

Body-Brush: A Body-driven Interface for Visual Aesthetics

Horace H S Ip
City University of Hong Kong
cship@cityu.edu.hk

Young Hay
City University of Hong Kong
younghay@cs.cityu.edu.hk

Alex C C Tang
City University of Hong Kong
cctang@cs.cityu.edu.hk

ABSTRACT

With the development of an innovative motion capture and analysis system using frontal infra-red illumination, and based on a systematic study of the relations between the human body movement and the visual art language, the Body-Brush turns the human body as a whole into a dynamic brush. The Body-Brush enables humans to interact intuitively with the machine to create a rich variety of visual forms and space within a virtual 3-D canvas.

Categories and Subject Descriptors

I.3.4 [Computer Graphics]: Graphics Utilities – *paint systems, virtual device interfaces.*

I.3.6 [Computer Graphics]: Methodology and Techniques – *interaction techniques.*

J.5 [Computer Applications]: Arts and Humanities – *performing arts.*

General Terms

Human Factors.

Keywords

Frontal infrared illumination, motion tracking, human-computer interface, gesture analysis.

1. INTRODUCTION

Human body movement and gestures are significant human expressions which communicate messages of human inner conditions and human interaction with the outer environment. In recent years, researchers made use of the advance of image analysis and motion capture system to enable human body to sketch in the virtual space. *Biped*, a new work by choreographer Merce Cunningham, translated the dancer's movement into animated virtual forms which were projected onto the stage screen. *DanceSpace* [2], an interface developed by researchers in the MIT Media Lab, using their tracking system *Pfinder* (person finder) [3], a real-time computer vision system, generates computer multi-colour graphic trail and music in corresponding to the motion of different parts of the dancer's body.

With a systematic study of the relations between the human body movement/gesture and the visual art language, the Body-Brush turns the human body as a whole into a dynamic brush and provides an intuitive tool for creating visual aesthetics. This is achieved with the development of an immersive computer-vision-based motion analysis system with frontal infrared illumination, and an innovative graphic rendering software mapping the body

motion gesture-path-energy to the colour-form-space visual attributes. By controlling the mathematical centres of the body, the motion speed and acceleration, the gestural spatial dimensions, and the body trajectory, the user can create 3D drawing and painting within a virtual 3D canvas. The same set of motion data can be also mapped to simulate a multitude of sculptural forms and architectural spaces. As a result, the sketch in the real space by this body-as-the-brush is transformed into the shaping of the virtual visual space.

2. TECHNOLOGICAL INNOVATION

We have developed a novel motion capture and analysis system using frontal infra-red illumination to capture human body motion data within a 3D space. With two arrays of frontal infrared illumination, the well-lit human body can be easily separated from the background. This motion capture and analysis system is inexpensive, portable, but effective to capture the 3D body motion data in real-time. Moreover, unlike previous approaches, since the reflection of infrared depends not on colour, the interface is highly ergonomic and robust as users are not required to wear specific colour clothing or sensor devices.

The Frontal Infrared Illumination technique in this project is developed from a number of concept and techniques. In particular, our key reference is the rear-IR-projection technique [1] developed by Aaron Bobick and James Davis of the MIT Media Lab, which we have modified and enhanced to suit our specific needs. Although the rear-IR-projection is good at producing sharp silhouette images (black human body on a white background), this technique is very hard, if not impossible, to create a well-lit ground floor for obtaining the top view of the user thus the 3D motion data. In our approach, background subtraction with direct frontal IR illumination is used. In order to produce images with high contrast between the foreground objects and the background, we use two infrared-sensitive black and white cameras (with IR-pass and visible-block filter), and two arrays of IR lamps. IR light helps to simplify the segmentation of the user's body from the background because the visibility of the human body does not depend on the colour of fabric on the human body. The computer can see the user clearly even he/she is wearing black clothes standing in front of an IR-absorb wall. These high contrast images reduce the computational complexity for separating the human body from the background based on background subtraction techniques, hence achieving real-time computation requirements.

3. SYSTEM ARCHITECTURE

The video images of the motion body are taken at orthogonal angles by the two infra-red sensitive cameras mounted outside of the 3-D canvas. From the two streams of video images, the user's position within the 3-D canvas space is calculated and the body gestures of the user are extracted and analyzed at video frame rate using a graphic workstation (a SGI Octane). A number of numerical measurements relating to the user's gesture are computed and these measurements are translated into various drawing attributes such as colour (hue, value, saturation, and opacity), stroke path and stroke cross-section (for 3D modeling).

Finally, these drawing attributes are painted onto a pair of stereo-images and projected back onto the 3-D canvas in synchronization of the user's movement, enabling real-time interaction between the user and the virtual painting and sculpture.

