Motion Stroke-A Tablet-Based Interface for Motion Design Tool Using Drawing

Haruki Kouda[1], Ichiroh Kanaya[2], and Kosuke Sato[1]

[1] Graduate School of Engineering Science, Osaka University, Japan
{kouda-h,sato}@sens.sys.es.osaka-u.ac.jp
[2] Graduate School of Engineering, Osaka University, Japan
kanaya@design.frc.eng.osaka-u.ac.jp

Abstract. Conventional animation tools provide users with complicated operations which require them to adjust too much variables to design a virtual model's 3D motion. In the proposed system, "Motion Stroke", users can control these variables only by their 2D drawings on a tablet surface. The proposed interface allows users to create new motions through a trial-and-error process which is nature in drawing of a picture on a paper. It offers a familiar form for designing of a virtual object's motion. We conducted several evaluations and confirmed that the proposed system allows users to explore their desired motions flexibly.

Keywords: Motion deign, Drawing, User interface.

1 Introduction and Motivation

A 3D motion design of a CG model is a cumbersome and complicated task since motions of all vertices of the model have to be controlled in each frame. The Keyframing is the most general method where a user only has to assign vertices' positions in several discrete frames, and then these positions are automatically interpolated and consequently the entire motion is created. However the simple interpolation of the Keyframing is not suitable for designing of a motion whose velocity gradually changes. In such a case, a lot of keyframes have to be prepared. The user also has to take multiple vertices' motions into account at the same time. Furthermore, when preparing keyframes, theq user cannot check a generated motion. Therefore, motion design with the Keyframing assumes a well skilled user.

In this paper, we propose a motion design system called "Motion Stroke" where a user can design 3D motions of a CG model with a 2D drawing on a tablet surface. The proposed method is suitable in the early stage of motion design since the user can perform a number of 2D drawings through a trial-and-error process to explore his/her desired motions. This is similar to a case that visual artists or designers perform rough sketches in early stages of their creative activities. A velocity of a user's drawing motion is not constant but gradually changes in a similar way to a basic animation motion which is known as "Slow In and Slow Out" [3]. Therefore, in the proposed method a user easily designs such a natural motion which could not been obtained easily by Keyframing technique. Furthermore, the user can change only the artistic impression of the motion by controlling a spatial frequency of a drawing.

J.A. Jacko (Ed.): Human-Computer Interaction, Part II, HCII 2009, LNCS 5611, pp. 821–829, 2009.

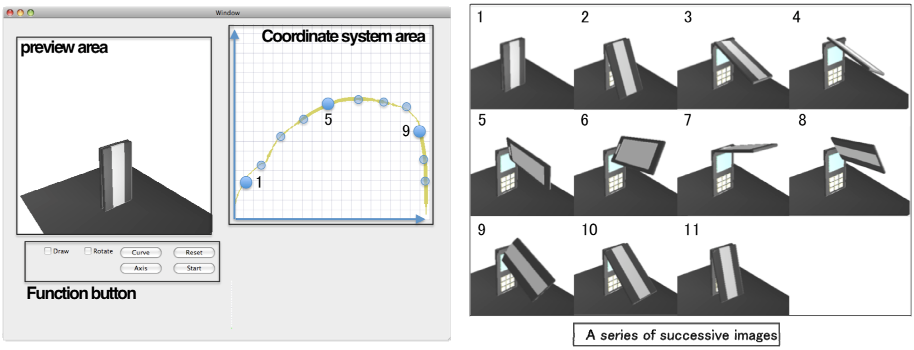

Fig. 1. System overview and design of motion (left) The system consists of simple GUI parts; preview area, function buttons, and coordinate system area. In the coordinate system area, two motion control parameters are assigned to each axis. (right) A new motion combined two simple motions arbitrarily is generated with the drawing in coordinate system area and result is continuously displayed in preview area.

The remainder of the paper is organized as follows: in the next section we briefly describe related works. Following this, Sec.3 presents the detailed principle and implementation of our proposed motion design method. In Sec.4, we describe the evaluations. We conclude with a direction for further work in Sec.5.

