The Olfactory Display of Abstract Information

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ABSTRACT
I am exploring the use of computer-generated scents to convey information. I present a brief overview of previous use of smell in HCI and elsewhere, and current technology and product advances that enable this research. Two works-in-progress are presented, exploring ambient activity & presence awareness, and abstract data representation. I discuss implications for future olfactory information display.

Keywords
Smell, scent, ambient media, presence awareness, activity awareness, communication, calm technology.

INTRODUCTION
William Buxton speculated about what conclusions a future anthropologist would draw about our physical make-up, from the tools (computers) used by our society. [3] He pointed out that modern computing fails to take advantage of certain aspects of our physical abilities and reflects a very distorted view of our senses. He mentions the absence of pressure sensors, or any adequate use of our extensive auditory abilities. And, I conjecture, our future anthropologist would conclude we had no olfactory skill at all.

Previous work has adequately demonstrated the value of ambient media. [4,6,10] Ambient media has the property of moving seamlessly from the periphery to the focus of our attention and back again. Scent is arguably the quintessential form of ambient media. It can exist quietly in the background, unnoticed by our conscious mind, but can bring itself to our attention when necessary - such as the invariably alarming odor of burning electrical insulation. In particular, smell has the potential for use in situations where our audio and video channels are unavailable, due to physical impairment or occupation by other tasks.

Current Technology
A number of companies (notably Digiscents and TriSenx) have recently announced plans to produce computer-controlled devices that output smell. Their literature proposes scented websites and smelltracks for DVDs or games. However, as the accuracy of smell reproduction - even in conventional fragrance applications - is less than perfect, it will not necessarily be possible to produce, on demand, the exact smell desired. Furthermore, the refresh rate of these devices will not and cannot match that of audio or video.

Smicons
For this reason, I feel the optimal use of the current near future's smell emission technology is in generation of a smell icon, or 'smicon:' a release of scent to convey information about an event or condition. Smicons recognize and allow for the limitations of the present & near future's state of the art in scent emission technology. The advantage of the smicon is that the scent emitted need not necessarily be intrinsically correlated with the event being displayed. For example, you could choose to smell cinnamon as you leave your door in the morning if there is heavy traffic on the way to work, so that you know to take the back way.

How We Smell: A Brief Primer
A brief understanding of the mechanism of smell is necessary to understand some fundamental facts about how computer generated smell can and cannot function.

We have approximately a thousand different kinds of receptors in our nose, each of which reacts to a small group of odours. Any given molecule will combine with some number of receptors to varying degrees and produce a characteristic response. An entirely different smell will combine with another but perhaps intersecting set of receptors, each to a varying degree. It is for this reason that smell is fundamentally not additive: smell A and smell B combined will not necessarily smell like A and B, but can smell like C, an entirely different scent. The nature of smell C can only really be determined by experimentation.

Compare this to vision, in which we have only four different kinds of receptors - red, green, and blue cones plus rods. This is the fundamental problem of computerized - indeed, all - smell production. [7]

PREVIOUS USES OF SMELL
We have evolved to use olfaction to sense information about our environment. Information about burning, what's being cooked, food freshness, and disease diagnosis can all be conveyed using smell. Abstract uses of smell, in which the scent is not directly correlated to the data conveyed, are more rare. Historically, temples in Japan and China usid incense clocks. A line of incense was prepared such that it

would burn for an hour; a second, different, incense would then burn for the next hour, and so on. In such a way, one could tell time to the hour with a sniff. [2] Gaver & Strong use scent emission to let the user know a loved one is thinking of them.[8] Tillotson has researched clothes that emit smell, primarily for health and wellness applications; however, no fully working devices have been built.[9]

The Scent Organ depicted in *Brave New World* [5] remains a literary construction, but scent has been used on a number of occasions in conjunction with other media. These include film (notably AromaRama, Smell-O-Vision, and *Polyester*), museums, and a small variety of virtual reality situations, notably for firefighter training. [1]

BUILT PROJECTS

inStink

Patricia is working late at the office. She starts to smell turmeric, cumin, and cardamom wafting across her desk. That's right: she promised she'd be home tonight for dinner. Her husband Jose is cooking Indian food and the neighbors are coming over. Better finish up that email and head home.

inStink is a system that explores the use of aroma to convey ambient presence and activity awareness. The input device is a spicerack, which looks and feels like a regular spicerack, sitting in a kitchen. At internet distance away, perhaps in an office, sits the output device: a system of airbrushes, each of which has a diluted essential oil corresponding to the spices in the rack. When a spice is used, the corresponding scent is sprayed into the air.

The relationship between the spices output and the food cooked is a synecdoche of smell: representative parts stand for the whole. Cinnamon and ginger and nutmeg imply gingerbread - but perhaps apple pie, or spice cake. There is an obvious difference between the food implied by those scents and that suggested by tumeric, cumin, and cardamom. However, there is a direct relationship between the spice used in cooking and the scent emitted; inStink only begins to explore issues of abstraction.

Dollars & Scents

Dollars & Scents is an attempt to reproduce previous ambient media research in a different medium. Wisneski [10] explored ambient display of stock market changes through a personal device held in the pocket that would heat up or cool down depending on the state of the market. Dollars & Scents takes an identical input, but instead releases scents into the air: roses if the market is going up, and lemons if it is going down.

DISCUSSION

inStink and Dollars & Scents are both explorations in using smell to convey information. I don't consider them complete user interfaces, and they currently remain untested, but feel there is a great deal of potential in the field. A simple 1-bit scent output device can be made with a PIC chip, a transistor, a solenoid and an (optionally refilled) spray perfume bottle. While realistic commercial solutions remain unavailable, such an arrangement can provide an opportunity for experimenters in the field of HCI to explore the role of aroma in their interfaces.

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