ABSTRACT
Human Computer interaction is typically constrained to the use of sight, hear, and touch. This paper describes an attempt to get over these limitations. We introduce the smell in the interaction with the aim of obtaining information from scents, i.e. giving meaning to odours and understand how people would appreciate such extensions. We discuss the design and implementation of our prototype system. The system is able to represent/manage an immersive environment, where the user interacts by means of visual, hearing and olfactory informations. We have implemented an odour emitter controlled by a presence sensor device. When the system perceives the presence of a user it activates audio/visual contents to encourage engaging in interaction. Then a specific scent is diffused in the air to augment the perceive reality of the experience. We discuss technical difficulties and initial empirical observations.

Categories and Subject Descriptors
H5.2 [Information interfaces and presentation]: User Interfaces. - Graphical user interfaces.

General Terms
Design, Measurement.

Keywords
Multi-sensory interaction.

1. INTRODUCTION
In real life human beings interact with the world and with each other in a multisensory way. They perceive their surroundings through all five senses, leading to a deeply detailed perception. The history of HCI is mainly built over the visual communication channel. Additional auditory and haptic interaction came later and are still regarded as optional companions of the former. Only in rare cases attempts have been made to model multisensory environments. In these environments the authors tried to achieve systems where the user is encouraged to get involved in 360°. There are several application fields where it could be an important limit to receive information only through the visual, auditory, and tactile channels. Examples about these applications are: simulation environments, e.g. for the firefighter training work [8]; the use of olfactory icons to show events (Microsoft’s smicons); applications in wellness, such aromatherapy [5], multisensory rooms designed for the care of newborn babies or old people [9], and applications in cultural environments such as interactive multisensory museums [4]. However, many aspects are still open in terms of technological research, design and evaluation. This work introduces a prototype of interactive multisensory environment, built over computer vision techniques for motion detection, multimedia contents and actuators able of spraying aromas in the air. Our main goal is to experiment with this setup while collecting problems and exploring opportunities about unrolling a fully immersive walk, look and smell path. We are developing two specific scenarios:

• The implementation of an interactive wine museum;
• The representation of the whole year cycle catching the sensations of changing seasons.

We claim that planning to layout these interaction scenarios without the olfactory component, would be not enough satisfactory for the full sensorial experience. We support our claim saying that when you try to create such a full sensorial experience, it is necessary, somehow, to use a consistent percentage of stimuli present in real situations [10]. Moreover, the sense of smell has the important function of adding a profusion of information to the perception, and mainly to modify the human’s emotional state [2, 6]. It is, thus, essential to support applications widely developed and used, with the sense of smell that is the most primitive among the human perceptions. The rest of the work is organized as follow: in section 2 we describe the state of art in the field of olfactory interaction; in section 3 we specify the system ar-
Olfactory displays do the inverse task as electronic noses do. These devices are designed with the goal of synthesizing scents from a digital description [7]. Olfactory displays are used in real life applications, such as, for example, “Incense Clock” of Japan and China life [8]. Olfactory displays are widely used as therapeutic devices in aroma therapy area, “aroma-chology” [5]. These projects are based on the idea that some scents stimulate good feelings in human beings like positivity, creativity, perspicacity. It is this quality of scents that is mostly tried to be reproduced using electronic systems. It dates back to the 50’s the attempt to use smell in interactive system, with its introduction in cinemas world [8] as an advertising campaign to bring back people to the cinema, after the advent of television. Films were complemented with 3D goggles, vibrating seats and scents emitters. The aim was to provide people with a new approach to the plot. Even if the “scented films” were not a success, the same technologies have been applied in environments of virtual reality. A seminal example is Sensorama, “an immersive virtual reality” [11], using 3D vision, vibrating seats, and scents, to reproduce real life scenes, such as motorbike ride, or a walk in a flower garden. Another example of virtual reality, as already cited, is the firefighter training developed by Carter and described by Zybura and colleagues in [14]. He focused his work in managing scents emission in quantity and quality; he says “olfactory output is completely proportional from hint of odor to a stench that makes you want to rip the mask off ...”. The sense of smell was also introduced in closed spaces, as museum and exhibitions, with the goal to create scents that could help visitors to remember the focus of our interests here; we will see an overview of these only.

2. STATE OF THE ART

Making an application that includes the sense of smell within the channels of communication with the user requires one to venture into largely unexplored area; that is due, mainly, to the trouble to understand how the brain is able to elaborate information received by the sense of smell [12], and, afterward, in which application area it’s useful to add these kind of interactions.

The smell allows us, easily, to draw the attention and to focus on what it’s considered important; Kaye suggests a sort of similarity between olfactory displays and “Calm Technologies” [13], suggesting that the perception of a scent changes quickly from the background to the foreground of our attention, and such changes in environmental scents could quickly attract one’s attention [8]. Typically, there are two macro areas in HCI in which one can find smell included:

1. Using smell as input with the creation of sensors able to identify the constituents molecules of a complex scent by using of pattern recognition algorithm and that can return this representation of the scent in a digital format; this is the main task of electronic noses; they obtained a large success in the past two decades and found a large usage in food and wine industries [3];

2. Reproduce scents by means of electronic devices; this is the main task of olfactory displays and its developments; in this way smell is an output channel and it is the focus of our interests here; we will see an overview of these only.
easily all the information acquired during the exhibition [1]. This idea was used in famous museums as Natural History Museum in London, Bow Street Old Whiskey Distillery in Dublin, Jorvik Viking Museum New York. Pletts Haque realized an artistic installation where she used colors and scent to mark off an exhibition area [8]. We can see examples in which smell completes the information received from other senses. The idea to provide information by the sense of smell was also realized in other applications such as “smicon” [7], where every scent is conventionally associated to the semantics of an information. For example Microsoft used this idea to create an extension of Outlook in which the sender of an email can be recognized by a smell that is emitted when a message arrives [7].