2 Related Works

A lot of approaches in making motion such as motion capture and physically based simulation have been developed. For example, performance-driven motion and puppeteering usually rely on a specialized input device or a motion-capture system [8]. The direct mapping that they assign between the character's DOFs and the device's DOFs requires a significant learning for the system. Shin et al. [7] proposed a motion capture methods for assigning a performer's full body motion to virtual characters of different sizes. Dontcheva et al. [2] proposed layered acting method that the user designs complex motions by multiple acting passes. These techniques are expensive to use and are not suitable for use of designing imaginary motions. An intuitive motion interfaces for novice users without special devices has been studied for many years.

To help novice users create motions easily, many new interfaces have been proposed. K-sketch [1] is a pen-based system that relies on users' intuitive sense of space and time while still supporting a wide range of uses. K-sketch enables users to create 2D animations, informal, for general purpose. Motion Doodles[10] is an interface for sketching a character motion. Users' drawings such as lines, arcs, and loops are parsed and mapped to a parameterized output motions that further reflect the location and timing of the input sketch. These two tools are produced with an aim of building working surroundings in which users' labor effectiveness have been reduced. But, with their system, because of use with motion library or interpolating technique, the range of motions that are made by is restricted and fine adjustment is so lazy work.

Performance timing for keyframe animation [9] is an interface to time keyframes using gestures without changing the motion itself. The system allows users to do act-out the timing information using a simple 2D input device such as a mouse or pen-tablet. Because of design limitation in the system, setting keyframe process and preview process is separated.

Ngo et al. [5] used an interpolation technique for manipulating 2D vector graphics. Key poses are embedded in a special structure called a simplicial configuration complex. Rademacher [6] used an interpolation for controlling the view-dependent geometry. Key geometries are associated with specific view directions and are blended according to the current view direction. Laszlo et al. [4] combined interactive character control with physics-based simulations. They showed an example in which the horizontal and vertical motions of the mouse were directly mapped to the character's individual DOFs.

3 "Motion Stroke" System

The proposed system "Motion Stroke" consists of a pen tablet (WACOM; Cintiq) and a computer (MacBook: Intel Core2Duo 2.1GHz, memory 2GB) as shown in Fig.2. Left figure of Fig.1 shows the outlook of the implemented software which consists of "preview area" where generated motions are displayed, a few "function buttons" and "coordinate system area" where users perform 2D drawings.

In the "coordinate system" area, two motion variables such as translation along x-axis or rotation around y-axis are assigned to horizontal and vertical axes respectively (Fig.3). Each point in the coordinate system represents a position and pose of a manipulated model, and thus a set of points on a user's drawing line represents a motion sequence. Users can control the two motion variables at the same time only by drawing a line in the "coordinate system area". Generated motions can be checked in the "preview area" while drawing lines. Therefore users can easily explore their desired motions through a simple trial-and-error process where they just draw-and-erase lines in the "coordinate system area". Furthermore, users can easily change the velocity of the motion only by controlling their drawing speeds. Right figure of Fig.1 shows an example of a generated motion with the proposed method. In this case, two different rotations around a hinge of a mobile phone model are assigned to the axes of the "coordinate system area". It is confirmed that a complicated 3D motion can be designed with a single 2D drawing line.

To combine more than three motion parameters, we propose to assign drawing parameter to the horizontal axis in a new coordinate system area. Fig. 4 shows the concept of the process. Drawing a line, users combine two motion parameters a and b.

The line is fitted to approximated curve L(s), and a new coordinate system area which s is assigned to horizontal axis is generated. After assigning additional motion parameter c to the other axis, user can combine motions. Fig.4 shows the concept diagram of this process.

