

# Daichi's Painting: Brushing Up Painting Skills with BrushDevice

Mai Otsuki, Masashi Tsukadaira, Asako Kimura, Fumihisa Shibata, and Hideyuki Tamura  
Graduate School of Science and Engineering, Ritsumeikan University  
1-1-1 Noji-Higashi, Kusatsu, Shiga, Japan

## ABSTRACT

We realize a painting system that imitates painting on real objects in the real world. Many studies have proposed methods of painting simulation on 2D canvas, and the quality of such methods is improving. However, painting on 3D objects is not easy using conventional input devices such as a mouse or graphics tablet with 2D display. We solved this problem by providing a ToolDevice in a mixed reality (MR) space. Our device, called BrushDevice, imitates paint brushes; users can change the brush type and stroke weight to express their creativity.

## INTRODUCTION

There have been many studies on painting simulation and their quality is improving [1][2]. In these studies, simulated painting using oils and watercolors on 2D canvas has been realized using conventional input devices such as a mouse or graphics tablet with 2D display.

On the other hand, in the real world, we paint on not only 2D canvases but also 3D objects. However, painting on 3D objects has not been considered in these studies. It is difficult to paint on such targets indirectly using a mouse or graphics tablet, and it is natural for users to want to paint the target directly. Therefore, we realized a painting system that imitates painting on real objects in the real world.

This study considers the following story:

*Daichi is a boy with good painting skills. He paints pictures on furniture, pottery, and stationery everyday. He has also attempted computer drawing, but has no sense of computers. One day, he accepted a present from his friend with the message "Express your creative mind using this BrushDevice with a computer!!" He started painting spontaneously and avidly using this device.*

To realize this story, we first developed a system in which users can directly paint on various objects in MR space and then developed BrushDevice for painting on 2D/3D objects, in a similar manner to how they would in the real world (Figure 1). A system for painting on virtual 3D objects using PHANTOM has already been proposed by Sandor et al. [3], however, it does not target real objects. The targets in our study were both real and virtual objects (Figure 2).

## BRUSHDEVICE

### Concept

We have presented novel interaction devices for various spatial operations. ToolDevice is a set of interaction devices using a metaphor of existing tools familiar in everyday

Copyright is held by the owner/author(s).  
UIST'09, October 4-7, 2008, Victoria, BC, Canada.



Figure 1: Concept of BrushDevice

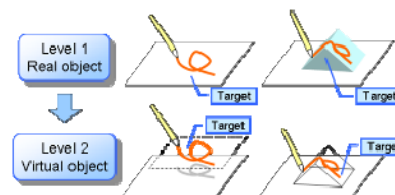


Figure 2: Painting targets of our system

life [4]. Such tools have a good affordance and each user already has a mental model for their operation. These advantages not only lead users to the correct operation, but also provide intuitive operation.

BrushDevice is a kind of ToolDevice that imitates the shape of a paintbrush familiar to many people, from beginners to professional artists. We aim to develop BrushDevice to realize subtle expressions as well as in the real world.

It requires the following two elements, for these purposes: (1) brush shape and (2) brush stroke. We address them as follows:

(1) In the real world, users choose a brush depending on their purpose. Most paintbrushes fall into two categories, round and flat. A round brush is used for painting in detail, and a flat brush is for painting large areas uniformly. Furthermore, the size of a brush is chosen depending on the size of the painting area. Our device can be changed between these commonly used brush types by changing attachments.

(2) In the real world, brush stroke has many characteristics, e.g., weight, density, or smoothness. We focus on stroke weight, which is important for subtle expression.

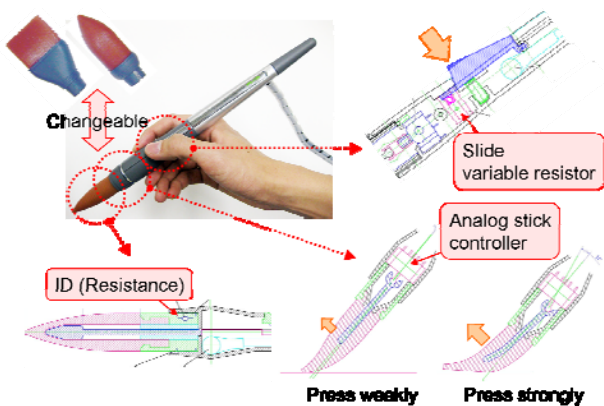


Figure 3: BrushDevice

In the real world, when users want to change the weight of a stroke, they tilt the brush or press it with varying force against the canvas. It is natural that users employ painting methods similar to those in the real world:

- (a) Pressure from the device to canvas (*Push*)
- (b) Distance from the device to canvas (*Distance*)
- (c) Tilt of the device against canvas (*Tilt*)

As mentioned previously, our painting targets include virtual objects, and *Push* cannot be used with them. Therefore, we also considered other methods that are conceivable from operation in the real world.

