Immersive Virtual Brush Simulation for Chinese Language Edutainment

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Abstract

Brush Simulation is an innovative method to create convenient virtual environment for educational purpose. It aims to assist Chinese Language learners to enjoy practicing the artful style of Chinese writing and water painting brush work, without the burden of natural resource preparation (i.e. ink and paper). Recent research has shown that depending on the level of immersion and the quality of interaction / communication between user and the virtual augmented agents in edutainment system, powerful learning results in edutainment can be achieved. Unfortunately, users are often required to interact indirectly through special input devices (i.e. tablets) which are rather uncomfortable and different from its traditional way. And, thus, it often dramatically damages the overall user's immersive experience. In this paper we propose new design for the Input Layer of Virtual Brush Simulation model employing the optical-based tracking technology that gets rid of the cumbersome input tracking devices, in order to provide user's higher immersive interaction in such edutainment system.

Keyword: Chinese langue, Virtual brush simulation, optical-based tracking, immersive interaction, edutainment.

I. Introduction

In recent years, many Virtual Brush Simulation models such as (Baxter, Scheib, Lin, & Manocha, 2005; Chu & Tai, 2004; Nelson & Tai, 2005; Strassmann, 1986) have been proposed targeting for a new possibility of practicing the traditional brush work on alternative digital media. For example, virtual brush used by modern painter artists has been suggested to be more convenient and economic for Arts work production, comparing to traditional practices. For Chinese language learners, through interactive educational games, virtual brush is also a good way to practice Chinese calligraphy and to learn the language at the same time. In Games and Cinematic industry, non-photorealistic painting style is more and more engaging to their consumers as special effects. Each of these applications requires an interactive simulation of virtual brush in real-time. However, the common problem in virtual brush simulation is that a user needs to constantly map his manipulation on the pointing device (i.e. tablet) to the monitor space where the actual footprint is generated. This often causes distraction to the interaction experience. Solving such input problem is very useful to provide natural interaction experience.

II. Related Work

Modern Virtual Brush Simulation System was initiated by Saito (Saito & Nakajima) and then later continued by other researchers (Plante, Cani, & Poulin, 2001; Wong & Ip, 2000; Xu, Tang, Lau, & Pan, 2002; Yeh, Lien, & Ouhyoung, 2002) to deal with the complexity of virtual brush simulation. In his simulation proposal, the process consisted of three separated layers of interaction: Input layer, Brush Simulation layer and Ink Dispersion layer – Figure 1:

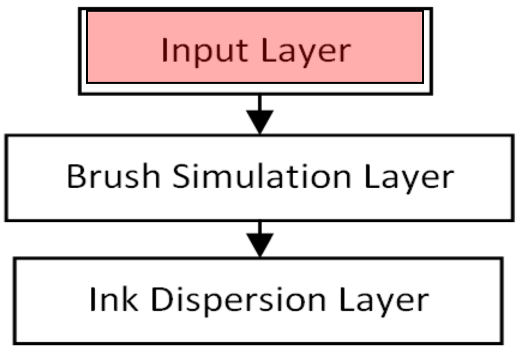

Figure 1. Modern Virtual Brush Simulation Model.

On top of the simulation model, input layer handles with the user manipulation data is usually generated by the input devices. Over the years, several input devices have been suggested, namely traditional 2D mouse, magnetic or ultra-sound pressure sensing tablet, haptic force feedback device and recently, Interactive tablet display (e.g. Wacom tablet series (Wacom Intuos, 2000)). However, such devices are in general not compatible with Chinese brush work practices due to its significant physical difference with traditional Chinese hairy brush, as illustrated in Figure 2.

On the other hand, optical tracking for virtual simulation (Rolland, Davis, & Baillot, 2001) has also gained more and more significant popularity for its capability of conducting flexible human-computer interaction on any working spaces such as wall, floor and even on the monitor itself. Optical-based tracking algorithms have been widely researched and has been proved to produce accurate tracking results in real-time, especially with the new parallel programming capability of GPUs (Chetverikov & Verestói, 1999; Sinha, Frahm, Pollefeys, & Genc, 2006; Tomasi & Kanade, 1991). In particular, SIFT (Heymann, Maller, Smolic, Froehlich, & Wiegand, 2007) is real-time color-based tracking algorithm which allows very stable tracking results without subjection to illumination variance and ad-hoc occlusion problem. This method has shown to be effective for tracking motion in general practice. In addition, 3D matching of points from multiple view points (stereoscopic) allows not just 2D planar tracking but points can be traced in 3D space (Stein, 1999). By specific installation of several markers, a full 6 Degrees of Freedom (DOFs) tracking can be achieved by using only two cameras.

III. New Input Layer Design

Inspired by current state of accuracy on optical tracking technologies, we introduce a new immersive and user-friendly setup for user input layer of the simulation system. This new setup aims to close the gap between the traditional experience of using actual brush work and the current digital simulation practice while maintaining an affordable and reasonable adjustment on the new installation.

The main driving force is that many users may have issue when adapting to the pen-based input device. It is because the pen-based input device (i.e. Wacom tablets) cannot provide the same feedback as natural as the traditional brush. There are two main reasons. Firstly, the pressure sensor on the head of the stylus is very different from the Chinese brush's which is made up of thousand of hair strands and bristles which are softer and provides very subtle haptic feedbacks. Secondly, it is unnatural for users to manipulate the brush on the tablet surface while they are looking on the monitor to observe the result where the actually footprint is generated – Figure 2.