To adjust artistic features of an input drawing, we implemented two types of modification functions. First one is to adjust the strength of drawing fluctuation. In the system, according to the position of "Smoothness" slidebar controlled by a user, the strength is changed as post processing. We assume that the fluctuation mainly appears in the middle components ($\pm$24~48 components) of P-type Fourier descriptor. The position of the slidebar indexes the weight of the middle components.

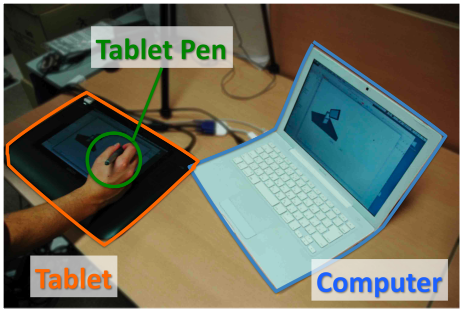

Fig. 2. Outlook of the system

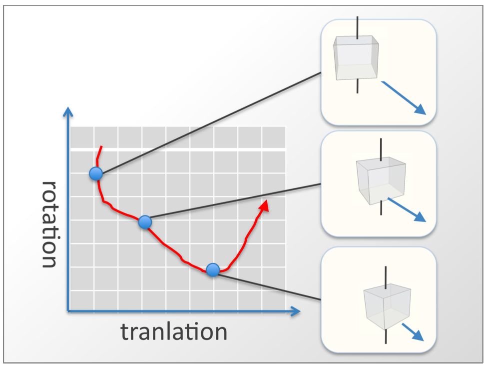

Fig. 3. Concept diagram of coordinate system view. A point in the view indicates a certain position and posture of the object. By changing the shape of drawing, user can combine two motions arbitrarily. By changing the speed of drawing user can adjust the timing of motion.

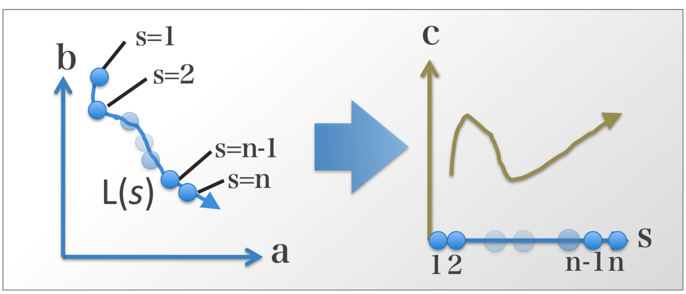

Fig. 4. Assigning motion to parameterized axis. Drawing parameter *s* was assigned to horizontal axis in new coordinate system area. Additional motion parameter *c* is assigned to vertical axis.

Another adjusting function is to regulate drawing velocity. “Constant” button fixes to a certain constant velocity in drawing, although the user may change the velocity of pen in input area. Once the user pushes the button, the smoothness of the drawing is normalized in time domain.

4 Evaluation

We conducted three kinds of experiments to evaluate how accurate users can reproduce their desired motions, how users use the proposed system when controlling more than two motion variables, and how an impression of a motion is changed when the spatial frequency of a drawing is changed.

4.1 Accuracy of Motion Reproduction

The first experiment was conducted to evaluate how accurate users can reproduce their desired motions. We prepared four sample 3D motions (i.e. four sample corresponding 2D lines shown in Fig.5). In the experiment, we let participants to watch sample motions and estimate the corresponding 2D lines. They could watch the samples anytime they wanted and drew lines in the “coordinate system area” and checked motions in the “preview area” until they thought they could draw correct lines. After that, we calculated the similarity between two drawing lines: a sample drawing line and a line drawn by a participant. We applied P-type Fourier descriptor for the line similarity calculation. Using P-type Fourier descriptor, a line is expressed as Fourier components. In the experiment, feature vector of each line is defined as a vector composed with 11 components that are the lowest of Fourier components (DC component and ±1~5 components). The line similarity is defined as Euclidean distance between two feature vectors.

