Odor Source Shape Visualization by Multispectral Fluorescence Sensing

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***Abstract*—A multi-probe based multispectral fluorescence imaging sensor was developed to visually discriminate odor sources in environment. The sensing mechanism was based on the complicated fluorescence interactions of between the multi-probes and the probes with odor molecules. The fluorescence change of a probes-containing gel film caused by odorant substances was recorded by CCD camera to visualize the shape of odor source. In this work, odor sources with complicated shapes were used to investigate the spatial resolution of the imaging sensor. The result demonstrated that the spatial resolution of our sensor has discrimination ability higher than 5 mm. In addition, the concentration estimation of each odorant in mixed odor sources was attempted. By using principle component analysis (PCA) and multiple regression analysis, the individual concentration of an acid/aldehyde mixed odor sources was analyzed successfully.**

Keywords—sensor; odor; fluorescence; odor visualization; multispectral imaging

I. Introduction

We are living in an environment surrounded by odors. The odor information includes the quality of odors, the intensity of odors, and the spatial distribution of odors in environment. From the viewpoint of substance, the odor is various chemical mixture gas, which have various concentration and distribution. On the other hand, the odor information also include indirect information related to odor source, e.g. subject; age, health status, something, freshness, toxicity or location. For example, some research has indicated that the body odor is related to health and aging status [1]. The freshness of tomato can be judged by the smell emitted during the growth process [2]. An information as substance is measured by gas or odor sensor, and the various information can be acquired through proper analyses. However, it is difficult simultaneous to obtain all of these information by using conventional odor sensors. H. Ishida at al. proposed a method to find a gas/odor source in which a portable gas sensor array was used to visualize the flow of a target gas [3] [4]. In this case, the quality of odors can not be detected because homogeneous sensors was used. On the other hand, S. H. Lim at al. developed a simple color metric sensor array that can detect a wide range of volatile analyses [5]. This concept is same as electronic nose, which utilize gas sensor array which have each different property [6] [7]. In this case, the spatial distribution of odors can not be detected due to its low resolution. It is a great challenge for the existing sensors to hold the ability that can both discriminate and visualize the complex odors in environment.

Recently, we developed a fluorescent imaging sensor, which can be used to visualize the spatial distribution of odors in environment and to discriminate the quality of odors [8] [9]. The sensing mechanism is based on the fluorescent interaction of odors with fluorescent probes, such as fluorescence resonance energy transfer (FRET), photoinduced electron transfer (PET), or matrix effects such as solvent and pH effect. The fluorescent change of a sensing film caused by the odor chemicals are recorded by a high sensitive CCD camera and visualized by using an image processing software. By using multiple fluorescent probes and PCA, we had revealed that fluorescence change with odorant depend on chemical structure [10]. Discriminating odorants as chemical structure, multispectral fluorescence change imaging of odorants will lead to various applications. In this work, we visualized odor source shape. Then, spatial resolution of visualization was revealed. Moreover, concentration estimation of odorants in odor source performed by using multiple regression analysis.

II. Experimental

A. Visualization of Odor Source Shape

First, the visualization of odor source shape was demonstrated, and the spatial resolution of our fluorescence image sensor was indicated. A hot agarose solution consisting of multiple fluorescent probes was poured into the mold, and cooled to form the fluorescence sensing film. Quinine sulfate, tryptophan, eosin B and rhodamine B were used as the fluorescent probes. Odor sources were prepared by two processed papers absorbed different odorants, which are hexanoic acid and salicylaldehyde. These odor sources are shown in Fig. 1. The agarose fluorescence film was then close to the odor sources with a distance of 5mm. After an exposure time of 60 s, the image of the fluorescent film was taken and compared with that before the odor exposure. Optical wavelength of 340±40nm, 350±50nm and 450±50nm were set at the light source side to provide the excitation light. At the camera side, the spectroscopic imaging was realized by using interference filters with wavelength of 380±5nm, 420±5nm, 510±6.3nm and 530±6.8nm.

B. Estimation of Each Concentration