

ELECTRONIC NOSES AND THEIR APPLICATIONS

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ABSTRACT

Electronic/artificial noses are being developed as systems for the automated detection and classification of odors, vapors, and gases. An electronic nose is generally composed of a chemical sensing system (e.g., sensor array or spectrometer) and a pattern recognition system (e.g., artificial neural network). We are developing electronic noses for the automated identification of volatile chemicals for environmental and medical applications. In this paper, we briefly describe an electronic nose, show some results from a prototype electronic nose, and discuss applications of electronic noses in the environmental, medical, and food industries.

INTRODUCTION

The two main components of an electronic nose are the sensing system and the automated pattern recognition system. The sensing system can be an array of several different sensing elements (e.g., chemical sensors), where each element measures a different property of the sensed chemical, or it can be a single sensing device (e.g., spectrometer) that produces an array of measurements for each chemical, or it can be a combination. Each chemical vapor presented to the sensor array produces a signature or pattern characteristic of the vapor. By presenting many different chemicals to the sensor array, a database of signatures is built up. This database of labeled signatures is used to train the pattern recognition system. The goal of this training process is to configure the recognition system to produce unique classifications of each chemical so that an automated identification can be implemented.

The quantity and complexity of the data collected by sensors array can make conventional chemical analysis of data in an automated fashion difficult. One approach to chemical vapor identification is to build an array of sensors, where each sensor in the array is designed to respond to a specific chemical. With this approach, the number of unique sensors must be at least as great as the number of chemicals being monitored. It is both expensive and difficult to build highly selective chemical sensors.

Artificial neural networks (ANNs), which have been used to analyze complex data and to recognize patterns, are showing promising results in chemical vapor recognition. When an ANN is combined with a sensor array, the number of detectable chemicals is generally greater than the number of sensors [1]. Also, less selective sensors which are generally less expensive can be used with this approach. Once the ANN is trained for chemical vapor recognition, operation consists of propagating the sensor data through the network. Since this is simply a series of vector-matrix multiplications, unknown chemicals can be rapidly identified in the field.

Electronic noses that incorporate ANNs have been demonstrated in various applications. Some of these applications will be discussed later in the paper. Many ANN configurations and training algorithms have been used to build electronic noses including backpropagation-trained, feed-forward networks; fuzzy ARTmaps; Kohonen's self-organizing maps (SOMs); learning vector quantizers (LVQs); Hamming networks; Boltzmann machines; and Hopfield networks. Figure 1 illustrates the basic schematic of an electronic nose.

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Electronic Noses Principles And Applications

Michel Renovell



Electronic Noses Principles And Applications:

Electronic Noses Julian W. Gardner, Philip Nigel Bartlett, 1999 This book aims to discuss the basic principles of an electronic nose and to provide an account of recent developments in this field with practical examples of its application It seeks to review the field together with the many new developments that have occurred since the first meeting was held on electronic noses in Iceland in 1991 It will be essential reading for anyone who is working researching or simply interested in electronic noses or machine olfaction A comprehensive appendix is provided at the end of the book *Electronic Noses* Julian W. Gardner, Philip Nigel Bartlett, The authors present an introduction to the basic principles of the electronic nose providing an account of recent developments in the field of artificial olfaction They include a number of examples of practical applications throughout the text Rapid and On-Line Instrumentation for Food Quality Assurance I Tothill, 2003-08-31 Many measurements of product and process characteristics have traditionally been off line involving removing the product and taking it to a quality control laboratory for analysis over a period of hours or even days However the development of faster more automated methods of production and the shift to more proactive quality and safety management systems such as HACCP has forced the food industry to look for more rapid methods with the potential for continuous real time measurement of products and processes With its distinguished editor and international team of contributors this important collection summarises key developments in this growing field Part one reviews the emergence of new methods for analysing food safety It includes chapters on the detection of foreign bodies other contaminants such as toxins pesticides dioxins and veterinary residues and rapid methods for detecting pathogenic and spoilage bacteria Part two discusses the measurement of product quality There are chapters on analysing ingredients such as additives and micronutrients genetically modified organisms and added water A number of chapters discuss methods for analysing food composition and the use of electronic noses to monitor food quality A final chapter reviews ways of integrating such measurements into effective process control Rapid and on line instrumentation for food quality assurance provides a benchmark of good practice in this important field and will be a valuable reference for the food industry Summarises key developments in the growing field of food quality assurance focussing on rapid and on line instrumentation Includes chapters on the detection of foreign bodies pathogenic and spoilage bacteria and other contaminants such as toxins pesticides dioxins and veterinary residues Discusses the measurement of product quality and analyses ingredients such as additives and micronutrients genetically modified organisms and added water Artificial Neural Networks in Food Processing Mohamed Tarek Khadir, 2021-01-18 Artificial Neural Networks ANNs is a powerful computational tool to mimic the learning process of the mammalian brain This book gives a comprehensive overview of ANNs including an introduction to the topic classifications of single neurons and neural networks model predictive control and a review of ANNs used in food processing Also examples of ANNs in food processing applications such as pasteurization control are illustrated Electronic Noses and Tongues in Food Science Maria Luz

