SAMURAI：A TRANSFORMATION SYSTEM FOR ANIMATION CHARACTERS BASED ON GLCIC TO ALLEVIATE THE WORKLOAD OF ANIMATION DIRECTORS

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ABSTRACT

People from various professions are involved in the production of anime, including directors, animation directors, character designers, and voice actors/actresses. Specifically, the role of an animation director is of importance in the realm of animation. The animation director serves as the unifying force in shaping the animation's style by meticulously reviewing and redrawing the key animations provided by the key animators. The aim of this study is to develop a redrawing system using GLCIC to reduce the workload on animation directors when redrawing original key animation. Specifically, this study devised a system that employs GLCIC to analyze and learn the distinctive drawing styles of individual animation directors from images of their work and subsequently apply those styles to the conversion process. In the experiment, we asked people whose hobby is drawing to experience the developed system, and conducted a qualitative evaluation using a questionnaire and a quantitative evaluation using KLM analysis. As a result, we found that there were issues with ease of modification and UI. Additionally, the KLM analysis revealed that improving the system could reduce work time by a quarter. In the future, we think to improve the system with the aim of increasing work efficiency.

KEYWORDS

GLCIC, Image Conversion System, Animator Support

1. INTRODUCTION

Japanese animation has garnered significant acclaim, both domestically and internationally, establishing itself as a cornerstone of Japan's content industry. According to an article from WeXpats Guide [1], Japanese anime is esteemed for its meticulous depiction of characters and backgrounds, with this commitment to high-quality animation being a prominent factor contributing to its favorable reception.

To create animation, People from various professions are involved in the production of anime, including directors, animation directors, character designers, and voice actors. In particular, an animation director is an important profession related to animation pictures. The animation director unifies the animation style by reviewing and correcting the key animations sent by the key animators as shown in Figure 1 [2]. According to Toyo Keizai Online [3], in a standard 30-minute anime episode, the total number of animation frames typically falls within the range of

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approximately 3,000 to 5,000 frames, and in the case of anime movies, this count can exceed 10,000 frames or more. However, the current anime industry is facing chronic labor shortages. Despite this heavy workload, the anime industry continues to suffer from a labor shortage.

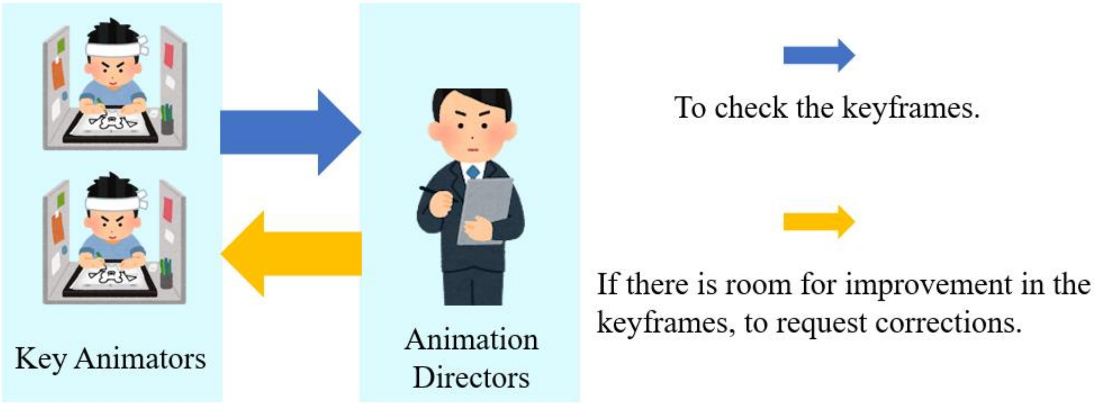

Figure 1. The role of an animation director.

Hence, this study aims to alleviate the burden on animation directors in correcting keyframes. Figure 2 shows that the system that we developed a called "SAMURAI (Supportive Artistic Masterpiece Uniting Real-time AI)." "SAMURAI" allows users to specify the areas they want to correct in the input image using a pen tablet and then apply the style of an animation director who has been trained only in the specified areas. Figure 2 shows examples of style redrawing with “SAMURAI”.