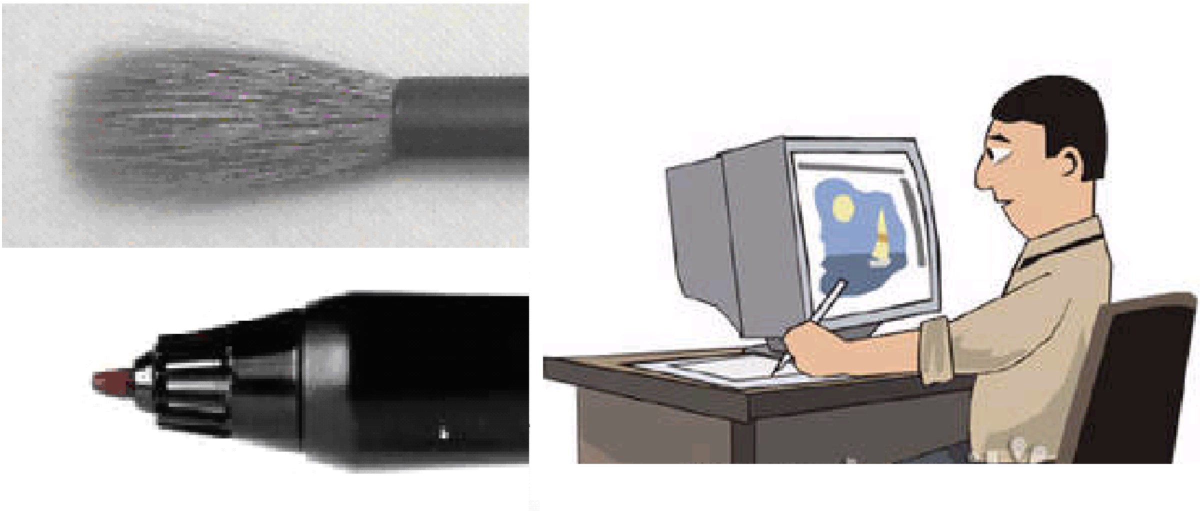

Figure 2. Two reasons for Interaction discomfort.

Instead of using common pointing device, our alternative setup would consist of two extra webcams to track the motion of the real brush, which is holding by the user as original setup and a flat LCD monitor using as interactive display for the simulation – illustrated in Figure 3.

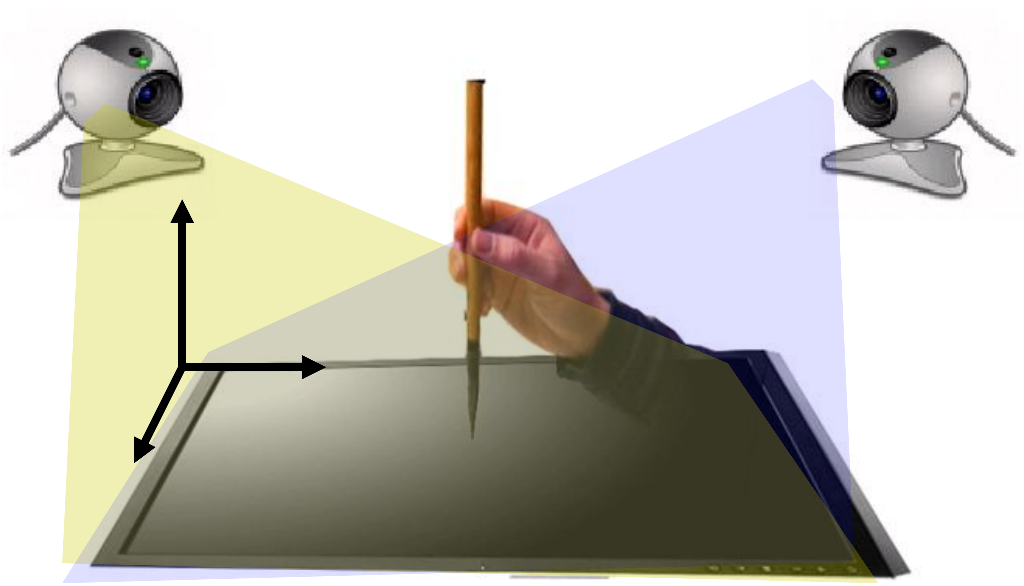

Figure 3. Illustration of our new Calligraphy Simulation system setup.

The setup employs two standard digital cameras (webcams) to record continuously in an alternating sequence (so as to double the framerate) over the painting area to deliver accurate tracking of the motion path of the brush. The recorded images will be transferred to Feature Point Tracking algorithms (Gabriel, Hayet, Piater, & Verly; Tsai, 1986; Zhou, Yuan, & Shi, 2009) for analyzing the actual motion and extracting the 3D motion path through 3D points matching algorithm. These techniques and algorithms have been intensively researched in academics over the years and have been proven to be reliable.

Finally, the simulation system will receive the motion input, perform the dynamics simulation and paint flow modeling in second and third layer in Figure 1and output the simulated results to the LCD display. The user is expected to experience the simulation immersive as if he is practicing the brush work in the tradition way.

IV. Summary and Future Work

In this paper, we described a new setup for user interaction with the Virtual Brush Simulation model employing optical-based tracking technology in order to minimize the discomfort from common tablet devices, in order to provide users' higher immersive interaction in such edutainment system.

Future work will comprise an implementation of the describe approach and testing against the previous interaction design to evaluate the usefulness and the immersion of optical brush tracking approach.

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