https://doi.org/10.5392/IJoC.2018.14.2.041

Emotional Communication on Interactive Typography System

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ABSTRACT

In this paper, we propose a novel method for developing expressive typography authoring tools with personal emotions. Our goal is to implement an interactive typography system that does not rely on any particular language and provides an easy, natural user interface and allows for immediate interaction. For this purpose, we converted the text data entered by a user to image data. The image data was then used for interaction with the user. The data was synchronized with the user's skeleton information obtained from the depth camera. We decomposed the characters using the formality of language to provide a typographical movement that responds more dynamically to the user's motion. Thus, this system provides interaction as a unit of characters rather than as a whole character, allowing the user to have emotional and aesthetic emotional immersion into his or her creation.

Key words*: Interactive Typography, Emotional Typography, Interaction Point, Skeleton Point.*

1. INTRODUCTION

In recent years, with the popularization of multimedia, a culture in which images, sounds, and characters are generally used has been formed. And interest in interactive typography which is a communication environment is growing. Interactive typography is the technique by which the user interacts with text with elements of movement for the purpose of communication.

Various tools for producing interactive typography are being developed [1]-[4]. The three common problems to the interactive typography authoring tools that have been developed so far is summarized as follows. The first is that it is limited to specific users. Today, the most way to create interactive typography that is divided into words or characters is to use professional animation or programming tools. However, this method requires specialized techniques and cumbersome production processes, making it difficult to produce kinetic typography effectively. The second, there are insufficient to reflect the active interaction of users. Existing systems have limited flexibility because they predefine user-selectable animation templates. The third is language-specific. Most typography systems only support certain languages, so you need to create a new system to use other language. This is a difficult, time-consuming and costly task.

Therefore, it is required to develop an interactive typography system which solves the above three problems. This paper aims to maximize the user's emotion by proposing and developing an interactive typography authoring tool which is actively interactive, language independent with natural user interface.

The methods proposed in this paper is as follows. First, graphic user interface that is easy to use by non-experts is designed, and techniques are provided for users to interact naturally by using gesture recognition technology. Then, a character decomposition method is used for the design of typographical actively interacting with the user. In the media exhibition, the user's experience interacting with the deconstructed characters rather than the chunky characters will induce the user to engage in typography system with active interaction.

The remainder of this paper is organized as follows. In Sect. 2, we review some works related with the proposed system. In Sect. 3, the proposed system is presented in detail. We conduct implementation and evaluation in Sect. 4 and conclude this paper in Sect. 5.

2. RELATED WORK

With the recent development of various sensors and computing power technologies, smart interaction between human and digital devices has become possible, and interface technology supporting natural human gestures is increasing rapidly. Research on interactive typography that reflects the user's participation directly in typography, which is a manifestation of this type of media change, is also active.

[2] is a kinetic typography authoring tool using a GUI method, and provides an editor type interface and supports a kinetic typography composed of up to 14 words. [3] is an interactive typography that introduces elements of the game as a way of interacting with typography and helps children to

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Manuscript received Nov. 21, 2017; revised Jun. 28, 2018; accepted Jun. 28, 2018

learn the language. [4] is an interactive typography video production tool that considers audio signals. This tool provides users with a GUI environment for creating and editing audio and synchronized animations.

Most of interactive typography authoring tools described above are targeted at English language and their animation unit is a character not a word. The English word has a simple structure in which characters are listed. So further decomposition in character is meaningless because it is less readable by humans. However, Korean words are decomposed into characters, and characters are again decomposed into vowels and consonants in a character. This is a common feature found in the languages of many Asian countries located in the cultural area of Chinese character. If animations based on the morphological features of these languages are performed in interactive typography, people will read and feel typography with the feeling of reading musical characters.

3. PROPOSED INTERACTIVE TYPOGRAPHY SYSTEM

Fig. 1 shows an interactive typography system that is language independent and responds to user gestures in real time. The proposed method consists of four processes: image processing, motion tracking, skeleton matching, and data visualizing.

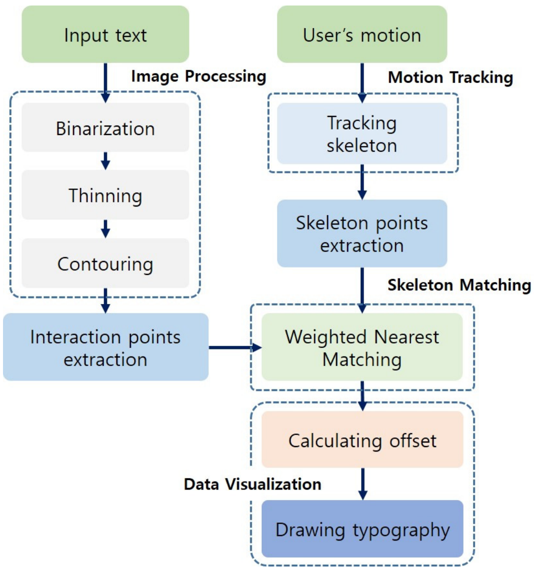

Fig. 1. Interactive typography system overview

In order to construct a language independent system, input character is processed as image data rather than text in this paper. Binarization, Thinning, and Contouring are used to extract interaction points to communicate with users. The interaction points are then matched with extracted skeleton points by performing motion tracking of the user. The typography is drawn according to the matched skeleton points. At this time, the drawing points are determined by calculating a separate offset value in order to maintain the shape of the character with drawing.

