Haptic Displays - Information Displays for the Sense of Touch

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Haptic display

What does the word “display” make you think of? We must look at a "visual display," such as a "liquid crystal display" to "see" or understand information processed by a computer. In other words, a visual display is a device that presents information to our vision.

A "haptic display" is a device that enables us to "touch and feel" information in a computer. The word "haptic" means "relating to or based on the sense of touch." A haptic display allows us feel such information as an object's hardness, viscosity, and warmth that would be difficult to see on a visual display.

Haptic = Cutaneous + Kinesthetic?

The eye is the only organ of vision that accepts light signals. In contrast, the sense of touch is a very complex and unified sensation felt by many kinds of receptors in the body. In this article, let us divide "haptic" into two categories, "cutaneous" and "kinesthetic."

The cutaneous sense is mainly felt by the skin, which is the largest haptic organ and contains several different kinds of receptors responding to pressure, temperature, skew, and tension. With this sense, we recognize the roughness of a surface, or surface texture, vibration, and temperature of an object.

The kinesthetic sense, or kinesthesia, is a sense mediated by receptors located deep inside the body, such as muscles, tendons, and joints, and stimulated by bodily movement and tension. We use this sense to recognize the physical shape and softness of an object in the hand; we capture its shape through joint angles and feel its softness by the tension of associated muscles or the force we apply.

These two categories actually are not so clearly separated, however; for example, it is reported that skin stretching or shrinking (i.e. cutaneous sense) around a joint affects the sense of its angle (kinesthesia).

Various haptic displays

In the last two decades, many kinds of haptic displays have been researched and developed. The variety of devices is a consequence of the complex nature of this sense and the mechanisms to artificially stimulate it. Cutaneous displays showing surface texture by stimulating the skin can be implemented using an array of thin rods that vibrate or poke out (Photo 1), a thin film with well-controlled vibrations, and even an electromagnetic stimulator of skin receptors.

The basic idea of a kinesthetic display, or a force display, is to immediately evoke the "right" reaction force when the user touches a virtual object. Displays in this category can also vary widely, including an "exoskeleton" type (the user wears an "armor suit" device controlled by motors and computers to...
Research and development of olfactory displays

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Recently, researchers of the information-related technology have come to join research and development work on olfactory displays; new approaches are now being pursued in this field. These researchers aim at using smells as computer-controlled media, as well as using olfactory displays as tools for aromatherapy or for research on the sense of smell. Various trials are now underway, for example, to use smells as an implicit information output from computers, or to add an odor to the world of multi-media applications and virtual reality (VR).

Among others, VR-oriented olfactory displays are actively pursued in Japan. For example, a wearable olfactory display has been developed at the University of Tokyo that can supply odors to a person who walks around in a VR space. An arm-mounted interactive olfactory display has been developed at Nara Institute of Advanced Science and Technology, focusing on the behavior when a person tries to pick up something to smell. In ATR, a scent projector, which delivers the odor locally to the nose without requiring a user to wear anything on the face, has been developed.

These types of olfactory displays are capable of providing smells synchronously with other interactive contents, so that they are expected to stimulate people to find a new way of using odors.