Preface

Biologically inspired approaches for artificial sensing have been extensively applied to different sensory modalities over the last decades and chemical senses have been no exception. The olfactory system, and the gustatory system to a minor extent, has been regarded as a model for the development of new artificial chemical sensing systems. One of the main contributions to this field was done by Persaud and Dodd in 1982 when they proposed a system based on an array of broad-selective chemical sensors coupled with a pattern recognition engine. The array aimed at mimicking the sensing strategy followed by the olfactory system where a population of broad-selective olfactory receptor neurons encodes for chemical information as patterns of activity across the neuron population. The pattern recognition engine proposed was not based on bio-inspired but on statistical methods. This influential work gave rise to a new line of research where this paradigm has been used to build chemical sensing instruments applied to a wide range of odor detection problems.

More recently, some researchers have proposed to extend the biological inspiration of this system also to the processing of the sensor array signals. This has been motivated in part by the increasing body of knowledge available on biological olfaction, which has become in the last decade a focus of attention of the experimental neuroscience community. The olfactory system performs a number of signal processing functions such as preprocessing, dimensionality reduction, contrast enhancement, and classification. By mimicking the olfactory system architecture using mathematical models, some of these processing functions have been applied to arrays of broad-selective chemical sensors.

The latests advances in this area where presented in the GOSPEL Workshop on Bio-inspired Signal Processing held in Barcelona 2007. This workshop gathered for the first time researchers working on bio-inspired processing for chemical sensing from around the world. One of the outcomes of this workshop was the project of bringing together research contributions of this field in a book. This volume is composed of extended versions of some contributions to the workshop plus some additional contributions from other experts in the field.

The book is organized in two sections: biological olfaction; and artificial olfaction and gustation. The first section focuses on the study and modeling of the processing functions of the olfactory system. In Chapter 1, the author revises the insect olfactory system from an information processing point of view. In Chapter 2, a signal processing

architecture based on the mammalian cortex is proposed. In Chapter 3, the author presents an experimental work to understand the high sensitivity of insects. In Chapter 4, the authors have performed non-invasive recordings of the olfactory bulb activity and present a technique to analyze the chemical information on these recordings. The second section is devoted to bio-inspired approaches to process chemical sensor signals. In Chapter 5, the authors propose a sensor chamber based on the olfactory mucosa that improves odor separation through temporal dynamics. In Chapter 6, the authors use a model of olfactory receptor neuron convergence to improve the correlation between sensor responses to an odor and his organoleptic properties. Chapter 7, the authors propose a method to convert chemical sensor signals to spike trains along with the processing of the signals based on the receptor neurons convergence. Chapter 8, the authors analyze the signal processing needs of an artificial chemical sensing system to detect malodors in open environments. In Chapter 9, the authors propose a chemical detection system for chemicals in liquid solution based on voltametric sensors.

We would like to thank the authors of this volume and the reviewers that helped to improve the quality of the chapters. We are also grateful to Springer's editorial staff, in particular to Professor Janus Kacprzyk that encouraged us to produce this scientific work. We also like to thank the network of excellence GOSPEL FP6-IST 507610 for its support in organizing the Workshop on Bioinspired Signal Processing. We hope that the reader will share our excitement on this volume and will find it useful.

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