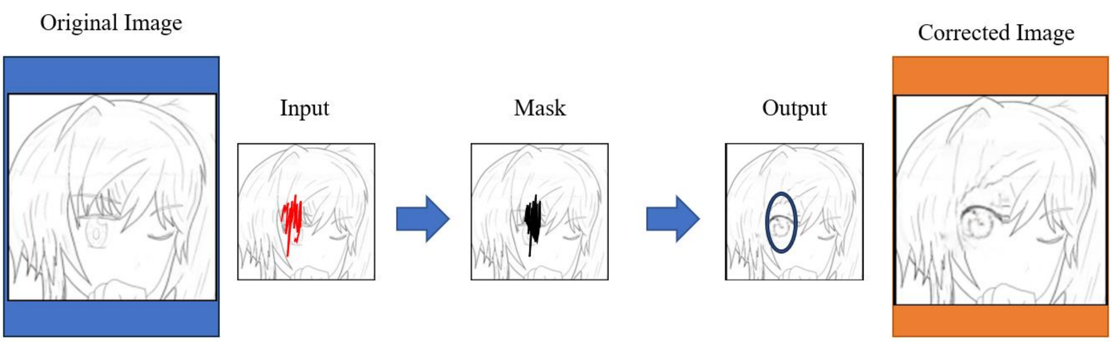

Figure 2. Examples of style correction in “SAMURAI”

2. Related Works

As part of the research on anime production support, there is AniFaceDrawing [4]. Their study's purpose is to generate high-quality anime images from rough sketches while achieving stroke-level disentanglement. To accomplish this, as depicted in Figure 3, it establishes associations between line strokes and the corresponding contour lines of anime images, training these relationships using StyleGAN. This enables the system to learn the process of generating anime images from sketches in real-time as users draw, resulting in stable anime images; however, it's worth noting that this system generates multiple images as candidates based on the user's drawing, making it less suitable for scenarios where users wish to modify specific parts.

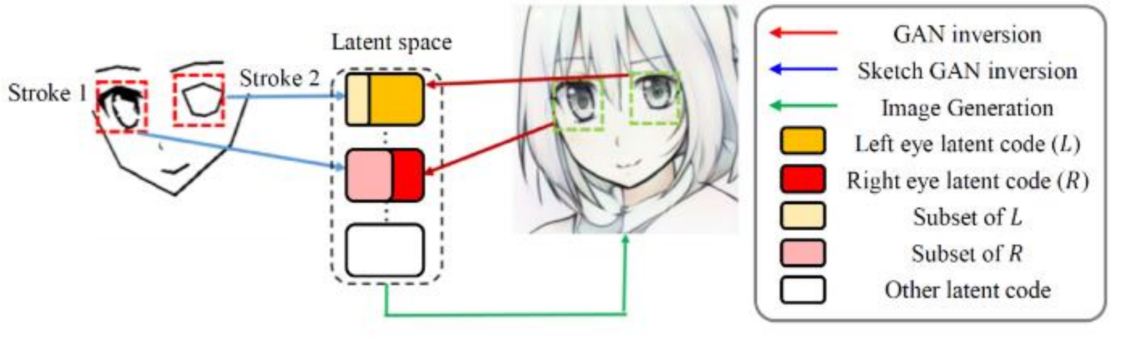

Figure 3. Overview of "stroke-level disentanglement" [4]

A study employed a training approach utilizing pix2pix [5], where standard line drawings and contour lines were paired as images. In their research, as shown in Figure 5, they utilized a trained model to predict and generate a line drawing of the outline of an object, such as a shoe, from an input image with a line drawing of the object's outline. Their findings indicate that the model performed with high accuracy for images with simple line drawings but struggled with images featuring complex line drawings.

This research focuses on creating key animations for animation, and it is difficult to employ this method for complex line drawings such as character line drawings.

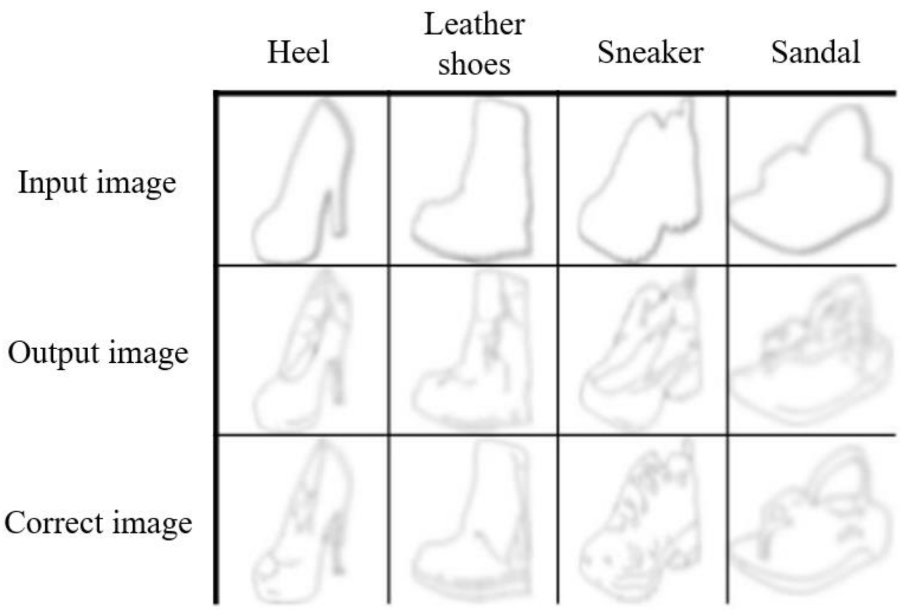

Figure 4. To automatically draw distinctive lines [5]

