Contribution ID: **40** Type: **not specified**

Control Chart for Monitoring a Multiple Stream Process based on Multilayer Perceptron Neural Network, with an Application to HVAC Systems of Modern Trains

Monday, 17 May 2021 11:55 (20 minutes)

Abstract

In recent years, rail transportation in Europe is regarded as a viable alternative to other means of transport, and this naturally leads to a fierce competitions among operators in terms of passenger satisfaction. In this regard, railway passenger thermal comfort is one of the most challenging and relevant aspects, especially for long trips. Indeed, new European standards, such as UNI EN 14750, have been developed over the past few years to normalize railway passenger thermal comfort at different operating conditions (e.g., vehicle category, climatic zone). To meet these standards, data from on-board heating, ventilation and air conditioning (HVAC) systems have been collected by railway operators to monitor air quality and comfort level in passenger rail coaches within the industry 4.0 framework. A dedicated HVAC system is installed in each train coach and, thus each train, usually composed by more than one coach, produces multiple data streams from each HVAC that fall within the class of the multiple stream processes (MSPs). A MSP can be defined as a process at a point in time that generates several streams of output with quality variable of interest and specifications that are identical in all streams. When the process is in control, the output from each stream is assumed to be identical, or, more in general, stationary of any kind. To improve the monitoring of a MSP and the detection of shifts in the mean of individual streams, a new control charting procedure based on a multilayer perceptron neural network is trained to solve for the binary classification problem of detecting whether the MSP is in control or out of control. Through a wide Monte Carlo simulation, the proposed control chart is shown to outperform the traditional Mortell and Runger's MSP control chart based on range [1] in terms of ARL_1, at given ARL_0. Finally, the practical applicability of the proposed approach is illustrated by an application to the monitoring of HVAC system data, that were acquired during lab tests, on board of modern passenger railway vehicles, and made available by the rail transport company Hitachi Rail based in Italy.

References

[1] Mortell, R. R., Runger, G. C. (1995). Statistical process control of multiple stream processes. *Journal of Quality Technology*, **27**(1), 1-12

Primary authors: Mr CESARO, Guido (Maintenance & System Engineer, Operation Service and Maintenance Product Evolution, Hitachi Rail Group); Prof. LEPORE, Antonio (Department of Industrial Engineering, University of Naples Federico II); Prof. PALUMBO, Biagio (Department of Industrial Engineering, University of Naples Federico II); Mr SPOSITO, Gianluca (Department of Industrial Engineering, University of Naples Federico II)

Presenters: Mr CESARO, Guido (Maintenance & System Engineer, Operation Service and Maintenance Product Evolution, Hitachi Rail Group); Mr SPOSITO, Gianluca (Department of Industrial Engineering, University of Naples Federico II)

Session Classification: Process analytics in railway applications

Track Classification: Data Science in Process Industries