- (d) Moving speed of the device (*Speed*)
- (e) Grip force to grab the device (*Grab*)

We developed a system in which the user can select various methods from the above.

### Implementation

The mechanism of BrushDevice is as follows (Figure 3):

- Resistance to identify attachments
- Magnetic sensor to detect the position and orientation of the device [i.e., *Distance*, *Tilt* and *Speed*]
- Analog stick controller to measure the pressure applied by the device to the canvas [i.e., *Push*]
- Slide variable resistor to detect grip force [i.e., *Grab*]

We developed an MR system with which users can paint various objects using BrushDevice in MR space. In this system, the strokes of round brushes are generated by placing circles on the user trajectory of the brush, and those of flat brushes are generated by arranging rectangles. The stroke weight, determined by input values from sensors, changes the size or shape of the circles or rectangles. In this system, magnetic sensors are used for tracking real objects.

### PILOT TEST AND DISCUSSION

Painting targets of the pilot test are a tabletop, real 3D objects, a virtual 2D plane, and 3D objects in MR space (Figure 4). We collected user comments. Figure 5 shows examples of painting results in our system.

We discovered the following from the pilot test:

- (1) Attachments: Most users felt that they could change the brush type easily. They painted by changing attachments actively, depending on their purpose.

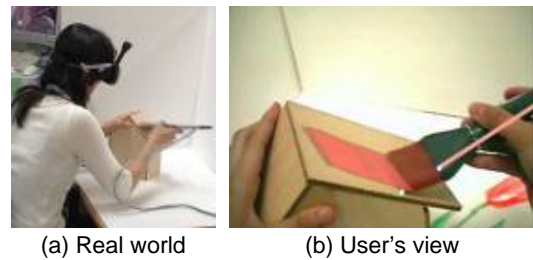


Figure 4: Users can paint a real object (small house) in the MR space.

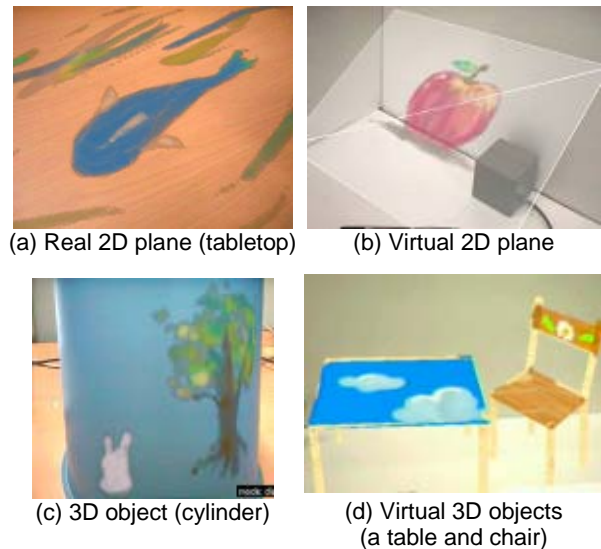


Figure 5: Examples of painting

- (2) Weight of brush strokes: Though each method had strong and weak points, most users could control the weight of brush strokes instantly and easily. *Push* and *Distance* were most favorable for most users because they are similar to real operation. *Tilt* was considered to be good for the 2D plane but difficult for curved objects. *Speed* was good for painting roughly but difficult to use for painting in detail. *Grab* was intrusive for real objects but easy for virtual objects.

### ACKNOWLEDGMENTS

This research was supported by PRESTO Program of JST and Grant-in-Aid for JSPS Fellows.

### REFERENCES

1. N. S.-H. Chu et al. MoXi: Real-time ink dispersion in absorbent paper. *Proc. SIGGRAPH 2005*, pp. 504 - 511.
2. W. Baxter et al. IMPaSTo: A realistic, interactive model for paint. *Proc. the 3rd Int. Symp. NPAR*, pp. 45 - 56.
3. Christian Sandor et al. Visuo-Haptic Systems: Half-mirrors considered harmful. *Proc. IEEE World Haptics 2007*, pp. 292-297.
4. Uesaka et al. TweezersDevice: A device facilitating pick and move manipulation in spatial works. *Adjunct Proc. UIST 2008*, pp. 55 - 56.