A Sustainable Practice Method of Hand-drawing by Merging User's Stroke and Model's Stroke

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ABSTRACT
Nowadays, people have become able to publish their comics easily because of the spread of Web services featuring their own content. However, it is not easy for them to publish such comics because of the difficulty of improving their hand-drawing skill. One practice method is tracing. However, it is not easy for people to maintain motivation for this practice method. In this paper, we propose a method which enables people to improve their hand-drawing skills and motivation by creating a merging of their hand-drawn character and a corresponding model which is drawn by others automatically. We validate the usefulness of our method by using the system and show how to change the appearance of illustrations.

CCS Concepts
• CCS → Human-centered computing → Human computer interaction (HCI) → Interaction devices → Displays and imagers

Keywords
Hand-drawing character; Average Character; Hand-drawing skill; Motivation; Practice Method

1. INTRODUCTION
Nowadays, people have become able to publish their illustrations easily because of the spread of Web services supporting users who wants to train hand-drawing skill generated content such as “pixiv” and “Nico Nico Douga”. In addition, people have also become able to share their content easily in Comiket (the Comic Market in Japan) which is the largest self-publishing fair in the world. In fact, there are a huge number of comics and readers of such comics. This situation has allowed beginners to produce comics easily.

Although there are many ways for people to share their own illustrations, it is not easy for people to create comics because creation of comics requires good hand-drawing skills and a good deal of creativity. In order to solve these problems, many methods and software have been developed. These enable people to create comics easily.

In this paper, we focus on how to improve users' hand-drawing skills. One of the basic methods of hand-drawing practice is tracing. The tracing method requires users to trace model’s stroke and to practice many times. It is not easy for users to maintain their motivation to practice by tracing. As a result, tracing often bores users and they give it up. Another practice method is imitative drawing. In the practice of imitative drawing, users again are predisposed to give up practice because it is not easy to make a user’s hand drawing look like the model of imitative drawing.

In order to maintain motivation for hand-drawing practice, we propose a method that merges the user's hand-drawing and the model's hand-drawn strokes dynamically. We believe that users can enjoy the practice of hand-drawing by using our method because our method beautifies a user's hand-drawn illustration and increases the user's satisfaction with drawing. Thus, our study might improve the user's hand drawing skills.

First, we discuss related work. Then, we propose a method to merge a user's hand-drawing and the model and introduce the prototype system based on our method. After that, we conduct an experimental test by using our system, and clarify the usefulness of our system. Finally, we conclude this paper and discuss future work.

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2. RELATED WORKS
Kim et al. [1] proposed a method to create a story of an original comic based on a large number of analyzed data on comics. This method produces templates for previous data of comic based on these analyzed data. Although Kim et al. focused on producing templates, we focus on producing illustrations.

ComiPo! [2] is a comic design software which does not include hand drawing techniques. That is because this software allows users to select 2D images of a character from prepared 3D data. In this system, users can control 3D characters in order to utilize them as 2D images. Then, the users can choose the shape of each component of the character’s face such as parts of the eye, mouth and hair. Users can easily make characters. However, they cannot

create their own characters. Our method enables users to draw their own characters by hand.

Limpaecher et al. [3] proposed a method to support drawing based on a data of other's stroke. In this method, when a user makes original strokes by hand, the system automatically adjusts the strokes by using a crowd-sourced drawing database. Zitnick et al. [4] proposed a method to beautify the user's hand-drawing based on the user's own strokes. In this system, the user draws strokes and this system finds matching sets of samples within individual database. Then, the user's strokes are merged and the sample strokes which are most similar to the user's. Participants evaluated the merged strokes as beautiful. Simo-Serra et al. [5] proposed a technique to convert rough sketches into simplified sketches automatically. This method consists of a fully convolutional neural network that is not like most existing convolutional neural network. Their method is able to improve the state of the illustration's pencil sketches.