The proposed system allows both keyboard input and drawing input, and output can also choose between 2D and 3D.

3.1 Image Processing

In this paper, preprocessing is performed to convert input character data into image data in order to maximize the motion effect of the text in real time. Image processing that converts characters to images has two advantages. One is that all the character data that can be input by the computer is recognizable. This ensures that the system proposed in this paper is not restricted to a specific language. The other is that it is possible to divide the components that make up the image so that more dynamic interaction is possible.

3.1.1 Preprocessing: In order to extract the minimum components of the input character from the user, the character data is outputted to the canvas of a predetermined size, and then the output image is captured and binarization is performed. Then the binarized image is inverted considering the convenience of work process.

In order to maintain the typography shape and interact with the user, information about several special points constituting the typography is required. These points are referred to as interaction points in this paper. The information of interaction points which are minimum points constituting the input image is extracted and these interaction points are connected with the user's skeleton points to show dynamic motion in real time. Information about interaction points is obtained through two steps: thinning and finding contour.

3.1.2 Thinning: The thinning algorithm is a process of extracting a skeleton which is a line of a pixel size for a target object. Thinning is a typical technique for extracting structural features from input images and has been used in a wide variety of image processing fields including character recognition. Among the existing thinning algorithms, there are ZS algorithms proposed by T. Y. Zhang and C. Y. Suen as proven algorithms [5]. In this paper, thinning using ZS algorithm is performed.

3.1.3 Contouring: The thinning result of the input image represents each thick line as a thin line with a thickness of 1 pixel. So, when interacting with only result image, each line cannot be moved individually, and lacks the feeling of liveliness.

In order to move a character actively corresponding to the human motion, the coordinates of the minimum points constituting the separated object (line) and the information on the direction connecting them are required. To do this, we use FindContours() function in OpenCV to separate the contours of thinned typography and find the hierarchical structure for each contour [6]. Outline detected as a result of contouring is represented by chain code. This is a set of interaction points and is used to control the character separately. The vector information for the interaction points resulting from the contouring leads to a line in an object that is separated in the subsequent drawing operation. Fig. 2 shows the results after thinning and contouring for each character.

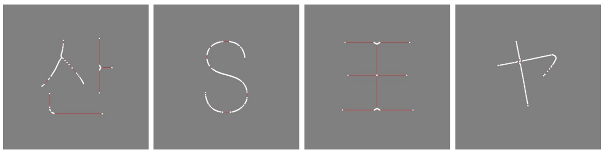

Fig. 2. Extracted interaction points by thinning and contouring

3.2 Skeleton synchronization

In this paper, a non-tactile gesture based interface that reacts immediately to the user's actions and reflects the results through the display is designed with Kinect.

In order for interactive typography to react instantly to the user's movements, it is essential to synchronize the user's skeleton information obtained from Kinect with the image information of the typography. For this purpose, the interaction points from the image processing of the typography are connected to the skeleton points of the user.

3.2.1 Matching gesture to typography: The matching between the skeleton points of the detected users and the interaction points of the typography is made by using the Euclidean distance between the two closest distance points. This method is called nearest matching in this paper. Euclidean distance is an algorithm to find the distance between two points in N dimension. When there is an interaction point $I_i = (I_x, I_y)$ and a skeleton point $S_i = (S_x, S_y)$ in two dimensions, the Euclidean distance using the distance between two points as a measure of the relationship is calculated by the following equation [7].

$$dist(I_i, S_i) = \sqrt{(I_x - S_x)^2 + (I_y - S_y)^2} \qquad \textbf{Eq. (1)}$$

From the results of nearest matching, we can see that the movement concentrates on a specific skeleton such as arms and legs in human motion. Thus, we guessed that human interaction would be richer if we give low weight to specific skeleton point and match a larger number of interaction points to a preferred skeleton point.

3.2.2 Weighted nearest matching: In this paper, we propose a method of assigning low weights to frequently used skeleton such as arms and legs to maximize emotional interaction. Weights are determined automatically based on the average moving distance of each skeleton point. Here, the range of weight values must be $0.5 \le w_i \le 1.5$. If the weight is not limited to the range of 0.5 to 1.5, the interaction points in the center of the body are matched with the skeleton point of the hand or foot, and the entire points of character moves along the hand.

Using the weighted nearest matching method, Equation 1 is modified as follows.

$$dist(I_i, S_i) = w_i \times \sqrt{(I_x - S_x)^2 + (I_y - S_y)^2} \qquad \textbf{Eq. (2)}$$

Fig. 3 shows how are matched the interaction points and the user's skeleton points for each character.