We recruited four participants from the local university. We explained all the system features to each participant, but did not show any demonstrations. Each participant practiced to use the system for ten minutes. Fig.5 shows the results of the estimated lines and Table.1 shows the calculated line similarities between sample lines and estimated lines. Note that a participant couldn’t estimate any lines in sample 3 and 4.

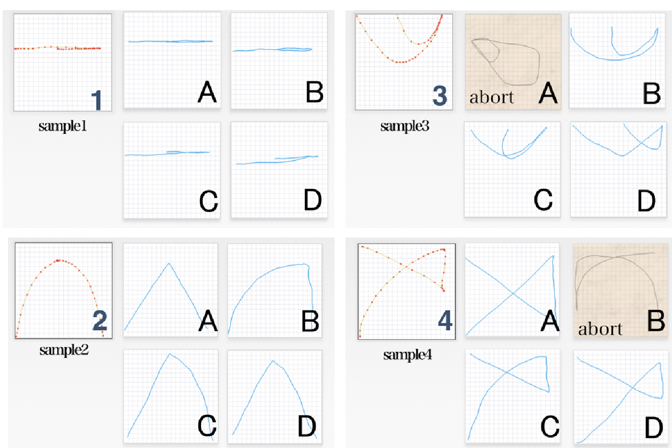

Fig. 5. Sample drawings and subjects input drawings

Table 1. Index of line similarity between sample lines and estimated lines

Subjects \ Sample	Sample1	Sample2	Sample3	Sample4
A	66.2	146.4	(×)	222.1
B	58.4	141.1	158.4	(×)
C	41.2	103.2	136.1	81.8
D	78.8	114.0	324.4	139.5

The results show that though participants could estimate correct lines in case of simple motions such as sample 1 and 2, it was difficult to estimate the correct lines in case of complicated motions. Therefore, a user of our system can reproduce the desired motion correctly when the motion is simple.

4.2 Observation of Motion Design Process

The second experiment was conducted to observe how users use the proposed system when controlling more than two motion variables. In the experiment, we used human–type object that contains four movable components; leg, hip, arm and shoulder. Combining four motions of these components, participants were asked to make walking motion. Fig.6 shows the overview of application used in the task. Selecting *checkbox* placed each sides of axis of coordinate system area, participants can select motions that should be combined by drawing. Pushing *Axis button*, a new coordinate system area in which parameter of drawing is assigned to horizontal axis is generated. Pushing *Play button*, participants can replay the motion.

We recruited three participants from the local university. We explained all the system features to each participant, but did not show any demonstrations. Each participant practiced to use the system for ten minutes with same model as mobile phone object used in 4.1. After the practice, each participant started the task. At the task, there was no time limitation.