Rodriguez Mendez, 2016-02-19 *Electronic Noses and Tongues in Food Science* describes the electronic products of advanced chemical and physical sciences combined with intuitive integration of microprocessors advanced bioinformatics and statistics. These include for example voltammetric bio electronic piezoelectric platforms made from a variety of components including nanoparticles enzyme biosensors heavy metals graphite epoxy composites metal oxide semiconductors microelectrodes microfluidic channels pre manufactured gas sensors redox enzymes and others and is an ideal resource for understanding and utilizing their power in Food Science settings. Devices used to analyse one particular food item can theoretically be adapted for other food items or components. This does not just mean the re deploying the physical platforms but also the mode of bioinformatic and statistical analysis. This includes artificial neural networks ANN linear discriminant analysis LDA partial least squares PLS principal component analysis PCA etc. In other words there is cross transference of chemistry physics concepts techniques findings and approaches from one food to another. Electronic noses and tongues are two of these devices but are advancing in application and importance. This book provides examples of the use of electronic noses and tongues to characterise components that contribute to sensory or compositional profiles from ripening to harvesting and from storage of raw materials to packaging and consumption. These devices are suitable for high throughput analysis quality control or to determine the nature and extent of spoilage and adulteration and have also been used to ascertain the geographical origins of food and mixtures. Presents latest developments in the application of electronic nose and tongue technologies to a variety of food specific needs. Includes both electronic nose electronic tongue and combined technology insights. Each chapter has sections on The physical and chemical platforms Analysis of specific foods Applications to other foods and areas of food science.

Electronic Nose Himanshu Patel, 2012-06 The sense of smell is one of our fundamental senses. Detection of smell plays vital role in wide range of industrial and domestic applications. Olfaction is a challenging new sensing modality for intelligent systems. With the emergence of electronic noses e noses it is now possible to train a system to detect and recognize a range of different odours. An electronic nose e nose is an intelligent sensing device that uses an array of gas sensors of partial and overlapping selectivity along with a pattern recognition component to distinguish between both simple and complex odours. To date e noses have had a variety of use in a number of applications from the food industry to medical diagnosis. In this book I have integrated the electronic nose working principle sensors used for E nose and overview of applications of E nose. For beginners as well researchers this book is a brief guide of E nose.

Agricultural and Food Electroanalysis Alberto Escarpa, María Cristina González, Miguel Ángel López, 2015-09-28 *Agricultural and Food Electroanalysis* offers a comprehensive rationale of electroanalysis revealing its enormous potential in agricultural food analysis. A unique approach is used which fills a gap in the literature by bringing in applications to everyday problems. This timely text presents in depth descriptions about different electrochemical techniques following their basic principles instrumentation and main applications. Such techniques offer invaluable features such as inherent miniaturization high

sensitivity and selectivity low cost independence of sample turbidity high compatibility with modern technologies such as microchips and biosensors and the use of exciting nanomaterials such as nanoparticles nanotubes and nanowires Due to the advantages that modern electroanalytical techniques bring to food analysis and the huge importance and emphasis given today to food quality and safety this comprehensive work will be an essential read for professionals and researchers working in analytical laboratories and development departments and a valuable guide for students studying for careers in food science technology and chemistry

Olfaction and Electronic Nose Matteo Pardo, Giorgio Sberveglieri, 2009-06-09 ISOEN addresses research in the fields of gas sensors and artificial olfactory systems In this edition we broadened the participation spectrum to all kinds of analytical instrumentation for odor measurement and to biological olfaction We also had a strong involvement in industry The audience comprises materials scientists chemists physicists engineers biologists computer scientists and application specialists e g food medical environmental security

International Workshop on Electronic Design, Test and Applications Michel Renovell, 2002 A collection of the 78 oral presentations and 24 poster papers from the January 2002 international workshop which brought together specialists from a broad area of electronic design manufacturing test and advanced system applications in the hope that the conference would integrate design test and application as cross dependent disciplines The contributions are organized into sessions focusing on analog test

communications digital signal processing and architectures low to high level fault simulation and identification high level design memory power issues in design and test sensor and analog design electrical engineering education electromagnetics and control fault tolerant digital systems image processing robotics submicron technology test generation and compaction and test techniques and methodologies Annotation copyrighted by Book News Inc Portland OR

