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Fault diagnosis in multiple stream processes using artificial neural networks, with an application to HVAC systems of modern passenger trains

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Rail transport demand in Europe has increased over the last few years, as well as the comfort level of passengers, which has been playing a key role in the fierce competition among transportation companies. In particular, the passenger thermal comfort is on the spotlight also of recent European regulations, that urge railway companies to install data acquisition systems to continuously monitor on-board heating, ventilation and air conditioning (HVAC) and possibly improve maintenance programs. Each train is usually composed by several coaches and produces multiple data streams from each HVAC data acquisition systems installed on board of each train coach. This setting can thus be regarded as a multiple stream process (MSP). Many control charts for MSPs can signal a change in the process but do not automatically identify how many and which stream(s) have shifted from the in-control state. To this end, an artificial neural network is trained to diagnose faults in an out-of-control MSP and its effectiveness is evaluated through a wide Monte Carlo simulation in terms of the correct classification percentage of the shifted streams. These results are also compared with those obtained by designing a control chart for each stream. The practical applicability of the proposed method is illustrated by means of real operational HVAC data, made available by the rail transport company Hitachi Rail STS.

Keywords

Fault diagnosis, Multiple stream process, Artificial neural networks

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