Perturbed Iterative Feedback Tuning

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Optimal performance of process control requires a controller synthesis based on a performance criterion. In order to minimize the criterion, a model for the process is normally required. Iterative Feedback Tuning (IFT) is a data driven methodology to tune controller parameters given a performance criterion, with penalty on the controlled variable deviations from a desired trajectory and with penalty on the control variable it self or it's increment. The methodology published in [1] have been extended and tested for a number of applications [2]. The method minimizes the performance criterion using a gradient based search method. The gradient is for single loop controllers estimated through up to three closed loop experiments, designed to give a consistent estimate. The first experiment provides input/output information of the system and the remaining experiments are used to form an estimate of the gradients of the input and output with respect to the controller parameters. Using closed loop data is advantagous since it is the loop performance that is subject to optimization. It also alows tuning of a stabilizing loop.

The advantage of IFT relies on the ability to achieve the desired performance in a few iterations. Plant experiments are costly and product produced meanwhile may have reduced quality since the process is perturbed from it's normal point of operation. When tuning controllers for disturbance rejection, IFT may only converge very slowly due poor signal to noise ratio in data. A solution using prefilters in the IFT algorithm to reduce the effect of noise and improve convergence rate has been proposed [3]. A different solution to meet the same end was proposed in [4]. This method uses external perturbations in order to achieve an improved signal to noise ratio and increase the convergence rate. This extended algorithm has been labeled Perturbed Iterative Feedback Tuning (PIFT).

This contributions aims at introducing the PIFT algorithm and showing how optimal excitation signals can be achieved. It is shown that an analytical solution for the excitation signal exists for the minimum variance control problem. For a general control problem an optimization problem for the excitation signal design is formulated. The optimal signals design dependent on system information which is assumed unknown in the IFT framework. This analysis nevertheless provide useful insight when designing an excitation signal for tuning the loop in an indusial process.

References

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