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A virtual 3D interactive painting method for Chinese calligraphy and painting based on real-time force feedback technology

Key words: 3D brush model; 3D brushstroke; 3D interactive painting; Real-time force feedback technology

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Motivation

1. Numerous approaches of virtual 3D painting have been proposed to realistically represent a brush and model its behavior and interaction with a 3D object surface. However, these methods are inappropriate for Chinese calligraphy and Chinese painting.

2. Chinese calligraphy and painting are usually created using Chinese brushes, which are different from western brushes. Such brushes are used to create the brushstrokes typical of Chinese art, which convey the artist's deep feelings when he/she paints on a 3D object.

Main idea

1. Based on force feedback technology, we designed a 3D Chinese brush model. Using this model, users can draw 3D brushstrokes in real time.

2. Users virtually paint in real time with a Phantom Desktop haptic device and 3D mouse (two-handed interaction), which can effectively enhance the reality of the interactive painting process.

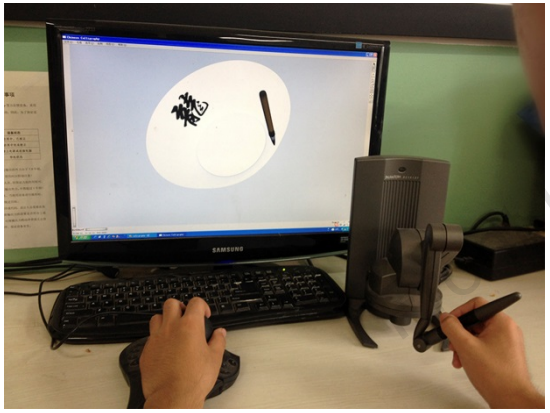
3. A local mapping technique is suggested instead of global surface parameterization vertices for the geometric model, which can effectively reduce the computational complexity.

Method

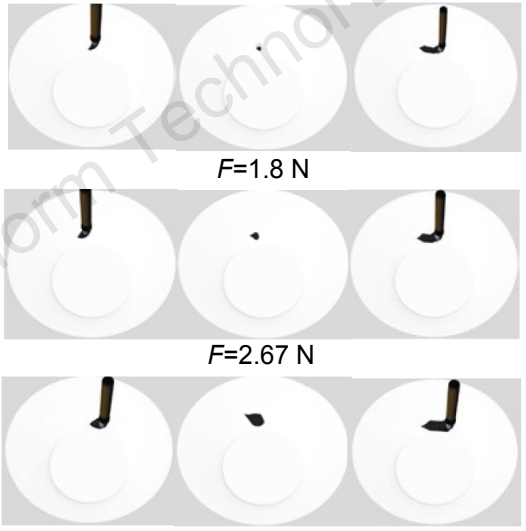
1. We adopt a spring-mass model to mimic a Chinese brush. In this model, we compute the force exerted on the brush through a perpendicular virtual spring, which deforms in the normal plane direction.
2. We simulate both small- and large-scale brush bending and stretching according to force in real time.
3. Along the painting direction, a complete 3D brushstroke is obtained by superimposing 3D brush footprints, which are obtained by projecting 2D brush footprints in the plane onto the 3D object surface in real time.

Major results

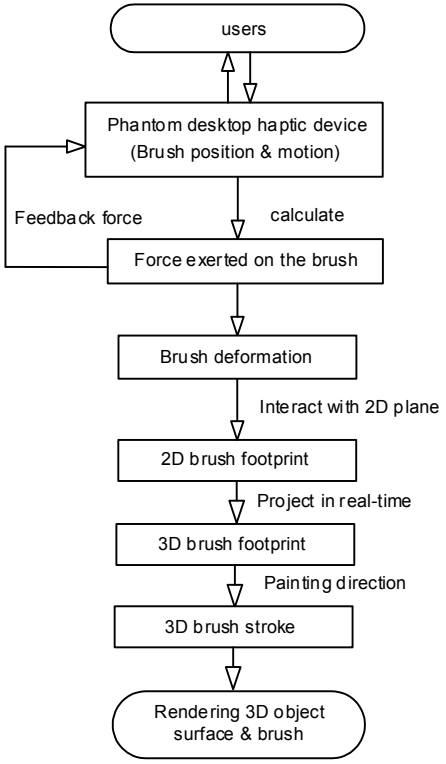
1. Users can realize interactive drawing on the virtual 3D object surface by realistically wielding the force feedback device.



The hardware setup for the virtual 3D interactive drawing system with force feedback



Brush deformation, 3D footprints and strokes (from left to right) when different pressures are exerted on the brush

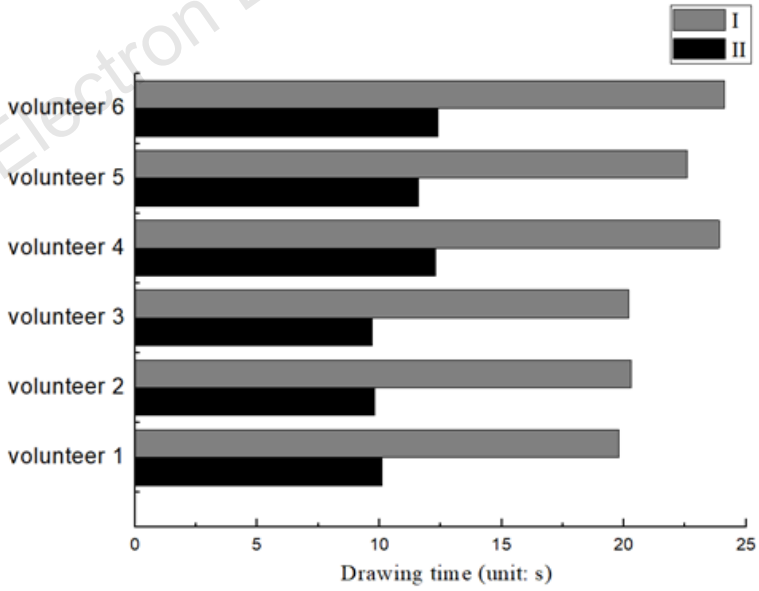


A schematic diagram of the virtual 3D interactive drawing system based on force feedback

Major results

2. In our system, the force information is input and output through the haptic device. Users can adjust the 3D brushstroke to the desired stroke through force feedback and visual feedback.

3. Our system with the two-handed interaction (HP SpaceBall 3D mouse and Phantom Desktop haptic device) helps to enhance reality for a painter in human-computer interaction 3D painting.



Drawing time with the two devices (I and II)

Major results

4. Compared with the “MoXi” system (Chu and Tai., 2005), users can do a better job simulating Chinese character features with our system, and users can also draw Chinese calligraphic works on the surface of a 3D object with our system.

“MoXi” system

our system

Conclusions

1. We constructed a 3D model of a Chinese brush to simulate the deformation of the brush based on force in real time, and then we computed the 2D brush footprint.

2. A real-time projection algorithm is presented to map the 2D brush footprint into the 3D brush foot-print, and then the 3D brushstroke is obtained.

3. Our method has been successfully applied in a virtual 3D interactive drawing system based on force feedback technology. With our system, the deformations and strokes of different 3D Chinese brushes are simulated in real time.