Preface

Although a human interface for vision and audio has been already been developed, an olfactory interface has not. However, people are becoming interested in olfaction as the next-generation human interface. A human interface for olfaction is composed of an olfactory display and an odor sensing system called an electronic nose. An olfactory display is an output of a machine, whereas the odor sensing system is its input. These are important to realize a human olfactory interface. Since an odor sensing system has been studied for last two decades, the researcher population is relatively large. An international conference of machine olfaction is held every two years. However, there are not many olfactory-display researchers, since the olfactory display only recently evolved in virtual reality. Although both fields have been studied separately, it is indispensable to see and understand both the olfactory display and the odor sensing system for developing human olfactory interfaces and their applications.

This is the first book to describe the entire human olfactory interface, including the olfactory display. This book introduces a new interface to researchers and developers in the area of human interface as well as researchers in the sensor field. It may also offer resources to developers in industries such as consumer electronics, electronic instruments, communications, virtual realities, foods, beverages, fragrances, chemicals, medicals, advertisements, amusements, and games. Final year undergraduates and graduates in the fields related to those above may read this book as an accessible starting point to understanding human olfactory interface.

This book is divided into two sections. The first section is composed of six chapters and provides the fundamental knowledge. Beginners can start learning human olfactory interfaces through this section. Even experts can update their knowledge, since this new field is progressing rapidly. People can use this section like a bible of human olfactory interface.

The second section is composed of 18 chapters and shows a variety of the latest studies in human olfactory interfaces, such as the technologies for both odor sensing and its presentation. People can learn the latest technologies through many case studies. This section describes materials and devices for sensing technologies, signal processing techniques, their application, and the evaluation techniques of human perception. Then, devices for olfactory display, evaluation techniques of olfactory display, and odor reproduction are explained. People can learn a variety of aspects of human olfactory interfaces through this section. Each chapter is briefly introduced below.

Chapter one is a very nice introduction of the physiological aspect of engineering. It describes olfactory receptors and the first stage of signal processing in the brain, the olfactory bulb. Chapter two then describes the basic characteristics of human olfaction, such as olfactory acuity, threshold, adaptation, and olfactory disorders. Moreover, it shows new non-invasive measurement techniques of brain activities related to olfaction.

Chapter three introduces the fundamentals of olfactory display, such as scent generation, scent delivery, and evaluation of olfactory display. Much information for olfactory-display beginners is available
in this chapter. Chapter four shows multimodal interaction of olfaction with other senses, such as vision and gustation. The cross-modal interaction between olfaction and vision can expand the range of scents using a small number of actual odors. Furthermore, the olfactory stimulus enables the pseudo-gustatory experience.

Chapter five introduces the fundamentals of the odor analysis method, such as sensory evaluation, gas analysis instruments, devices for odor sensing systems, and pattern recognition techniques. This chapter is a good introduction for beginners in olfactory display as well as those of sensing systems. Chapter six shows the combination of odor sensing system with an olfactory display called an odor recorder. Since a variety of odors can be expressed using the mixture composition of odor components, it shows the overview of the mixture quantification techniques, followed by the case studies of odor recording.

Then, individual studies are described in section 2. Chapters 7 and 8 show sensing materials coated with quartz crystal microbalance. Radio frequency sputtered organic films in chapter seven and polymeric nanomaterials in chapter eight have interesting sensing properties. Chapter nine describes the microcantilever array combined with a preconcentrator. The theory, the experimental setup, and the experimental result are shown in this chapter. Chapter ten introduces a spherical surface acoustic wave sensor coated with organic film. The device enables a long propagation path compared with conventional surface acoustic wave sensors in spite of its compact size. Chapter eleven shows the technique of real-time mass spectrometry. High-throughput detection of explosives has been successfully demonstrated.

Chapters 12 and 13 explain the system of electronic noses. The electronic mucosa in chapter twelve utilizes signals in spatio-temporal domain to raise the sensing capability. Chapter thirteen shows the application of an electronic nose to the environmental monitoring at the International Space Station for seven months.

Chapters 14 to 16 study the issues of data analysis in the odor sensing system. Chapter fourteen shows the mathematical method to increase the robustness against sensor drift. Chapter fifteen provides the method of exploratory data analysis to check the data quality, to calculate the statics, and to obtain the data structure easily. Chapter sixteen shows the method to suppress the influence of background smells mimicking the biological adaptation characteristics.

Then, objective evaluation methods of human perception are described in chapters 17 and 18. Chapter seventeen shows the salivary biosensor to detect the sedative state induced by fragrance. Chapter eighteen explains near-infrared spectroscopy to monitor cortical response to flavoring. The adaptation of cortical responses is used to measure the similarity between the flavors.

Chapters 19 to 23 are related to an olfactory display. Chapter nineteen describes a scent generation device called an aroma chip. The surface of a chemical container is composed of a functional polymer gel for controlling release of a scent utilizing its phase transition between sol and gel. Chapter twenty shows an olfactory display based upon an inkjet printer mechanism. Since it enables the emission of scent pulse for a short time, various olfactory characteristics can be measured. Chapter twenty-one shows the combination of the fluid dynamics simulation with olfactory display. The scent with concentration, at any point in virtual space, calculated by the simulator is emitted using an olfactory display.

Chapter twenty-two shows the interaction of image with olfaction and its evaluation. The method of scent emission through the display screen and the psychological effect evaluated by point-of-gaze measurement are described. Chapter twenty-three explains the empirical study focusing on the influence of olfaction to augment multimedia application.

Chapter 24 describes odor reproduction using odor code extracted from molecular informatics. The concept of odor reproduction using the odor code is discussed.
Plenty of topics from various aspects, such as physiology, odor perception, cross-modal interaction, devices and signal processing methods of odor sensing systems, and devices and evaluation of olfactory display are provided. Readers can learn almost all the issues in the human olfactory interface. Since this is the first book to cover the whole human olfactory interface, it is expected to become a distinguished reference in this field.

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