3. OUR PROPOSAL

As we mentioned before, we describe here a prototype of an interactive multisensory system, supported by presence sensors, multimedia contents and actuators capable of spreading specific aromas in the air (see an example in Figure 1). We aim at testing problems and opportunities concerning the realization of immersive paths. It is possible to split the project in the investigation of two different scenarios, interrelated, since they are using the same basic components.

An interactive wine museum. This scene describes an immersive multisensory experience inspired by the desire of incrementing the knowledge about wine making regional culture. The user visits a multimedia exhibition; when she comes in a predefined “interaction area”, she is involved by several sensations including sounds, images and odors. The stimuli have an evocative and involving nature and enhance the message transmitted by the installation.

The representation of changing seasons. This scene describes an experience that is inspired by the cultural heritage of Sardinia. The user visits a multimedia exhibition, when arriving at a transition point, for example an airport, she is caught by typical images of wildlife in Sardinia, with some typical scents of the underwood. The user gets involved in the cycle of seasons, and can look how earth and sea, colors and scents change in time and space.

3.1 Implementation

The whole project consists in the design and implementation of an indoor environment including two different components: a video-camera allowing capturing the user movement; a mechanical activated device, correlated to the first, able to spray scent and, thus, reproduce olfactory experiences. The two stages are linked together by developing software that performs several tasks in pipeline:

1. The area in front of the camera is constantly monitored and the video is recorded at a slow pace of one frame per second;
2. Each frame is compared with the previous N (where N is a user defined parameter) to determine when a user is really interested in interacting with the experience;
3. A signal is sent to the actuator that releases a puff of scent which is sprayed towards the user to complement the experience with the olfactory channel.

Our main initial focus was on the realization of the device that can reproduce scents. The project was intended to model a kind of virtual path, an enabling technology to lay out different applicative models for our studies. As we mentioned before, the two first examples we are planning are: an implementation of a wine museum in a natural confined environment; and the sensorial experience of the changing seasons across the year. The details of the detection device, which allows identifying human presence in the interaction zone, and of the hardware device, capable of controlling a scents emitter, are as follows.

3.1.1 The video device

The video device is realized using a webcam. The webcam is positioned above the interaction zone between the user and the virtual representation of the object. The webcam can detect a change in the interaction zone. To do this, the device, continually collects information from the video by means of image processing techniques. Such simple video capturing algorithms, one frame per second of the video, and comparing frames two by two, can be easily deployed to an embedded architecture at a later time. With the comparison, we can obtain differential connected regions from pairs of images in black and white. These connected regions allow understanding if any user is in the interaction zone. When connected regions are identified, and also the presence of the user is recognized in the area, the scents emitter is fired.

Figure 2: Prototype realized.

3.1.2 The hardware device

The hardware device is realized connecting a DC motor to an external microcontroller with a specific programming to provide the necessary pressure to a scent spray (see Figure 2). We can imagine the motor as a sort of remotely controlled electronic finger, which spays scents, by pressing on
a button. The motor can, possibly, be in three different states:

1. A state NOP, where it does not have energy enough, and it is in a no-motion condition;
2. A state RIGHT, where it receive energy along a direction, and moves along right direction;
3. A state LEFT, where the input energy has inverted polarity, and it moves along the opposite (left) direction.

3.1.3 Communication between devices

As said before, the scents emitter works only if it receives some external signal and this will provide energy to the motor. This signal is managed by the video device. When the video device identifies the presence of an object of a predefined dimension in the interaction zone, it sends a signal to the actuator (the high-level scheme is in Figure 3). At the moment, in the prototype, the signal is sent via a serial interface. In the future, it will travel over the network, so that webcam and emitter device will not be obliged to stay on the same computer.

4. CONCLUSION AND FUTURE WORK

The smell is one of the most important senses in the daily life. It provides necessary information to understanding the surrounding environment and to complete and complement the information from other senses. In our implementation the smell is the fundamental vehicle of interaction of the whole work. The idea is to realize a localized environment where it is possible to place, side by side, videos, sounds and olfactory sensations. The installation suggests the user to interact with the environment while not forcing her to do so. This way she can decide to get captured by surrounding information. As of today, it is only at a proof of concept stage and, in the future, the prototype will be improved along two directions:

1. We want to be able to setup the video acquisition system to allow to figure out how long a user stays in the interaction area. This information will be used to determine how many times it will be necessary to emit scents and in which quantity;
2. A second main improvement will be to modify the hardware device, replacing the “electronic finger” with a piezoelectric device.

On the prototype we will do some measuring to choose optimal positioning of environment emitters. Moreover we will introduce methods of post ventilation in the environment, to leave unchanged the perception for users not affected by the current interaction.

5. REFERENCES