Although these methods convert the user's strokes and do not focus on improvement of the user's own hand-drawing skills, our approach also converts the user's strokes and focuses on improving the user's handwriting skill.

Yoshino et al. [6] developed the game software for Nintendo DS. This game enables people who have some problems about literacy to train handwriting. This software gets users to maintain learning motivation by gamification.

Fukuya et al. [7] proposed and implemented a piano learning system that considers how to maintain the motivation. Up to now, the way of learning the piano has been that people have to read the music and practice it little by little. Therefore, it takes a long time to reach a goal and they accumulate frustration. However, this system expands the allowable range of mistakes and complements mistakes. As a result, the learner can have a successful experience while practicing and maintain their motivation. The aim of our approach is to give users a successful experience and learning hand-drawn illustration effectively.

A great deal of effort has been put into supporting the comic creators. What seems to be lacking, however, is that users do not draw illustrations with a great deal of personality. In addition, one of the basic practices of hand-drawing is simple work; tracing, copying a model. This makes people bored and leads them to give up practicing. If people want to change hand-drawing skill and acquire better drawing, people need to make a great effort to practice the illustrations for a long time.

Now, the purpose of this paper is to improve user's hand-drawing skills in a sustainable way and also improve motivation. We are concerned with a method to merge the user's hand-drawing and that of a model. Additionally, we assume that this method maintains their motivation.

3. PROPOSAL METHOD

In this chapter, we explain our sustainable training method that merges the user's hand-drawn stroke and model's hand-drawn stroke.

3.1 Interaction Model

As previously noted, it is possible that tracing and imitating can make users bored. In this work we aim at keeping the users' motivation without them becoming bored.

In order to archive the objective, we propose the following cycle which enables users to improve their hand-drawing skills with motivation (see Figure 1). Then, we explain this cycle.

1. A user selects a cartoon character of a model.
2. The user tries to draw the character by hand.
3. At the same time, our system merges the user's hand-drawn strokes and the model's strokes simultaneously and displays the merged one. The merged one is similar to the model.
4. The user imagines that the merged stroke is hand-drawing by him/herself because the system merges his/her stroke and the model's stroke and displays the average stroke in a moment, and the character can be recognized as his/hers. After that, user enjoys the practice because user can draw the character more beauty than previous hand-drawing character. Go to 2.

The user's hand-drawn character will become better than the first one after several trials of this cycle because the user recognizes a merged character as his/her own hand-drawn character and then, learns character's form. The user can obtain good hand-drawing skill naturally when this cycle is completed.

We constructed our system, which enables users to practice based on this cycle. In addition, we examined what changes appear in the hand-drawing when users actually make use of our system.

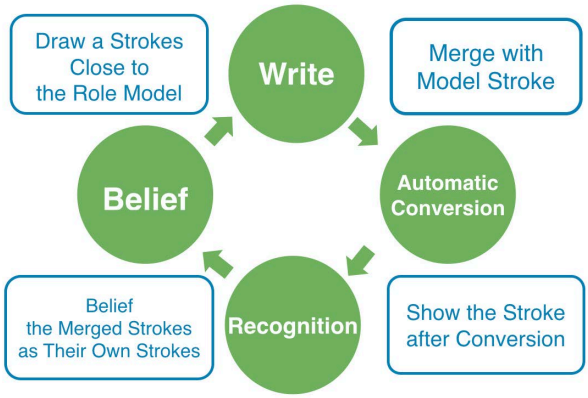

Figure 1. Cycle for improving user's hand-drawing skills

3.2 Merge Algorithm

In this work, we utilize users' hand-drawn characters as mathematical expressions in order to merge a user's hand-drawn character and a model's stroke as follows.

