Contribution ID: **51** Type: **not specified**

Detection of transient changes in urban air pollution by PM10

Monday, 17 May 2021 14:05 (20 minutes)

According to the World Health Organization, the increase in the concentration of PM10 (particulate matter) in the air, values greater than 50 µg /m3, is a serious problem that threatens the environmental balance. Several research projects have been proposed in the detection of pollution peaks in offline and online mode to keep the variation of PM10 under control. While the increase in the concentration of PM10 has a finite duration, the sequential detection of transient changes is required.

This work addresses the sequential detection of abnormal changes of a finite duration in PM10 concentrations. First, the Vector Autoregressive Model (VAR) is designed to describe the measurements corresponding to an acceptable concentration mode of different PM10 stations (sensors). In order to validate the model, we checked the main statistical assumptions about the residuals such us their Gaussianity and the absence of serial and cross correlations. Then, we tested the model on abnormal data for the generation of residuals. The aim of this study is to detect change-points respecting the maximum detection delay when the PM10 is out of control under the constraint on the probability of false alarm rate (when the PM10 is under control) during a given period.

Unlike the traditional sequential change-point detection, where the duration of the post-change period is infinite, the sequential detection of transient changes should be done with a prescribed delay L. Thus, the detection of a transient change with delay greater than L is considered as missed [1,2]. The minimax non-Bayesian criterion is used. Therefore, it aims to minimize the worst probability of missed detection under the constraint on the worst-case false alarm rate.

We adapted the previously developed theory to the transient change detection in multivariate time series. Then, the finite moving average detection algorithm is designed, studied and applied to the multivariate time series of PM10 data.

Our approach is tested on PM10 data provided by Atmo-VISION within INTERREG Upper Rhine program, and financed (among others) by FEDER, Atmo Grand Est and EMS. The hourly PM10 concentrations are measured by using stations in Strasbourg city.

References

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Session Classification: Process control

Track Classification: Data Science in Process Industries