Hairlytop Interface: A Basic Tool for Active Interfacing

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ABSTRACT
The Hairlytop Interface is a high scalability interface composed of hair-like units called smart hairs. The original version of the smart hair comprised a shape-memory alloy, drive circuits, and a light sensor. Simply placing the smart hair above a light display device enabled each smart hair to be bent and controlled by modulating the intensity of light from the display. Various prototypes of the Hairlytop Interface have been created to show its high flexibility in configuration. This flexibility should help users to develop their own moving interfaces.

Author Keywords
Smart hair; Hairlytop Interface; shape-memory alloy; soft actuator; haptic; surface display; smart material interface.

ACM Classification Keywords
H.5.2 [**Information interfaces and presentation**]: User Interfaces – *Interaction styles*

INTRODUCTION
Many animals use their hair/fur to communicate their emotional state. For instance, bristled hair often indicates anger, excitement, or surprise. Similarly, a cluster of filament-like materials, such as hair and carpet pile, has sufficient potential to act as a human-machine interface if its shape is controllable as for animals. The Hairlytop Interface, which is a collection of such filament-like material, called "smart hair", is a system originally based on this concept [4]. Comprising a shape-memory alloy (SMA), drive circuits, and light sensor, a smart hair placed over a conventional light display such as LCD enables it to be controlled through changes in the intensity of light.

One of the main characteristics of the Hairlytop Interface is its high degree of flexibility in configuration. The generic structure of the smart hair is quite simple allowing various types of smart hairs to be easily developed. This flexibility should help users to develop a variety of original moving interfaces. Plentiful variations provide lots of different modes of interactivity.

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RELATED WORK
A collection of soft, filamentary materials is often used for creating various types of interfaces. Nakajima et al. developed FuSA2, a graphic display consisting of optical fibers [2]. This system offers a soft surface to the touch, like a coating of fur, and provides visual feedback by stroking, tearing, and other actions. However, it is not shape controllable. The fur interface by Furukawa et al. is an active fur interface [1]. Using vibration motors, their system offers controlled bristling, but this interface requires motors to control every piece of fur, and hence causes low flexibility in configuration. Nakayasu et al. developed next a system called "plant", which is an application of their proposed motion display [3]. The display is composed of sparsely integrated SMA-based units. Each unit is fixed tightly to a frame, but its configuration is not easy to change.

BASIC STRUCTURE OF THE HAIRLYTOP INTERFACE
The basic structure of the Hairlytop Interface (**Figure 1**) is a collection of smart hairs. The SMA of each hair is covered with a flexible tube and connected to the drive circuit incorporated with a light sensor. The amount of bending of the SMA integrated flexible tube can then be controlled through light intensity. In this original version, a conventional LCD display is used to provide the controlling modulation signals of light.

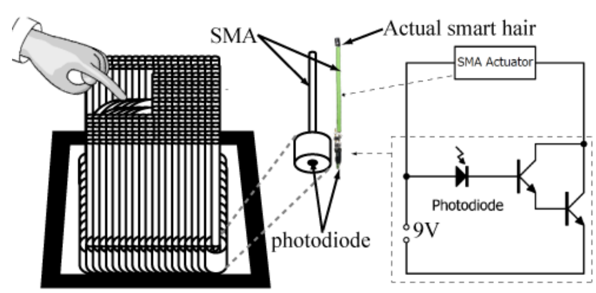

Figure 1. Illustration of the Hairlytop Interface, smart hair, and its basic drive circuitry.

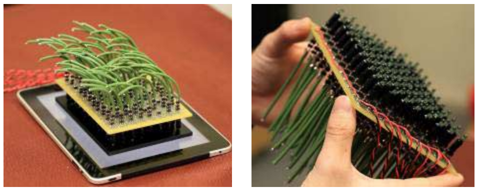

Figure 2. Photos of the Hairlytop Interface

(Left: atop a LCD; Right: view of light sensors)

VARIATIONS OF THE HAIRLYTOP INTERFACE

Furry decoration

To improve its appearance, a furry decorated version of a smart hair was developed (Figure 3). By covering the original smart hair with fur for handcrafts, the original, lawn-like appearance becomes a furry animal-like appearance common to many domestic and wild animals (Figure 4). This appearance should help the Hairlytop Interface to be used as an emotive communication medium as with animals.

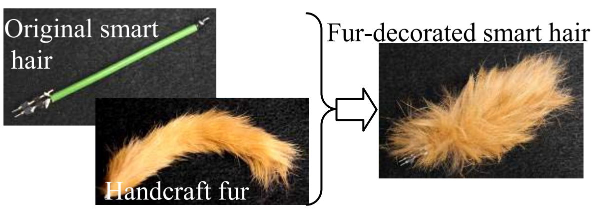

Figure 3. Furry decoration of a smart hair.

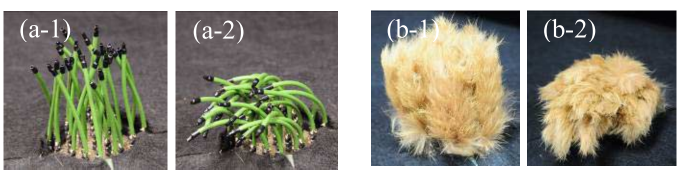

Figure 4. Original version of the Hairlytop Interface (a-1, a-2), and a furry-decorated version (b-1, b-2).

Variations of control signals

As the basic structure of the smart hair is simple, it is easy to change sensors. In consequence, various kinds of signals can be used to control its movements. The left panel of **Figure 5** shows a prototype that uses a line signal from a tablet. In this version, the smart hair represents a dog’s ear, which can express in its movements emotions such as joy and sadness. To control the bending of the smart hair, different frequencies within a sound signal are generated periodically.

Figure 5. Hairlytop interfaces controlled by acoustic signals.

The right panel shows another prototype that uses an acoustic signal. In this version, any musical instruments, or even handclapping, can be used to control the amount of bending of the smart hair. Using sound to control the Hairlytop Interface makes its design much easier for the casual user.

Block-like structure to improve their composition

When considering situations where thousands of smart hairs are used, block-like smart hairs might be more suitable (Figure 6). Although a smart hair does not need a signal wire, a power cable is necessary. In this situation, connecting power cables is a bothersome task. This block-like structure helps users to join and separate thousands of smart hairs. In the figure, SMA is installed on top of a black box. Inside the box, basic drive circuits are inserted. A silver tape attached to the surface of the box is used to supply the current. Thus, a simple contact between blocks enables power to be supplied. Additionally, four magnets are mounted in the box and used to couple and decouple one box from another. This function should make re-configuring boxes much easier.

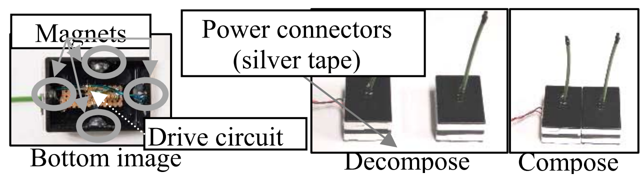

Figure 6. Prototype of block-like smart hairs.

CONCLUSION

Various prototypes of the Hairlytop Interface are described to highlight their high flexibility in configuration. The smart hairs have ample potential as a fundamental unit that could form various user-interactive interfaces. In future work, we shall continue to develop such interfaces with a view to broaden their application.

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