1. When a user draws a stroke of a target character, the method acquires the user's stroke as a series of points.
2. Next, this system increases the number of points of this stroke by spline interpolation.
3. This system executes Fourier series expansion by using these interpolated points in order to express the stroke as mathematical expressions. The mathematical expressions are generated by the parametric representation t as follows

$$\begin{cases} x = f(t) \\ y = g(t) \end{cases} \quad -\pi \le t \le \pi.$$

$f(t)$ indicated as below($g(t)$ is as same as $f(t)$)

$$f(t) = \frac{a_0}{2} + \sum_{n=1}^{\infty} (a_n \cos nt + b_n \sin nt).$$

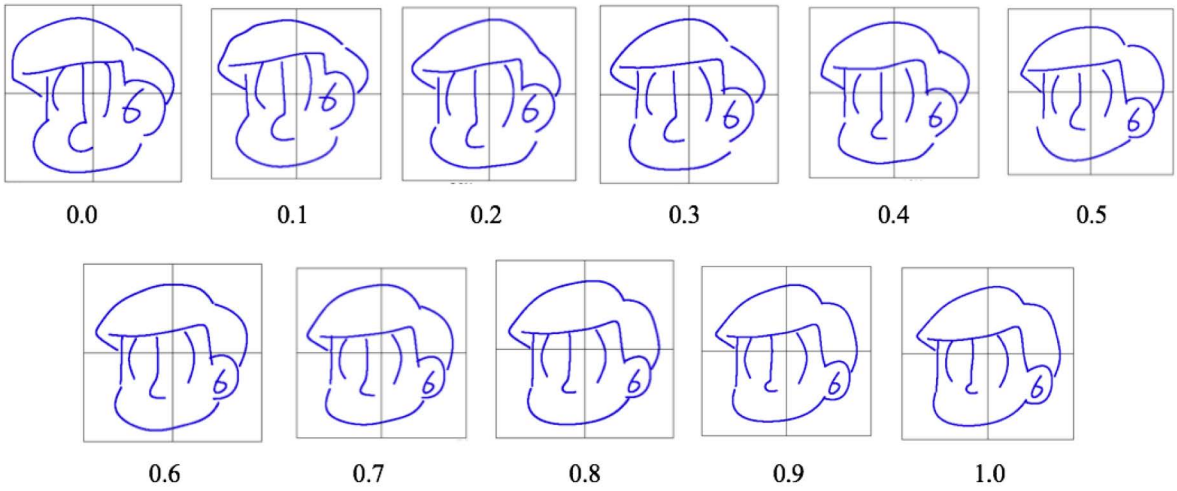

Figure 2. Weighted average illustrations from 0.0 to 1.0

By using this algorithm, we can express the mathematical expressions for a stroke of the model as follows

$$\begin{cases} x = f_{model}(t) \\ y = g_{model}(t) \end{cases} \quad -\pi \le t \le \pi.$$

On the other hand, we can also express the mathematical expressions for a stroke of the user's hand-drawn character as follows

$$\begin{cases} x = f_{user}(t) \\ y = g_{user}(t) \end{cases} \quad -\pi \le t \le \pi.$$

As a result, the average formula of this stroke is the following the mathematical expressions

$$x = \frac{f_{model}(t) + f_{user}(t)}{2}$$

$$y = \frac{g_{model}(t) + g_{user}(t)}{2}.$$

This average hand-drawn stroke is displayed by changing the value t from $0\ to\ \pi$.

In this paper, we introduce the weighted value $\alpha(0 \le \alpha \le 1)$ in order to enable users to change the merge rate depending on the users' preference and motivation. The merged stroke is expressed as in the following mathematical expressions

$$x = \alpha \cdot f_{model}(t) + (1-\alpha) \cdot f_{user}(t)$$

$$y = \alpha \cdot g_{model}(t) + (1-\alpha) \cdot g_{user}(t).$$

In this paper, we called α the “proportion of merging".

If a user has no confidence in drawing, the user might want to select a high merge rate. On the other hand, if a user has confidence in drawing, the user might want to select a low merge rate. Users are able to choose a merge rate to suit their preferences.

