FlexibleBrush: A realistic brush stroke experience with a virtual nib

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ABSTRACT
We describe FlexibleBrush, a system that provides a unique drawing experience using brush strokes. FlexibleBrush employs several techniques, including time-lagged visual feedback, and a virtual nib, to create the sense of a smooth brush texture while drawing, without using haptic feedback. In contrast to other paint software systems that focus on inks, FlexibleBrush focuses on the process of drawing. FlexibleBrush uses an innovative virtual nib cursor which changes shape dynamically as strokes are made. The operation of FlexibleBrush can be seen in the associated video and in this paper we describe how FlexibleBrush works and the type of drawing experience that it enables.

Categories and Subject Descriptors: H.5.2 [User Interfaces]: Graphical User Interfaces (GUI), Haptic I/O.

Additional Keywords and Phrases: calligraphy, cursor feedback, stroke, brush

INTRODUCTION
Most paint software packages provide various inks that can be used to create different drawing styles[2]. Different ink types are associated with different widgets (e.g., pencil, air brush, marker, and brush and so on). Several inks also provide texture. Typically, the user draws lines by utilizing these widgets. Further flexibility is provided through the use of touch-sensitive tables for input, with which users can easily control parameters such as ink width and shape using pressure input.

The disadvantage of this ink-based approach is that to create complex and original shapes such as those in calligraphy, users need to switch frequently between different widgets (modes) which interrupts the flow of the work. Drawing its inspiration from Asian calligraphy, FlexibleBrush provides just one tool, a pen with a virtual nib. By varying the type of stroke that is made with this brush tool, users can create a wide range of drawings without the distraction of having to constantly switch between widgets. Users vary the type of stroke by varying the physical parameters of how the brush moves just as in done in calligraphy with brush, paper, and ink. By exploiting appropriate physical properties a unique stroke experience and effect is created[3]. Due to the absence of mode switching, feedback is continuous and users can learn to associate different actions with the brush with resulting types of stroke.

In developing FlexibleBrush we focused on the creation of a good stroke experience in the absence of haptic feedback. We sought a stroke experience that would mimic the sense of smoothness and texture that is experienced when drawing or writing a line with brush or pencil. By relying on new forms of visual feedback while drawing, we were able to avoid the need for a haptic device to supplement the stroke experience, in contrast to ink- (widget-) based systems[1] that provide a haptic experience at the cost of requiring a special device.

Flexible Brush
FlexibleBrush is designed to create a realistic feeling of making brush strokes using visual feedback only. This feeling is created by the use of a dynamically changing cursor which mimics brush-like properties.

IMPLEMENTATION
Behavior of virtual nib:
FlexibleBrush uses a virtual (on-screen) nib. In a typical painting system, the pointing position is the same as the starting position for drawing. Thus users exercise close control of the cursor position through direct pointing. In the physical world, brushes do not act this way. It is hard to predict exactly where the ink will drip from a real brush that has been dipped in ink and then put to paper. In this realistic case, expert calligraphy becomes a matter of creating shapes that are defined by the relative, rather than absolute, positions of their component strokes. As in calligraphy with a real brush, the FlexibleBrush system does not allow for di-
rect pointing. Instead, time delays, and the behaviour of the virtual nib are used to translate the discrete world of a pointing interface into the analog, less exact, but more esthetically pleasing world of calligraphy. The effect of this change in paradigm is to allow users to feel the stroke while drawing it, somewhat analogously to the feeling they would get with a real brush. In exploring the design space of analogue brush we found that imposing a delay between the pointing point and the drawing start point was an essential part of the experience being sought. This delay was built into a unique “virtual nib” cursor that changes length dynamically as strokes are executed.

Figure 2: Dynamically modifying the Virtual Nib

The virtual nib is the key to realistic stroke experience in FlexibleBrush. The virtual nib is composed of several oval images arranged in a sequence that follows the stroke, creating the kind of wavy movement of a brush tip as it moves over the paper and spreads the ink. The oval images in the virtual nib act as a brush cursor. The oval images follow the sequence of input position supplied by the mouse or tablet device in response to user inputs. Satisfactory brush stroke movement can then be created using the mapping expressed in the following equations (one for the x-coordinates and the other for the y-coordinates).

\[
Ox[i]^+ = \frac{current \ inputted \ position \ x - currentOx[i]}{F}
\]

\[
Oy[i]^+ = \frac{current \ inputted \ position \ y - currentOy[i]}{F}
\]

Ox[i] and Oy[i] are the x and y coordinates, respectively, of each oval image. An index of i indicates the number of an oval image within the sequence of ovals that the virtual nib is comprised of. F is a constant representing the value of a deceleration parameter. There is an integer number of oval images in the virtual number and this parameter setting may be varied (along with other parameters) in FlexibleBrush to create different stroke experiences. For example, if you want to create the type of stroke experience typical for a small brush, then the number of oval images used in the virtual nib should be smaller. Another feature of the virtual nib is that it fades into transparency away from the surface of the virtual paper being drawn on, so that the user naturally focuses on the area where the brush is interacting with the paper to create the stroke.

How to draw a line:
A line being drawn extends from the last oval (closest to the virtual paper) in the virtual nib(fig.3). The resulting line path of the stroke being made depends on the way in which the virtual nib moves. A line is drawn when the user presses the mouse button or touches the surface of display using the pen-device. The weight of each brush (i.e., the width of the stroke in pixels) is increased when it presses against the paper, just as the tip of a real brush will flatten and widen as it is pressed against the paper.

Figure 3: How the virtual nib looks as it interacts with the stroke being made

Figure 4: some samples with FlexibleBrush

CONCLUSION
Figure 4 shows some samples of characters and figures created with FlexibleBrush. In the hands of a skilled user, FlexibleBrush can create characters that are reminiscent of manual calligraphy and it provides a somewhat similar stroke experience. Informal user testing has also been carried out with Flexible Brush. Initially, users tended to find it difficult to control the FlexibleBrush, but with experience they were able to exert finer control of the virtual nib, using it to create flowing shapes and virtual calligraphy. Just as in real calligraphy, effort is required to learn how to use FlexibleBrush skillfully, but the effort is rewarded by an ability to create esthetically pleasing shapes and characters with smooth, flowing strokes.

REFERENCES