kawalan adalah salah satu sumber utama tidak linear yang boleh menyebabkan banyak kesan yang merosakkan pada prestasi gelung kawalan suatu proses. Kajian kaedah pengesanan geseran statik telah menjadi salah satu bidang penyelidikan penting dalam kawalan proses. Dalam kerja terkini ini, kaedah pengesanan geseran statik berasaskan ARX yang Nisbah Kemungkinan Umum (GLR) dicadangkan dan keberkesanannya dianalisis. Pelaksanaan kaedah yang dicadangkan melibatkan tiga tahap utama; 1) pengenalan model ARX, 2) ujian GLR, dan 3) pengujian hipotesis statistik. Kaedah pengesanan yang dicadangkan telah digunakan untuk dua kajian kes penanda aras simulasi dan hasil menunjukkan bahawa kaedah ini berkesan dalam mengesan geseran statik. Had stik dinyatakan jika statistik ujian GLR $\mathcal{L}(R)$ melebihi had ambang keputusan, $h(\alpha) = 3.841$, dan hipotesis nol ditolak pada tahap penting 5%. Sebaliknya, jika nilai $\mathcal{L}(R)$ terletak di bawah $h(\alpha) = 3.841$, hipotesis nol diterima dan ketiadaan stik dikonfirmasi. Di samping itu, juga diperhatikan bahawa kaedah yang dicadangkan itu adalah tidak