Figure 2 shows the weighted average illustrations from 0.0 to 0.1. In this figure, 0.0 means the user’s original hand-drawn character and 1.0 means the model of the hand-drawn character.

4. PROTOTYPE SYSTEM

We developed the prototype system using Processing which is a language for learning how to code the sketchbook (see Figure 3). The prototype system automatically merges a user’s hand-drawn character and a model of a hand-drawn character, based on the proposed method. In addition, this system allows users to change the degree of merging by moving a slide bar.

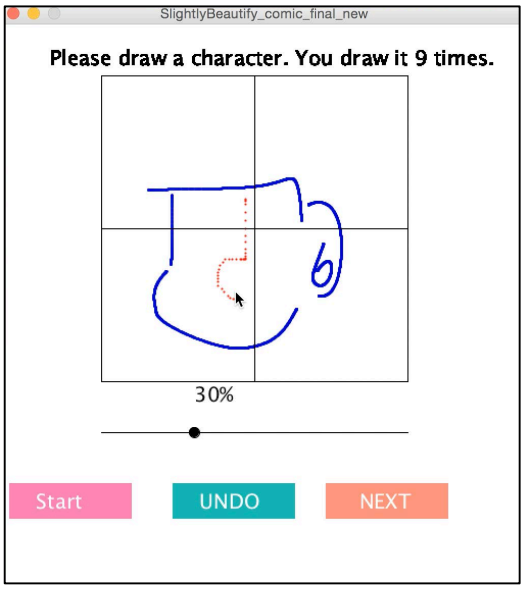

Figure 3. The prototype system which merge user’s stroke and model’s stroke automatically.

In the prototype system, the user chooses a model character which is hand-drawing. Here, our system cannot merge the user's stroke and the model stroke because it cannot generate mathematical expressions for the user's stroke until the user finishes the current stroke. Thus, our system shows red dots while the user is drawing the stroke (see Figure 4). Then, our system generates mathematical expressions for the user's stroke and also generates a weighted average stroke by using the proportion of merging, α after the user finishes drawing the stroke. Finally, this system displays the weighted average strokes (see Figure 5).

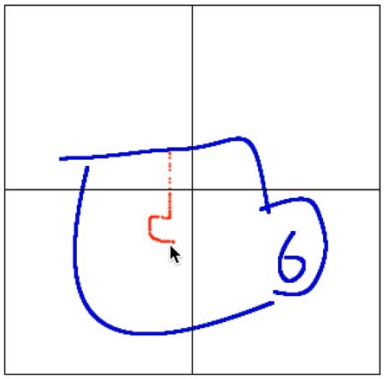

Figure 4. The system displays red points that show the user's stroke.

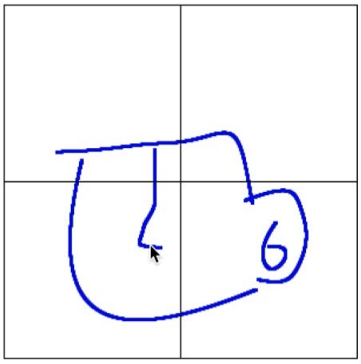

Figure 5. The weighted average stroke is displayed as a blue stroke after merging the model.

If the user pushes the "Next" button after drawing all the strokes of the target character, the system saves the series of points of the user's hand-drawn character and a PNG image of a weighted average character. After that, the system clears this canvas.

5. EXPERIMENT

In order to clarify the usefulness of our system, we compare the tracing exercise with an exercise using our system.

In this chapter, we shall discuss the questions of how improve the hand-drawing skill and how users feel when using our system. We compare the tracing method of writing with using our system.

5.1 Method

In this experiment, we focus on the difference between before practice and after practice.

We asked the nine participants to try a hand-drawing test by using our system and also using tracing. They are undergraduate students and had no confidence in drawing an illustration.