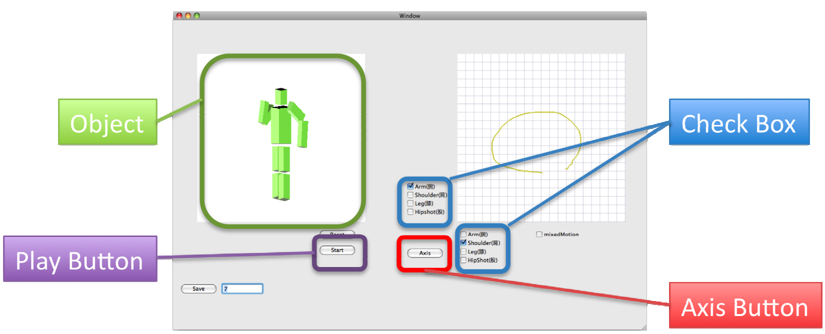

Fig. 6. Application overview used in the task

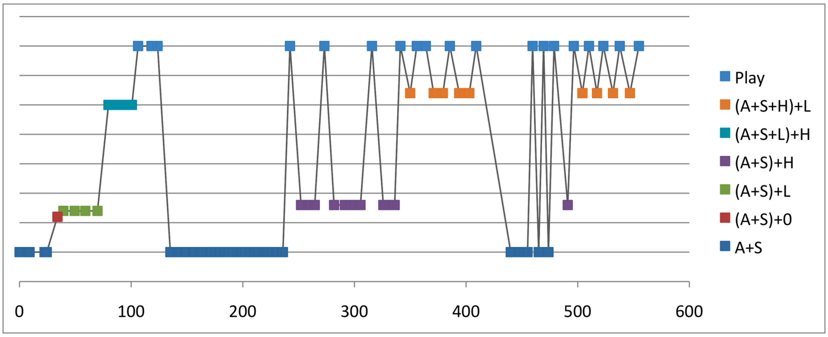

Fig. 7. Proceed history of the task by user A Horizontal axis shows time [sec], and vertical axis shows category of motion combined (A:arm, S:shoulder, L:leg, H:Hip)

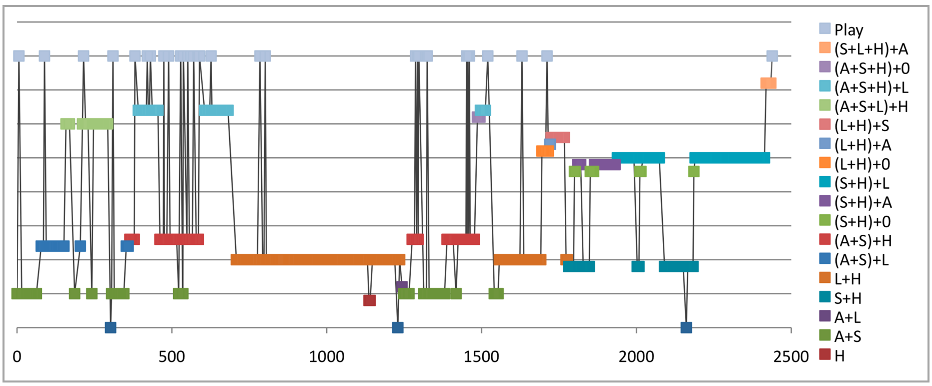

Fig. 8. Proceed History of the task by user B

Fig.7 shows the history of the task by user A. X-axis of graph shows time [sec] and Y-axis shows category of combining motion. For example, from 120[s] to 240[s], user A combined arm and shoulder motion, and after that, she pushed "*Play button*" once to replay the motion and start further combining hip motion. From the history, user A could combine four motions in first two minutes at the task. She also rarely used "Play button" to replay the motion in the early stage of the task. It may be said that these behavior are caused by familiarity or work efficiency of the proposed system. From the interview with user A after the experimental task, she said that she could draw lines without watching coordinate system area, but with preview area. It seemed that she could combine motions since with physical activities of hand drawing. Using the system, she could draw lines and check generated motions simultaneously.

On the other hand, Fig.8 shows the history of task by user B. This participant tried to create variety new motions by changing the order of combining motions. From the interview with user B, same as user A, he could understand the way to use of application in short time, and explored his desired motion flexibly.

Throughout this experiment, we speculate that user had become familiar with the operation method of the system in a short time. They also could complete the task using advantage of drawing in work efficiency or sensuous operation.

4.3 Evaluation of Motion Impression

In this evaluation, we checked if a spatial frequency of a drawing line could control the impression of a motion. We prepared the following five motions with a CG model of a mobile phone introduced in Fig.1. The "motion 1" is the basic motion composed with three sequences; (1) the phone is opened, (2) the monitor is twisted, (3) the phone is closed while twisting (we refer a line used to make motion 1 to sample line). By resampling points on sample line equally-spaced, The "motion 2" is obtained. Motion 3(motion 4) is obtained with a line that is made by multiplying middle-Fourier components of sample line by 4(8). Motion 5 is obtained with a line that is made by removing middle-Fourier components of sample line.

We prepared 5 pairs of adjectives (hard-soft, ugly-beautiful, rough-smooth, heavy-light, natural-artificial) and a questionnaire according to a 7 point Likert scale.

The result shows the participants felt "motion 2" is heavier than "motion 1". It seems that fluctuation in time of line used to obtain motion 2 affected the impression of weightiness.

