Colorful Touch Palette

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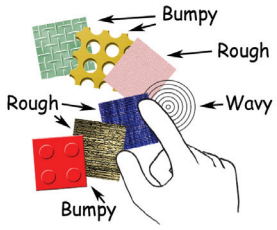


Figure 1: Concept drawing

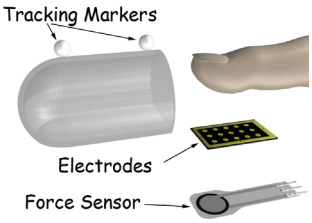


Figure 2: "Tactual Cap"

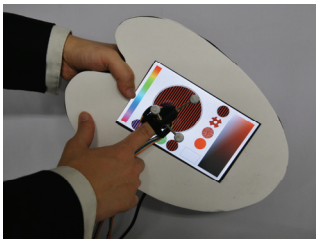
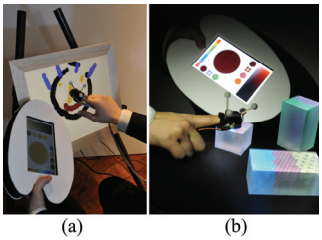


Figure 3: "Touch Palette"


(a) (b)
Figure 4: "Texture Canvas"
(a) 2D canvas (b) 3D canvas

1. Introduction

Previously, pictures were painted using tools such as crayons or even by hand. Surfaces such as canvases or walls, provided the tactile sensations of the drawing surface while painting. However, this tactile experience has got lost because of advances in computer graphics software. Besides, a conventional multi-touch interface [1] can not provide tactile sensation. We propose a novel interactive painting interface called *"Colorful Touch Palette"* that may help us to rediscover our creativity. The user can touch the canvas having the electrode, select or blend tactile textures of their choice, draw a line, and experience the tactile sensations of painting as shown in Figure 1. Various tactile textures can be created by blending textures as paints. This interface can be used to design complex spatial tactile patterns for haptic-friendly products. Moreover, this system can be potentially used to create novel tactile paintings.

2. Technical Innovations

To realize the concept of this interface, following features are required.

(1) Providing various types of tactile sensation that the user can recognize comfortably.
(2) Creating new tactile textures by blending original textures.
(3) Providing tactile feedback according to the motion and posture of the finger.

With regarding to feature (1), the previous electro-tactile stimulation system [2] could provide only uniform rough textures and could not provide grating convex patterns with a resolution higher than the electrode interval. We improved the technique of electro-tactile stimulation of spatial patterns, and we archived various patterns of tactile sensations. We provided various degrees of roughness by changing the intensity and controlling the distribution and variances of each electrode. We also virtually increased the spatial resolution by changing the stimulus points faster than the fingertip movements as occasion demanded, instead of synchronizing both movements.

We designed the blending method of tactile textures for realizing feature (2). It is known that each polar stimulus can produce different sensations: sense of vibration by anodic stimulus and sense of pressure by cathodic stimulus [3]. To calculate the stimuli of the blended tactile textures, we defined a pressure model **Mp(*x*,*y*)** and a vibration model **Mv(*x*,*y*)** for each tactile texture and described a texture as **T(Mp,Mv)**. When the user blends two different tactile textures (**T1(Mp1, Mv1)** and **T2(Mp2,Mv2)**), the blended texture (**Tb(Mpb, Mvb)**) can be calculated as follows:

$$Mpb(x, y) = Mp1(x, y) \wedge Mp2(x, y)$$
$$Mvb(x, y) = Mpb(x, y) \wedge (Mv1(x, y) \vee Mv2(x, y))$$

For feature (3), we implemented temporal patterns of electro-tactile feedback. In previous works, the special distribution of electrode intensities in the finger pad was not controlled according to the human motion. Here, we measured the movement and the contact state of the finger, and used the data to provide tactile feedback according to the velocity and pressure of the finger.

3. System Configurations

This system is composed of a *"Tactual Cap"*, *"Touch palette"* and *"Texture Canvas"*.

"Tactual Cap": a cap shaped device, as shown in Figure 2, that consists of a high-density electrode matrix for providing tactile feedback, a pressure sensor for estimating the contact state of the fingertip, and tracking markers for detecting the fingertip posture.

"Touch Palette": a palette shaped display that consists of a touch panel. Several types of visuo-tactile textures called "tactile colors" are arranged as shown in Figure 3.

"Texture Canvas": we propose two types of canvases – a 2D canvas and a 3D canvas, as shown Figure 4. The 2D canvas consists of a touch panel monitor mounted on an easel. It is used for painting a tactile picture. The 3D canvas consists of a solid screen, a projector, and motion tracking cameras. It is used for surface prototyping.

The user blends the tactile colors together on the *Touch Palette* using a finger with the *Tactual Cap*, which creates various tactile colors. Then the user touches and draws a visuo-tactile painting on the *Texture Canvas* at will with tactile feedback. The user can appreciate the visuo-tactile picture he/she painted on the basis of the tactile feedback. The painted tactile pictures are archived, and other users can enjoy them with stimulating tactile sensations.

References

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