We developed two systems for this experimental test. The two systems were similar in appearance. These systems display sentences of how many times users draw a character, a frame and matrix-like grid for hand-drawing, and three buttons. The system for our method shows the slider bar for changing the degree of merging, and enables characters to be changed in shape (see Figure 6). The tracing system shows the model of the character in the frame for hand-drawing (see Figure 7).

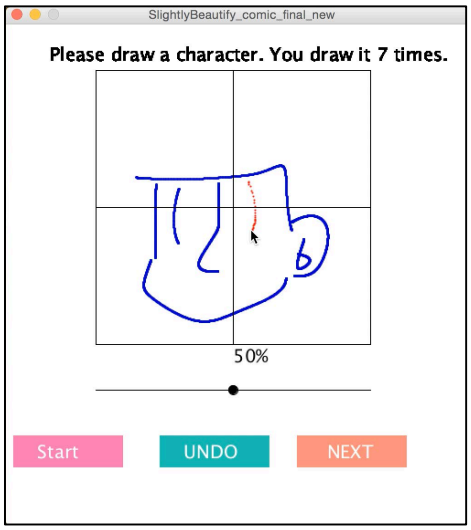

Figure 6. The system which enable to change the degree of merging and character's shape.

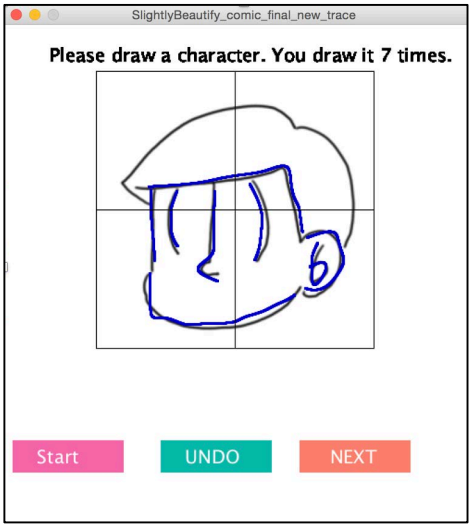

Figure 7. The tracing system. User trace the black lines by hand.

In this experiment, we prepared instruction papers in which we presented hand-drawn models and information on stroke order (see Figure 8). The participants tried to practice hand-drawing while consulting these instructions. In this test, the participants tried to

draw characters 30 times. During the first five times and the last five times, the participants tried to draw the characters only while looking at this instruction, without the system's support. For the middle 20 times, the participants tried to draw them with the system's support. The reason for these method is that the participants needed to recognize the character's shape and stroke order and we wanted to observe the participants' skill in hand-drawing.

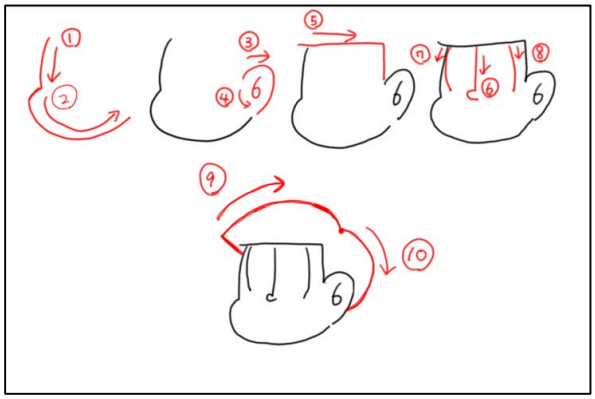

Figure 8. Instructions for hand-drawn character.

We selected three characters, "Osomatsu-san (©Fujio Akatsuka)", "Hello Kitty (©SANRIO)" and "Pikachu (©Pokèmon)" (see Figure 9) as the dataset, which are popular in Japan. Then, we prepared the model strokes of these characters by tracing original illustrations.

