Linköping studies in science and technology. Dissertations, No. 1162

Multivariate Exploration and Processing of Sensor Data - applications with multidimensional sensor systems

Henrik Petersson

Akademisk avhandling

som för avläggande av teknologie doktorsexamen vid Linköpings universitet kommer att offentligt försvaras i hörsal Planck, Fysikhuset, Linköpings universitet, fredagen den 12 september 2008, kl. 10.00. Opponent Johan Trygg, Umeå universitet, Umeå, Sverige.

Abstract

A sensor is a device that transforms a physical, chemical, or biological stimulus into a readable signal. The integral part that sensors make in modern technology is considerable and many are those trying to take the development of sensor technology further. Sensor systems are becoming more and more complex and may contain a wide range of different sensors, where each may deliver a multitude of signals.

Although the data generated by modern sensor systems contain lots of information, the information may not be clearly visible. Appropriate handling of data becomes crucial to reveal what is sought, but unfortunately, that process is not always straightforward and there are many aspects to consider. Therefore, analysis of multidimensional sensor data has become a science.

The topic of this thesis is signal processing of multidimensional sensordata. Surveys are given on methods to explore data and to use the data to quantify or classify samples. It is also discussed how to avoid the rise of artifacts and how to compensate for sensor deficiencies. Special interest is put on methods being practically applicable to chemical gas sensors. The merits and limitations of chemical sensors are discussed and it is argued that multivariate data analysis plays an important role using such sensors.

The contribution made to the public by this thesis is primarily on techniques dealing with difficulties related to the operation of sensors in applications. In

the *second paper,* a method is suggested that aims at suppressing the negative effects caused by unwanted *sensor-to*-sensor differences. If such differences are not suppressed sufficiently, systems where sensors occasionally must be replaced may degrade and lose performance. The strong-point of the suggested method is its relative ease of use considering large-scale production of sensor components and when integrating sensors into mass-market products. The *third paper* presents a method that facilitates and speeds up the process of assembling an array of sensors that is optimal for a particular application. The method combines multivariate data analysis with the 'Scanning Light Pulse Technique'. In the *first and fourth papers,* the problem of source separation is studied. In two separate applications, one using gas sensors for combustion controI and one using acoustic sensors for ground surveillance, it has been identified that the current sensors outputs mixtures of both interesting- and interfering signals. By different means, the two papers applies and evaluates methods to extract the relevant information under such circumstances.

•

Department of Physics, Chemistry and Biology
Linköpings universitet, SE-581 83 Linköping, Sweden

Linköping 2008

ISBN 978-91-7393-841-9 ISSN 0345-7524