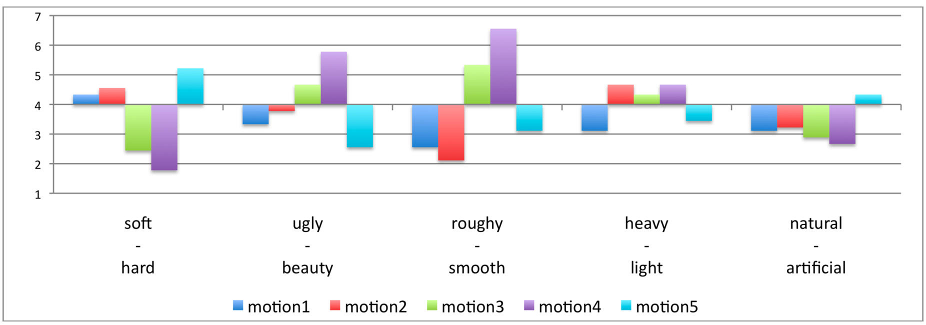

Fig. 9. Result of questionnaire

Moreover, the participants felt "motion 3 or 4" is harder, uglier, heavier and rougher than "motion 1". On the other hand, "motion 5" is more natural than "motion 1". It seems that fluctuation in space of line used to obtain motion 3, 4 or 5 affected the impression of refinement.

5 Conclusion

In this paper, we proposed a novel motion design system "Motion Stroke" where users can create a wide range of 3D motions with simple 2D hand drawings. Three types of experiments show the proposed system is sensuous for creating simple motions in the early stage of the motion design, where it allows users to control impressions of designed motions.

For future work, it is necessary to design the interface considered not only the variable adjustment process but also the shape design process or the variable definition process.

References

1. Davis, R.C., Colwell, B., Launda, J.A.: K-sketch: A“ Kinetic ”Sketch Pad for Novice Animators. In: CHI 2008 Proceedings, pp. 413–422 (2008)
2. Dontcheva, M., Yngve, G., Popovic, Z.: Layered Acting for Character Animation. ACM Transactions on Graphics 22(3), 409–416 (2003)
3. Lasseter, J.: Principles of Traditional Animation Applied to 3 Computer Animation. Computer Graphics 21(4), 35–44 (1987)
4. Laszlo, J., van de Panne, M., Fumie, E.: Interactive Control for Physically-based Animation. In: Proceedings of ACM SIGGRAPH 2000, ACM Press / ACM SIGGRAPH, Ed., Computer Graphics Proceedings. Annual Conference Series, pp. 201–208. ACM, New York (2000)
5. Ngo, T., Cutrell, D., Dana, J., Donald, B., Loeb, L., Zhu, S.: Accessible Animation and Customizable Graphics via Simplicial Configuration Modeling. In: Proceedings of ACM SIGGRAPH 2000, ACM Press / ACM SIGGRAPH, Computer Graphics Proceedings. Annual Conference Series, pp. 403–410. ACM, New York (2000)
6. Rose, C., Bodenheimer, B., Cohen, M.: Verbs and Adverbs: Multidimensional Motion Interpolation Using Radial Basis Functions. IEEE Computer Graphics and Applications 18(5), 32–40 (1998)
7. Shin, H.J., Lee, J., Gleicher, M., Shin, S.Y.: Computer Puppetry: An Importance-Based Approach. ACM Transactions on Graphics 20(2), 67–94 (2001)
8. Sturman, D.J.: Computer Puppetry. IEEE Computer Graphics and Applications 18(1), 38–45 (1998)
9. Terra, S.C.L., Metoyer, R.A.: Performance Timing for Keyframe Animation. In: Eurographics/ACM SIGGRAPH Symposium on Computer Animation (2004)
10. Thorne, M., Burke, D., Van de Panne, M.: Motion Doodles: An interface for sketching Character Motion. ACM Transactions on Graphics, TOG (2004)