3. SAMURAI: A SYSTEM FOR REDRAWING KEY ANIMATION

This study aims to alleviate the load work on animation directors in correcting key animations and employs "Globally and Locally Consistent Image Completion (GLCIC) [6]" as an image redrawing method. GLCIC is a machine learning network realized through research by Iizuka et al., and is constructed from three types of networks as shown in Figure 5.

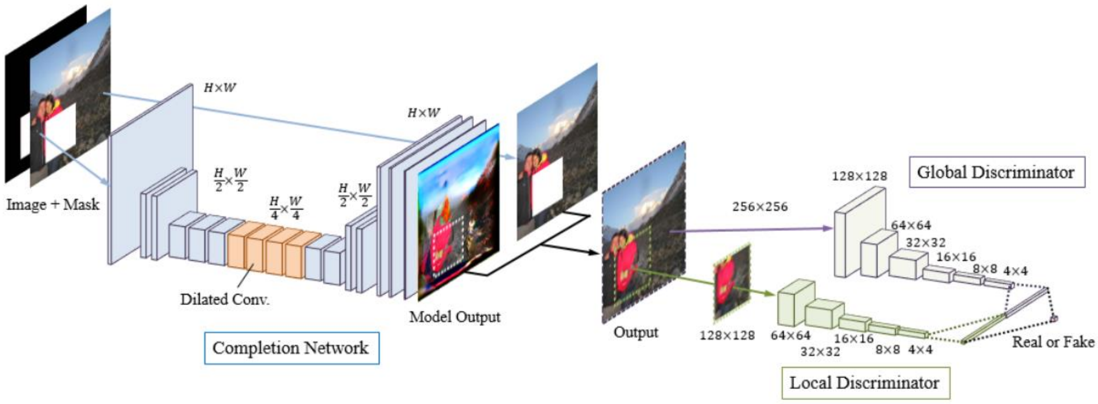

Figure 5. The Mechanism of GLCIC [6]

To describe specifically, the completion network exclusively comprises convolutional layers. When presented with an image containing certain missing components, along with a corresponding mask denoting those areas, the network generates an output image in which the absent segments have been restored. The global discriminator network takes the completed image as its input and evaluates the overall image for consistency. Simultaneously, the local discriminator network receives the completed region as its input and assesses the naturalness of the restored portion. The training process involves a strategic interplay: the completion network is trained to avoid detection by the discriminator network when restoring missing regions, while the discriminator network is trained to discern and expose the restored elements crafted by the completion network. This alternating training methodology is instrumental in achieving a cohesive and natural-looking image completion.

This study is broadly divided into two phases: the learning phase and the completion phase. Figure 6 shows two phases in this study.

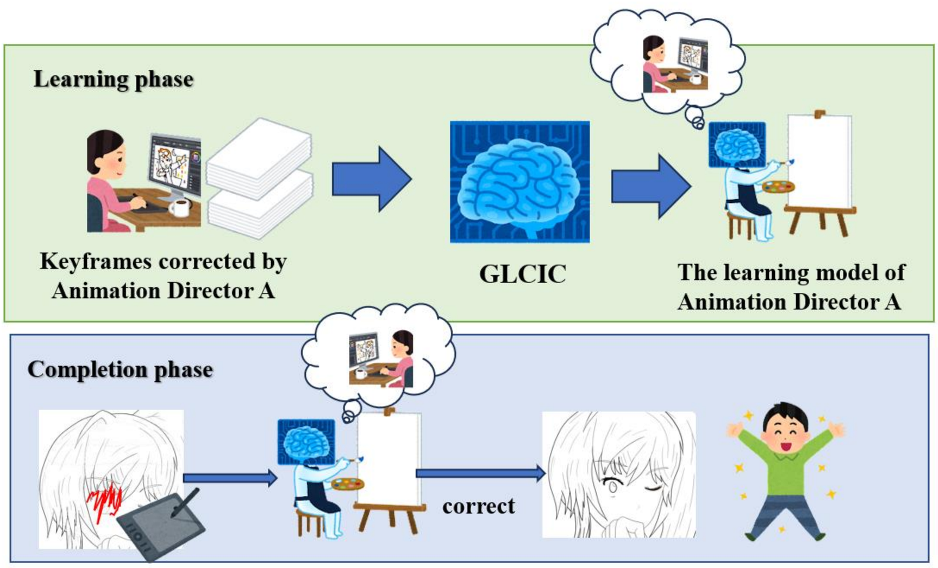

Figure 6. The learning phase and the completion phase.