Chemical Sensors Ghenadii Korotcenkov, 2011-11-02 Chemical sensors are integral to the automation of myriad industrial processes as well as everyday monitoring of such activities as public safety engine performance medical therapeutics and many more This massive reference work will cover all major categories of chemical sensor materials and devices and their general functional usage from monitoring and analyzing gases to analyzing liquids and compounds of all kinds This is THE reference work on sensors used for chemical detection and analysis In this final volume of the Chemical Sensors will be found the latest in new chemical sensor applications including remote chemical sensing for such applications as atmosphere monitoring new uses for electronic noses and tongues wireless chemical sensors and new future directions for chemical sensors in industry

agriculture and transportation Smart Structures and Materials, 2000 **Handbook of Machine Olfaction** Tim C. Pearce, 2003 Electronic noses that means instruments which mimic the sense of smell They are very useful for a remarkably variety of applications e g in food and pharmaceutical industry in environmental control or clinical diagnostics The book covers biological and technical fundamentals up to date research contributed by renowned international scientists as well as application oriented news from successful E nose manufacturers It is a unique standard work for scientists in research and

development and for users of electronic noses **Microsensors, MEMS, and Smart Devices** Julian W. Gardner, Vijay K. Varadan, Osama O. Awadelkarim, 2001 Microsensors and MEMS micro electro mechanical systems are revolutionising the semiconductor industry A microsystem or the so called system on a chip combines microelectronic circuitry with microsensors and microactuators This emergent field has seen the development of applications ranging from the electronic nose and intelligent ear to micro tweezers and the modern ink jet nozzle Providing a complete overview of microsensor technologies this unique reference addresses vital integration issues for the successful application of microsensors MEMS and smart devices Features include Review of traditional and emerging fabrication processes including bulk and silicon micromachining microstereolithography and polymer processing methods Focus on the use of IDT interdigital transducer microsensors in the development of low energy budget wireless MEMS or micromachines Coverage of the latest applications in smart devices including the electronic nose tongue and finger along with smart sensors and structures such as smart skin An overview of the development of intelligent sensing devices through the use of sensor arrays parametric compensation of sensor signals and ASIC technology Comprehensive appendices outlining vital MEMS material properties relevant web sites and a guide to key institutions active in the field Microsensors MEMS and Smart Devices presents readers with the means to understand and evaluate microsystems Advanced students and researchers in microelectronics engineers and developers of microsensor systems will find this comprehensive treatment essential reading Detailed coverage of material properties makes this an important reference work for mechanical engineers physicists and material scientists working in the field

Sensor Fusion: Architectures, Algorithms, and Applications ,2001 **American Laboratory** ,2005

Environmental Biotechnology - ISEB4 Piet Lens, Mark C. M. van Loosdrecht, 2000-05-31 Environmental biotechnology is set for an increasingly prominent role in tackling ecological problems Not only can it help to minimise the pollutant loads released into the environment but it may also help to boost the local carrying capacity of ecosystems in a holistic and ethically sound way These concepts were addressed at the ISEB 4 symposium which brought together scientists approaching environmental biotechnology from different basic disciplines along with technologists and regulators dealing with environmental quality This issue contains selected papers from the symposium Sections cover biodegradation and bioconversion microbial community structure nitrogen and phosphorus removal sensors modelling and control integrated treatment concepts air treatment flocs and granules and sulphur and metals Some papers deal with fundamental processes others are technologically orientated These techniques may be the building blocks for a new generation of environmental biotechnological applications i e clean production processes and closed water and resource cycles All together this issue gives a clear overview of the current state of the art of environmental biotechnology It also illustrates the big role environmental biotechnology will play in future sustainable development of both the developed and developing countries

Handbook of Optical Fibre Sensing Technology José Miguel López-Higuera, 2002 The pursuit of more efficient

telecommunications has resulted in a major research push towards communication systems that are lighter faster more reliable and cheaper This has given rise to great advances in devices and in fibre optics A spin off of this research is the development of optical sensors which use photonic materials and concepts Optical sensors have wide ranging applications in various fields including telecommunications civil engineering chemical industry biomedical applications and the electrical power industry This comprehensive handbook written by a wide spectrum of leading international researchers offers a clear understanding of the theory as well as focusing on the many practical applications throughout the industry The book is organised into four main sections Preliminary Offers an overview of Fiber Optic Sensing Technology the applications where it can be used successfully and also serves as an overall introduction to the handbook This section also analyses current publications in the field Fundamentals of Photonics and Components for Sensing Describes the photonic concepts and components needed in order to carried out the understanding the design and to realise photonic sensor systems Principles and Techniques for Sensing Provides the principles and techniques in which the photonic sensing technology is based in order to understand how sensors work and how sensors can be made Applications An ample overview of the developments which are successfully taking place in laboratory and field trials as well as the available sensors in the current market and the future trends in this field Applications are featured throughout the text and this section focuses primarily on niche applications This handbook would prove to be a valuable reference resource for researchers engineers and postgraduate students in fibre optical sensing as well as practising engineers in optical communications and electronic engineering civil engineering aerospace industry biomedicine and robotics

Chemistry and Industry ,2000 Proceedings of the 8th International Controlled Atmosphere Research Conference ,2003 **McGraw-Hill Yearbook of Science and Technology** McGraw-Hill,2005-12 From one of the most trusted sources for high quality information authoritative reviews of the most significant recent developments in science and technology Edited and illustrated for clarity and ease of understanding by non specialist and expert alike

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