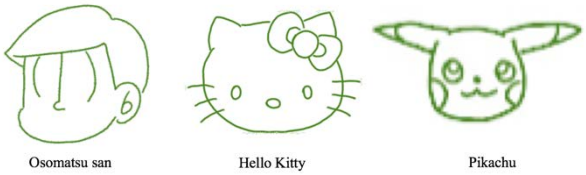

Figure 9. Model characters.

5.2 Results

We focused on the difference between hand-drawn illustrations before practice and hand-drawn illustrations after practice in each method.

Figure10 shows the results of hand-drawn illustrations by using the system for tracing. Figure 11 shows the results of hand-drawn illustrations by using our method. In these figures, three types of strokes are overlaid. Green strokes show the model illustration, blue strokes show illustrations before practice, and red strokes show illustrations after practice. Figure 12 shows the results of how change user's original stroke by tracing (top rows) and using our method (bottom rows). In Figure 12, the illustration on the left shows strokes before practice and on the right shows after it.

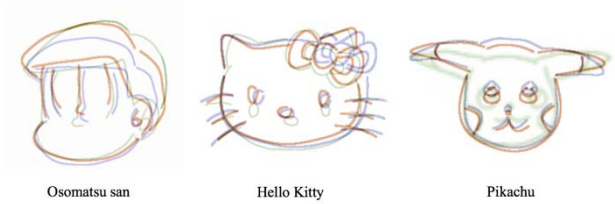

Figure10. Results of illustrations produced by tracing.

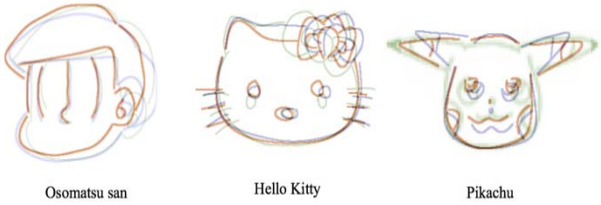

Figure11. Results of illustrations by using our method.

First of all, we discussed the result of aspect as handwriting skill. We found that the strokes after practicing by means of both methods look like the model's the strokes. However, improving hand-drawing skill after practicing by tracing was bigger than by using our method. There was not much improvement of the shape

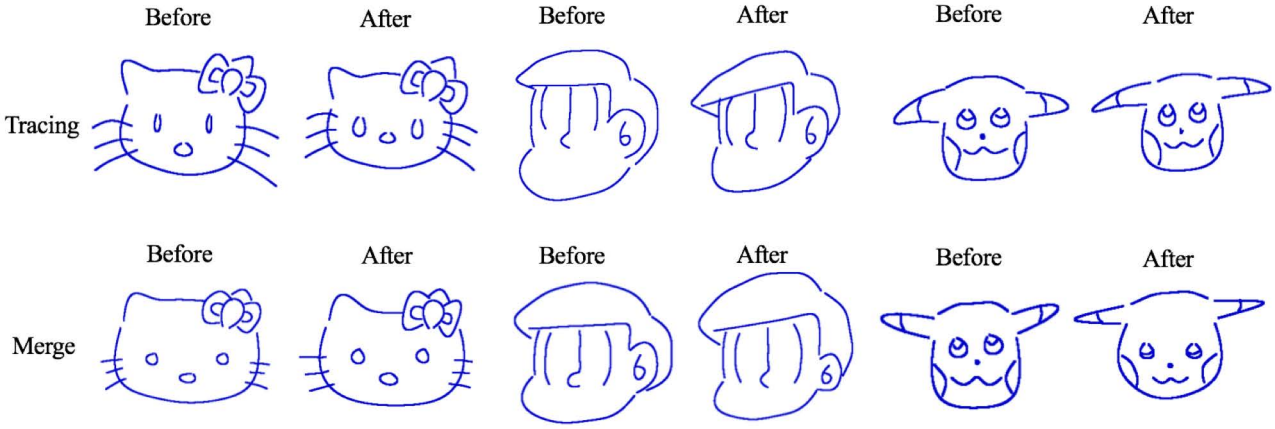

Figure 12. Original strokes by means of tracing (top rows) and our method (bottom rows).