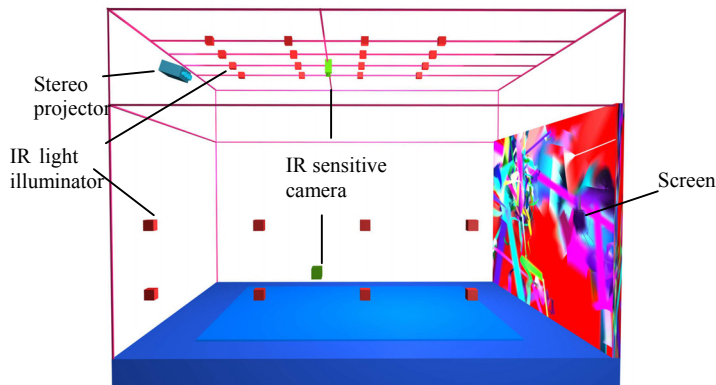


Figure 1. Illustration showing setup of Body-Brush Interface

4. VISUAL AESTHETICS

The relationship between the aesthetic visualization and the body motion pattern is built upon our visual intuition. User can choose the range of colour hue(s) in a 360° palette marked on the floor of the 3D canvas. Colour value varies according to motion speed change, while colour saturation to motion acceleration change. The body dimension as seen from the ceiling view will determine the size of the brushstroke.

The 3D position of the body-brush is related to the median points of the body as seen from the side-view and the ceiling cameras in orthogonal directions. At time of motion, the changes of height on the farthest left and right positions of the human body are added to the change of mathematical center from the side-view. If there is acceleration, the 3D path of the brushstroke will be exaggerated accordingly. This "Virtual path" simulates our intuitive conception about painting action.

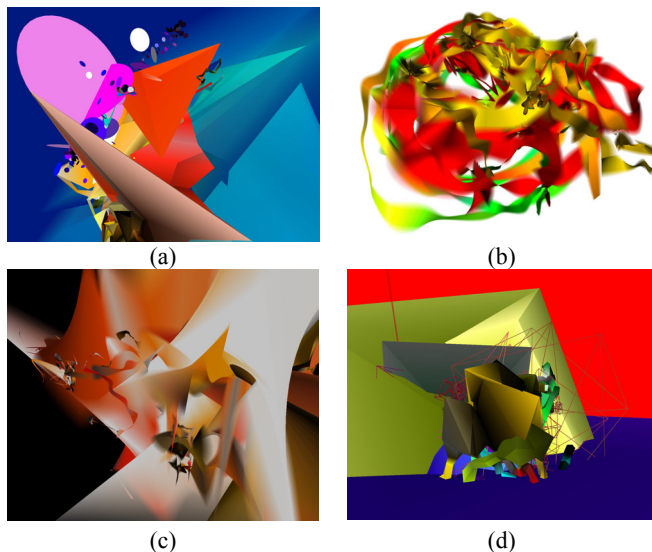


Figure 2. Pictures from Body Brush

- (a) A Kandinsky-style work by collaboration of 5 users
- (b) Work by a little boy running in circular path

- (c) Variation of colour tonality and saturation, and brushstroke style in response to body motion
- (d) An architectural structure built by 3 users

Contrast to many other interfaces, the Body Brush also provides many visual alternatives to interpret and represent human motion and gesture. The rich visual simulations can be pre-defined with a specially developed GUI (graphical user interface). Using this GUI, users can pre-set the visualization environment of the visual output in synchronization with the body motion. Moreover, a rich variety of post-production features, based on the same set of motion data, are available. The GUI also enables users to define their body-graphic mapping relations, and to walk-through the virtual space and perceive the artwork with different camera positions and composition frames. This viewing pattern, including the camera path, the preference of the visualization environment, and the time lag when searching for a new visual destination, can be tracked and documented in the system for future analysis.

5. FUTURE DEVELOPMENT

Body-Brush can be applied in diverse domains. Professional visual artist can use this intuitive interface to create rich 2D, 3D or animated visual artworks and polish the visual presentation with our GUI. Choreographers and dancer can augment their dance performance by transforming in real-time their dance into rich visual simulation. It can also provide a unique visual experience for audience in museums, galleries, or any public venue. No prior training is needed to for general audience to create vibrant pictures out of their body movement. In some sense, this interface liberates human creativity.

Future development of the Body-Brush will focus on the expansion of the audio-visual feedback dimensions of the interface. A new research, Body-Baton, aiming at transforming body motion data to simulate sound and music, has been gaining its momentum. This project, when combining with the Body-Brush, will enable us to "see picture from music and hear music from picture", through a systematic mapping of the relationships between the body movement/gesture, graphics, and music.

6. ACKNOWLEDGEMENT

This work is sponsored by an internal research grant, the Centre for Innovative Applications of Internet and Multimedia Technologies (**AIMtech** Centre) and the Research Centre for Media Technology (RCMT) of City University of Hong Kong.

7. REFERENCES

- [1] Davis, J. and Bobick, A. 1997. SIDEshow: A Silhouette-based Interactive Dual-screen Environment. *MIT Media Lab Perceptual Computing Section Technical Report No. 436*, MIT.
- [2] Sparacino F., Wren C., Davenport G., and Pentland A., "Augmented Performance in Dance and Theater", *International Dance and Technology 99 (IDAT99)*, pp 25-28, 1999.
- [3] Wren, C., Azarbayejani, A., Darrell, T., and Penland A. 1995. Pfunder: Real-time tracking of the human body. In *SPIE Conference on Intergration Issues in Large Commercial Media Delivery Systems*.