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Estimation of alarm chattering

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ABSTRACT

Chattering alarms (alarms that repeat excessively in a short time interval) create a level of nuisance to the operator. According to industrial alarm standards, no chattering is acceptable. Therefore, reducing the amount of alarm chatter is a primary goal in redesigning alarm parameters. A quantitative measure to assess the degree of chattering for an alarm has recently been proposed. This measure is based on run length distribution which is the distribution of time differences between consecutive alarms. This chattering index is currently calculated empirically based on alarm data. In this paper, we develop a method to estimate the chattering index based on statistical properties of the process variable as well as alarm parameters. The estimation can be used for developing analytical methods to optimally design alarm parameters for minimal chattering.

1. Introduction

The level of reliability of industrial alarm systems is an important factor directly affecting safety, product quality and overhead costs in industrial plants. The practice of alarm design is crucial in determining whether the alarm system works properly or it distracts the operators with announcing too many nuisance and false alarms. Improperly configured alarm systems are abundant in industry. This is often due to an excessive number of configured alarms and the time consuming nature of alarm rationalization practice. As a consequence, the number of alarms during abnormalities in the plant operations is usually higher than what the operator can comprehend and respond to. Most of the alarms during these alarm floods are nuisance (valid alarms with no usable information). Alarms that annunciate excessively, unnecessarily, or do not return to normal after the correct responses are taken, are called nuisance alarms [2]. The majority of nuisance alarms are either redundant alarms or chattering alarms. Redundant alarms occur when multiple process variables trigger alarms due to a single fault. In this case the operator is already aware of the abnormal situation but keeps receiving alarms which distract him/her from treating the abnormality. On the other hand, a chattering alarm is an alarm that repeats excessively in a short period of time. Chattering alarms are also a distraction to the operator and should be avoided.

Alarm management has recently gained a lot of attention among researchers. Related problems are investigated from different perspectives [13–15]. In [3] many problems in industrial alarm systems are addressed and the qualitative methods to meet the expectations of a good alarm system are summarized. In [4] a computerized tool for alarm system improvement is presented A number of methods were proposed to eliminate nuisance alarms: creating a model of the system or part of it, prioritizing and grouping alarms, shelving the repeating alarms and tuning the alarm limits and delays. Two visualization tools known as “high density alarm plot” and “alarm similarity color map” to assess the performance of alarm systems are presented in [5]. The proposed idea is to identify highly chattering tags and redundant alarms by plotting colored graphs. A method for designing deadbands by applying time series analysis techniques is developed in [6], where it is proposed to model the process variable as an autoregressive integrated moving average (ARIMA) structure and use the model to predict the future values of the process variable and its prediction interval. In [7] a technique is introduced for optimal design of alarm limits by analyzing the correlation between process variables and alarm variables. A technique to optimally design alarm limits and processors (filters, deadbands, delay timers) is proposed in [10] based on the receiver operating characteristics (ROC) curve.

According to ISA 18.2, a widely used standard on alarm systems, there should be no chattering alarms [2]. Processing techniques such as alarm deadbands and delay timers are usually used to reduce the amount of alarm chatter. However, practical configuration of these processing techniques is based on some general rules that are derived experimentally [11]. To the best of our knowledge, there are no analytical design methods targeting chattering reduction, mainly due to inexistence of analytical relations between alarm chattering and design parameters.

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