During the learning phase, keyframes that have been corrected by an individual referred to as Animation Director A are utilized to establish a dataset for GLCIC. Subsequently, a learning model is constructed to replicate the distinctive style of Animation Director A.

In the completion phase, an original key animation serves as input, and specific areas requiring correction within the key animation are identified. Only the designated regions are then corrected to align with the style of Animation Director A.

To achieve this goal, we developed the "Supportive Artistic Masterpiece Uniting Real-time AI (SAMURAI)" system shown in Figure 7. The developed system allows animation directors to learn their own work in the system in advance, allowing them to convert it into their own painting style. By converting the drawing style, you can unify the style of your animation work. Next, we will explain how to use the system. The key animation director receives images from the key animator and inputs them into the system. Then, they designate the specific area to be corrected using a digital pen and generate a corresponding mask image. Finally, the key animation director transforms the image by pressing the modify button.

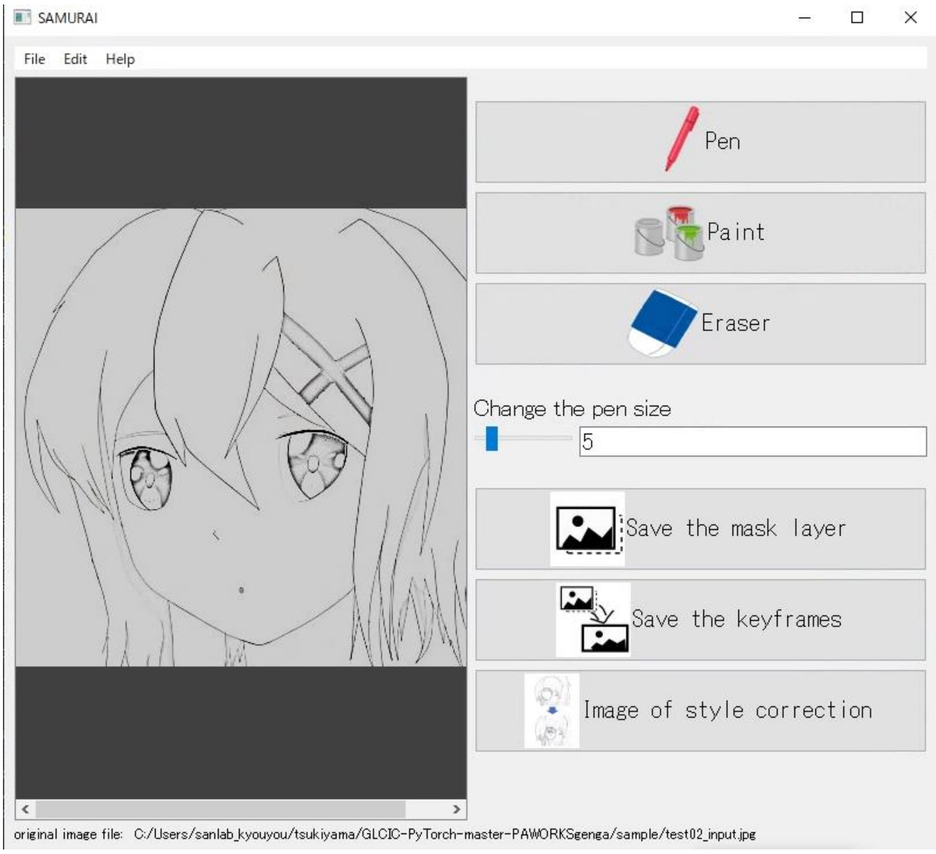

Figure 7. "Supportive Artistic Masterpiece Uniting Real-time AI (SAMURAI)" system.

Figure 8 shows the SAMURAI system algorithm. The example in Figure 8 shows an example of the learning model for animation director S.

