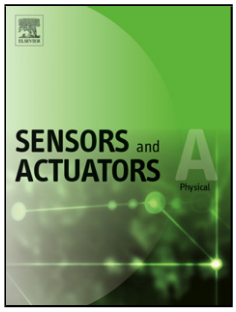

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Data Validation of Multifunctional Sensors Using Independent and Related Variables

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Abstract

To enhance the reliability of multifunctional sensors, a novel data validation strategy is presented by handling independent and related variables separately. The maximal information coefficient (MIC), which can measure the strength of the correlation between two variables, is applied to divide all variables of multifunctional sensors into related and independent. For one thing, the k-nearest neighbor (kNN) rule is introduced to accomplish fault detection and isolation of independent variables, and the grey predictive model GM(1,1), which has the advantages of low computation burden and high accuracy, is adopted to achieve data recovery of faulty independent variables. For another, the kernel principal component analysis (KPCA), which can handle possible non-linearity of data, is employed to realize fault detection of related variables. An iterative reconstruction-based contribution (IRBC) method is developed to isolate all faulty related variables, and data recovery of them are implemented using a fuzzy similarity (FS)-based reconstruction method based on the spatial correlations among related variables. An experimental system for multifunctional sensors is built to evaluate the proposed strategy, and the performance comparisons with its counterparts are also conducted.

Keywords: Multifunctional sensors, data validation, maximal information coefficient, kernel principal component analysis, k-nearest neighbor rule, fuzzy similarity

1. Introduction

High quality sensor measurements are preliminary requirements to monitor and control industrial processes. In the cases of two or more parameters have to be measured, multifunctional sensors have aroused widespread interest of scholars for their merits of compactness, low consumption and convenient processing compared to the regular sensors [1, 2]. Nowadays, multifunctional sensors have been widely applied in more and more engineering applications such as aerospace engineering, environmental engineering and chemical engineering [3–6].

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