Controller performance monitoring Solutions

(a). Root cause analysis of oscillating control loops

Motivation

In modern industrial plants, plant-wide disturbances are a common problem as process units are strongly linked with each other. Disturbances occurring in one control loop may propagate through the unit/plant and upset many process variables, thereby resulting into a plant-wide problem. Examples include oscillations caused by a sticky Valve, an aggressively tuned controller etc. Such plant-wide oscillations have a negative impact on the product quality and the running costs of the plant. This motivates the need for getting to the origin of the disturbance and mitigating the root cause at the earliest.

Problem

The problem statement given to us was to develop a data driven solution to isolate the source loop resulting in oscillating disturbance. The only information available was the historical process data and no prior process knowledge was available.

Solution

As a first step to the solution, spectral analysis of all available process measurements was done to group the loops with similar oscillation period. Each group/cluster of loops is then analysed separately to get to its root cause loop.

To isolate the source loop resulting in plant wide oscillations, causal relationship between all available process measurement was established. Two different approaches - Granger Causality and cross-correlation function were used as the underlying principle based on the literature study of existing work in this area.

The proposed solution was applied to two sets of industrial case study where process units were affected by an oscillating disturbance. The algorithm developed could correctly identify the source loop. The work is in currently in progress where we are trying to analyse the proposed solution on more industrial test cases.

(b). Prioritizing control loops for improved plant performance

Motivation

Control loop monitoring systems are now being widely used in the process industries to efficiently operate the plants. The main objective is to reduce the operating/running costs by highlighting the poorly performing control loops that need attention. Since the number of control loops in a plant is huge, it is expected that the number of loops that need attention is equally large. It is economically infeasible and practically not possible to improve the performance of all loops, thereby necessitating a methodology to prioritize their optimization and maintenance. This is essential to ensure continuous profitable operation of the plant.

Problem

The problem statement given to us was to use data driven techniques to determine the poorly performing control loops and prioritize them for an improved plant performance. The scope of work was limited to analyse and prioritise the control loops at unit level. The information available was the routine operating data of all control loops in the unit. The importance/criticality levels of individual control loops were also defined.

Solution

Performance analysis of all controlled process variables was done to identify poor performing loops that required attention. The performance of a control loop can be quantified by the loop output variance. If a loop is performing well and meeting the specified performance targets, it is expected that the output variability of that loop is well within the acceptable bounds. This principle was used as a base to separate the loops with acceptable and non-acceptable performance.

An algorithm was then designed to provide an importance score to each of the control loops with non-acceptable performance to prioritize them for maintenance/optimization. To develop a good ranking algorithm, the interactions and causal relationship between all process variables were studied using data driven techniques. Loop ranking was done by considering the criticality level of each loop and the economic benefits that can be realized by improving its performance.

The algorithms designed was validated on few simulation/industrial case studies and gave promising results. The work is in currently in progress where we are trying to analyse the proposed solution on more industrial test cases.