of characters by using our method. In these results, tracing was better than our method as improving a hand-drawing skill, because our system converts the users' strokes gradually. Therefore, users found it difficult to master the model's strokes of characters only 20 times practice. However, our method gave users a little effect about their hand-drawing skill. In addition, these results were caused by personal handwriting skill. For example, some users who draw a character completely before the practice didn't change the strokes. So, if we conduct a long-term experiment, we may prove that our method is the effective means of practice.

Next, we discussed the result of aspect as user's mentality. We found that a lot of user liked practice by using our method because they were enabled to draw strokes their own way without a stress. Although the users' hand-drawing skill improved using the tracing method, they got tired while they practicing illustrations in this way. We may say that when using the tracing method, it is not easy to maintain motivation and the user might give up practicing for a long time.

In contrast, users drew characters without stress when they used our system. This was because the user can handwrite his/her own characters using our merging method. Therefore, practice by our method is effective for a long-term training.

6. DISCUSSION AND CONCLUSION

In this paper, we have proposed a drawing method that merges the user's hand-drawn strokes and a model's strokes automatically in order to sustain the users' motivation to continue to practice hand-drawing. In addition, we implemented a prototype system and conducted an experimental test.

The results of this experiment show that the tracing method is more effective in improving a user's hand-drawing skill than our proposed method. However, by using our method, users make good hand-drawing skill at least. In addition, our method enables users to maintain motivation. Thus, our method is that to merge the strokes automatically and gradually gave a good effect for users' hand-drawing skill and mental condition. So it is likely that users really feel like they are drawing their own characters and our method is easier than the tracing method. As a result, we can say that users should select our training method according to their perseverance.

In conclusion, our study found that improving hand-drawing skill is not easy. If users want to be good at drawing, they must practice frequently. However, if they feel stress and do not have the motivation to draw characters, it is possible that they will give up drawing them before acquiring good hand-drawing skills. In a future work, we are planning to conduct a longer-term experimental test of practice approaches by comparing our method and the tracing method. In addition, we will clarify how long it takes for users to acquire good hand-drawing skills by using this method and how do users feel while practicing some characters.

There is room for argument on this point. It needs further consideration. We believe our approach to practicing drawing comic characters will support many people who want to acquire good hand-drawing skills.

7. ACKNOWLEDGMENTS

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8. REFERENCES

[1] Kangwon Kim, Koji Mikami, Kunio Kondo, and Mitsuru Kaneko. 2010. Manga design: a by-step method for original story construction. Information Processing Society of Japan(IPSJ). pp.118-127, in Japanese.

[2] ComiPo!, DOI= http://www.comipo.com/ .

[3] Alex. L., Nicolas F., Adrien T., and Michael C. 2013. Real-time drawing assistance through crowdsourcing. ACM SIGGRAPH 2013 Conference Proceedings, Volume 32 Issue 4, No. 54.

[4] C. Lawrence Zitnick. 2013. Handwriting beautification using token means. SIGGRAPH 2013.

[5] Edgar Simo-Serra, Satoshi Iizuka, Kazuma Sasaki, and Hiroshi Ishikawa. 2016. Learning to simplify: Fully convolutional networks for rough sketch cleanup. ACM Transactions on Graphics (SIGGRAPH).

[6] Kanako Yoshino, Masami Takata, Seiichi Tenpaku, Kazuki Joe. 2007. Development of the handwriting training software on Nintendo DS. Information Processing Society of Japan (IPSJ). pp.81-84, in Japanese.

[7] Yuto Fukuya, Yoshinari Takegawa, Hidekatsu Yanagi. 2016. A piano learning support system considering motivation. Information Processing Society of Japan (IPSJ), in Japanese.