Odor Sensor System for Early Fire Detection and Its Application to Utility Mobile Robot

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Odor sensing systems have attracted much attention in recent years, because of being required to develop an objective evaluation method for odors instead of a human sensory test. The odor sensing systems, called the electronic nose (e-nose) systems have been applied to various areas (e.g. food processing area, medical area, welfare area, etc.) [1]. The areas applied the e-nose systems have been expanded increasingly, and several applications in the areas of odor sensing systems can be found in literatures [2, 3].

In this paper, we demonstrate an odor sensing system for early fire detection. It is known that fire alarm systems generally sense smoke, heat and flame to detect fire. The detectors, however, cannot detect initial stage of fire. Then we develop an odor sensing system for early fire detection by using commercially available metal oxide odor semiconductor (MOS) sensors. Here we consider house fire as the target detected by the sensors and, especially, we discuss the fire caused by a cigarette. It is show that sensing a generation of hydrogen in an incomplete burning can be utilized to detect the early stage of fire. We made experiments in using the sensors in a chamber and the room which was assumed as a more practical environment. Here we aim the fire caused by a cigarette, therefore the odor of the burning tobacco is used as the target odor. The odors assumed to generally exist in the house are used as the disturbing odors. The odors are generated in two ways. One way is generating a single odor, separately. The other way is generating two odors with an interval of several minutes, sequentially. Commercial MOS-type sensors of five types (New Cosmos Electric Inc.) were used in this experiment. Each sensor is characterized by the sensitivity to hydrogen, ammonia, hydrogen sulfide, Volatile Organic Compounds (VOC) and various odors widely. With the above sensors, the sensor array is constructed. The sensor array generates the response pattern to the odors, which typical response patterns are shown in fig.1 and fig.2, which the responses to the target odorants can be characterized by the response of the CH-H type sensor with a selectivity of hydrogen.

Figure 3 shows the result of the principal component analysis (PCA) using the sensor response pattern constructed by the sensor array output sampled at 7 minutes after stating the experiments. The measurement data were obtained by experiments in the room (6m×12m×3m). The measurements using two odors were obtained by generating a second odor with 1 minute after generating a first odor. The result shows that the target odor, that is, tobacco, can be discriminated from the disturbances. The response patterns to the target odor were different from the responses to the disturbances, which was characterized by the response to the hydrogen. Though the concentration of the target odor is increasing, the one of the disturbances are constant or decreasing. Thus the response pattern to the mixtures was similar with the response to the target. Therefore the mixtures using the target odor can also be isolated from the other odorants. The detection of the generation of hydrogen could be utilized to discriminate fire from the disturbances. We also applied the sensing system to the odorants generated by burning some materials, that is, cellulose, polyethylene and nylon. Then we see that the proposed system can also be discriminated the odorants generated by burning materials from the disturbing odorants. The system was applied to the mobile utility robot named “Banryu” (tmsuk, Inc.) [4].

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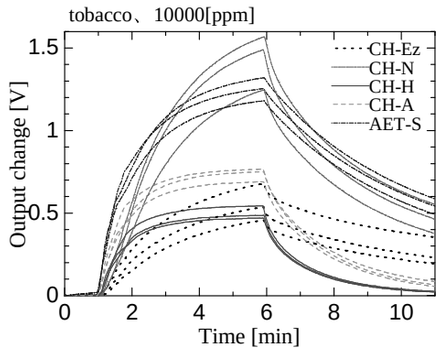

Fig.1 Response to the odor of the burning tobacco in the chamber

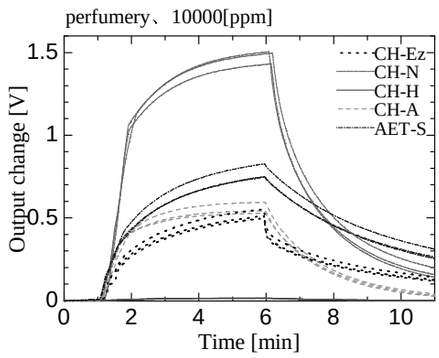

Fig.2 Response to the odor of the perfumery in the chamber

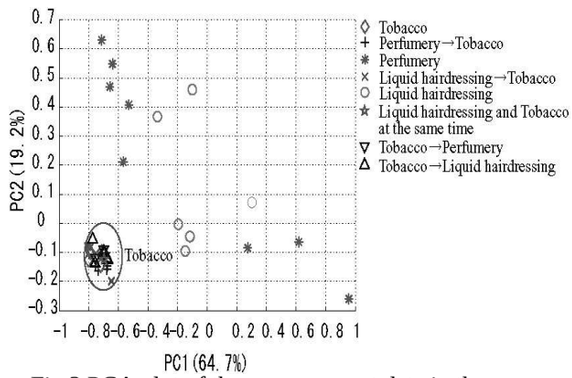

Fig.3 PCA plot of the measurement data in the room