ANN Based Approach to Integrate Smell Sense in Multimedia Systems

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ABSTRACT

Despite the wide usage of multimedia in several applications, research in the field of olfaction is immature in helping humans work and communicate through multi-sensory interfaces, including smell. There is no consistent method of testing user capability of smell. Therefore, smell detection and generation systems are not well integrated into today’s multimedia systems. In this paper, the authors propose an odor sensing system with the capability of the discrimination among closely similar 20 different odor patterns and propose an on-line classification method using a handheld odor meter (OMX-GR sensor) and neural network that can be used in different multimedia applications. The proposed system is integrated to enhance the functionality of an online multimedia shopping system that is capable of selling products with visual and auditory senses.

Keywords: Multi-Sensory Systems, Multimedia Systems, Odor Sensing System, Olfaction, Smell Detection

1. INTRODUCTION

The Multimedia systems are widely defined as Multi Sensory systems that convey information about the current state of the real world environment by congregating signals from several receptors in the ears, eyes, and other sense organs. The signals from one side of the body are sent through nerve fibers to the cerebral cortex on the opposite side of the brain, where they are perceived and interpreted in terms of our previous experiences, knowledge, and expectations. The five well known physiological systems that lie at the core of the human perceptual experience are Olfactory (smell), tactile (touch), visual (sight), auditory (sound), and perception of flavor (taste). Nonetheless, extensive research has been carried out to develop multimedia systems that can capture, store and reproduce sound and video with high quality (Paeda et al., 2008; Pfeiffer, Lienhart, & EfIsberg, 2001). However, there are the other three senses, smell, touch and taste that received less attention within the multimedia research area. These senses, in addition to sight and sound, can recreate an environment similar to the real world environment in particular the smell sense. This is because amongst the three other senses the smell is the only sense that can be perceived from a long distance.

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Nonetheless, few odor-sensing tools have been proposed in limited applications. This is because of the complexity on designing olfactory system that can perceive different smells for humans with a variety of preferences. Table 1 presents some of these limited applications from the literature.

However, these systems are barely designed to fit on the industrial applications to reduce the cost of productions or prevent risks and hazards when handling toxic gases. Therefore, the implementation cost for these aforementioned olfactory systems is irrational for multimedia systems. In this paper, therefore, we present the design of a low cost odor system that can be employed in a multimedia environment. The odor system proposed in this paper has employed the Artificial Neural Network (ANN) technique of humans brain to discriminate amongst different smells. The organization of the paper is as follows: Section 2 presents a brief description of the human olfactory system and Section 3 provides a summarized overview of ANN techniques. Section 4 presents a justification of the ANN usage in smell sensors. The proposed system is presented in Section 5. The performance evaluation and conclusions are presented in Sections 6.

2. MODELS OF THE OLFACTORY SYSTEM

The goal of much of the research regarding the olfactory system is to understand how individual odors are identified. Many researchers have produced mathematical models of the olfactory system. These models often include simulations of the neurobiological information processing systems (biological neural networks). The olfactory information is processed in both the olfactory bulb and in the olfactory cortex. Figure 1 illustrates the main information processing structures within the brain. The olfactory cortex performs pattern classification and recognition of the sensed odors. Once identified, odor information is transmitted to the hippocampus, limbic system, and the cerebral cortex. The connection to the hippocampus explains why odor can sub-consciously evoke memories. Conscious perception of the odor and how to act on the odor takes place in the cerebral cortex (Li & Hopfield, 1989). The mammalian olfac-

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**Table 1. Limited applications from previous research**

<table>
<thead>
<tr>
<th>Application</th>
<th>System Specification</th>
<th>Year</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>agricultural</td>
<td>single coated thermistor as the odor sensor</td>
<td>1961</td>
<td>(Moncrieff, 1961)</td>
</tr>
<tr>
<td>smell detector</td>
<td>an array of eight electrochemical sensors</td>
<td>1964</td>
<td>(Wilkens &amp; Hartman, 1964)</td>
</tr>
<tr>
<td>Electronic nose</td>
<td>pattern recognition techniques</td>
<td>1994</td>
<td>(Gardner &amp; Bartlett, 1994).</td>
</tr>
<tr>
<td>polymer gas sensors</td>
<td>an integrated circuit based device that performs data acquisition from a miniature array of 32</td>
<td>1994</td>
<td>(Hatfield, Neaves, Hicks, Persaud, &amp; Travers, 1994)</td>
</tr>
<tr>
<td>An Intelligent E-nose</td>
<td>of measuring signals from arrays of resistive and piezoelectric sensor types in the same board</td>
<td>1997</td>
<td>(Dyer &amp; Gardner, 1997)</td>
</tr>
<tr>
<td>Robot head that reacts to some smells</td>
<td>A recognition algorithm that uses a look-up table that contains sensor outputs and their derivatives</td>
<td>2001</td>
<td>(Miwa, Umetsu, Takanishi, &amp; Takanohu, 2001)</td>
</tr>
<tr>
<td>chemical industry to detect toxic gases and gases without smell</td>
<td>The sensor electronics is based on a scanning version of a vibrating capacitor (Kelvin probe)</td>
<td>2002</td>
<td>(Li &amp; Hopfield, 1989; Mizsei &amp; Ress, 2002)</td>
</tr>
</tbody>
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