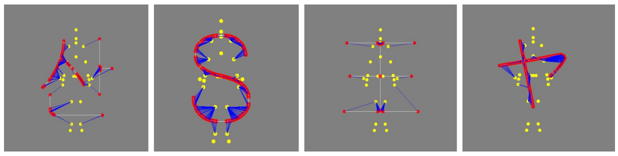

Fig. 3. Matching the interaction points of character and user's skeleton points

3.3 Data visualization

The interactive typography system developed in this paper starts to be activated from the moment when the user's joint information is recognized and draws the figure during the set interaction time according to the tracked skeleton information. At this time, each skeleton points is drawn in the same scale space as the input image.

3.3.1 Calculating offset: When you draw a character, matching the interaction points to the location of the skeleton points breaks the shape of the character. This is because human joints and characters have a completely different shape. Distorting the character's shape is like undermining the meaning of the text message of the user. Therefore, it is necessary to correct the errors that occur in matching.

In order to maintain the character shape, the distance between the skeleton point $S_i = (S_x, S_y)$ and the interaction point $I_i = (I_x, I_y)$ in the user's standard pose should be kept constant. In consideration of this, the offset value is calculated by the equation (3). In this equation, $S'_i = (S'_x, S'_y)$ is the position value of the new skeleton point moved by the user.

$$offset(x, y) = (S'_x \times \frac{I_x}{S_x},\ S'_y \times \frac{I_y}{S_y}) \qquad \textbf{Eq. (3)}$$

3.3.2 Drawing typography: In general, when the user accesses the three-dimensional stereoscopic contents rather than the monotonous contents on the plane, the sense of reality is increased.

We select line as the basic element for visualizing interactive typography on the screen. Lines that match the user's motion can be expressed in 2D or 3D according to the user's needs. Like a line consists of dots in 2D space, a 3D object consists of lines in 3D space. Fig. 4 shows the shape of a 3D object made up of lines.

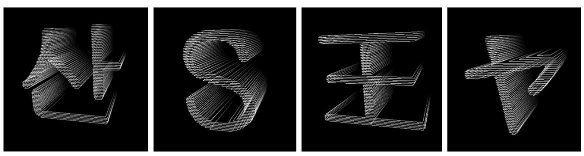

Fig. 4. 3D shapes of typography

4. IMPLEMENTATION AND EVALUATION

The proposed system was implemented by using Kinect for Windows SDK 2.07 and OpenCV 3.2, Visual Studio 2015 C++ language, Openframeworks 0.9.8.

Fig. 5 is a screenshot of entered typography using the touch pad. The input using the touch-pad can be extended to general drawing work. Allowing the user to draw various attributes helps the user to be more immersed in the free display environment.

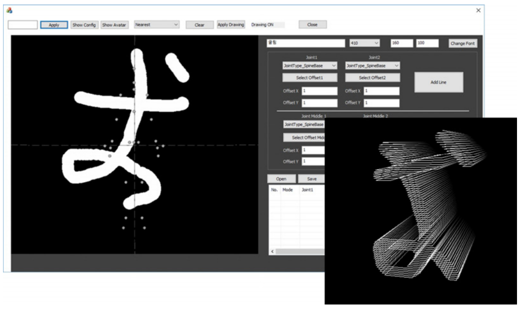

Fig. 5. User interface and 3D interactive typography screenshot

At present, the standard that can objectively compare the performance of the interactive typography proposed in this paper is not properly set. In particular, interactive typography includes not only a visualization for object recognition and drawing task, but also an interaction with the user, so there are few comparative studies.

Two evaluations methods are performed to demonstrate the performance of the proposed system. One is the objective evaluation which measures the dynamic level of the user's interaction and the other the subjective evaluation which the questionnaire survey about the satisfaction of the interaction is performed.

The dynamic degree of the user's interaction is measurable by how aggressively the user interacts. After 5 users experienced interaction with 22 characters, we measured the percentage of typographical interaction points and the matching of 10 high priority skeleton points. As a result, we found that the weighted nearest matching rate 50.66% is higher than the nearest matching rate 38.40%.

The subjective evaluation of the proposed system consists of a questionnaire survey of 20 participants participated in this system. Experiments on English and Korean showed that participants were satisfied with about 83.5% for our interactive typography system. It is expected that the high level of satisfaction of the participants is due to the effect that the components of the characters move separately according to their gestures.

5. CONCLUSION

In this paper, design and implementation method of an interactive typography system that responds to a user's gesture in real time is proposed. The proposed system is a typography authoring tool that provides an easy user interface and immediate and dynamic interaction that is not dependent on a specific language. Language-independent system can save time and cost of separately producing typography for each language. And in order to provide a more dynamic movement of the typography synchronized with the user's motion, the characters were disassembled using the formative features of language. Interactive typography of moving components separately rather than lumps gives a feeling of alive to user.

As a result of testing the developed interactive typography, users showed immersion and satisfaction in moving typography like their avatar. This means that interactive typography is a means of conveying various emotions through interaction, rather than just showing simple character movements to the user. The interactive typography system proposed in this paper especially dynamic and effective in Hangul, Japanese, and Chinese, which can decompose text.

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