242f A Novel Procedure for Oscillation Detection and Characterization of Oscillation in Control Loops

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Oscillations in control loops can happen due to: i) valve non-linearity (stiction, hysteresis, and backlash), ii) external oscillating disturbance, iii) poorly tuned controllers, or iv) a combination thereof. It has been reported that about 1/3rd of all controllers in process industries oscillate due to the reasons mentioned above. To understand and diagnose the root cause for these oscillations, characterization of oscillations has been attempted both in time and frequency domain. Although several oscillation detection methods have been proposed, it is observed that due to the non-constant nature of industrial signals, these methods are not widely applied.

In this work, a new characterization approach based on a modified Empirical Mode Decomposition (EMD) procedure with an adaptive threshold is proposed. The goal of this characterization is to isolate all the dominant oscillation modes. Zero crossings are then identified in each oscillation mode. The uncovered zero-crossings in each oscillation mode gives complete information regarding: (i) non-constant mean, (ii) time instances when the oscillations are present, (iii) strength of the oscillations at different times and (iv) time period of each sweep of oscillation. Since this characterization has to be routinely applied across thousands of loops, the number of tuning parameters in the characterization algorithm has to be minimum (preferably zero). Special attention will be paid to this aspect of automation in this paper and we will discuss the tuning parameters in our approach and how these can be automatically fixed. Hence, in summary, the main focus of our work is both on detecting oscillations in control loops and a detailed characterization of oscillations to aid in:

1. Diagnosing the root-cause for oscillation as stiction, improper controller tuning or external disturbance.
2. Diagnosing the root-cause when multiple loops oscillate.
3. Computing realistic performance indices for controller performance assessment.

Results obtained from over 50 industrial datasets will be presented in the session.