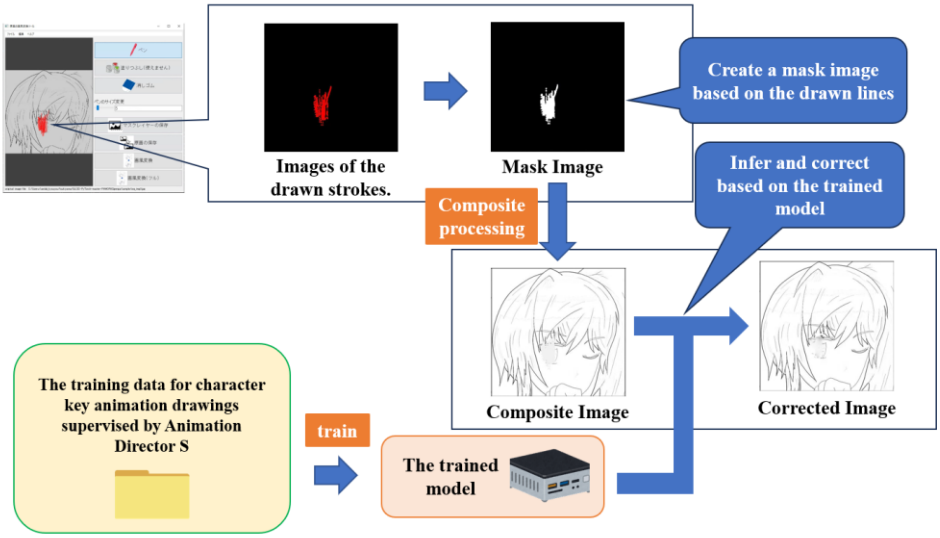

Figure 8. The algorithm of "SAMURAI" system.

4. EXPERIMENTS

In the context of our experiment, this study engaged the participation of a teenage male and a 20-year-old male illustrator who experienced the SAMURAI system. Figure 9 shows the scene of the experiment. Subsequently, we conducted a qualitative evaluation via a questionnaire survey, employing a five-point scale for assessment. Additionally, to quantitatively evaluate the reduction in user workload, this study applied Keystroke-Level Model (KLM) analysis. For the conversion model in this study, we utilized a model trained on illustrations by Key Animation Director S.

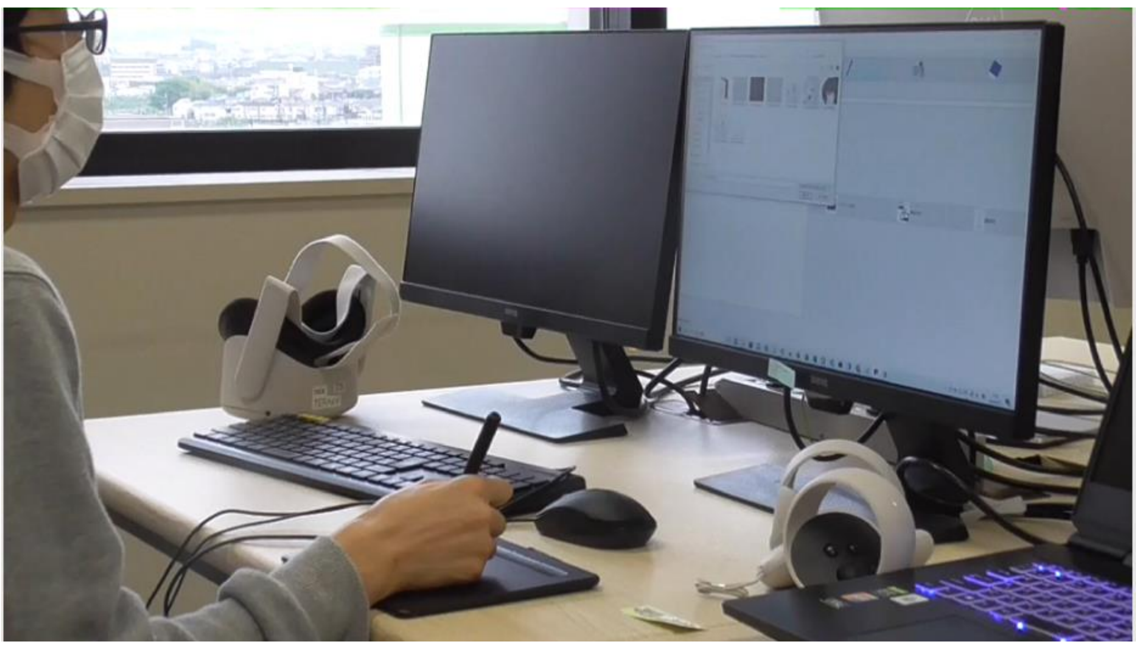

Figure 9. The scene of the experiment

It's essential to note that the experiment received ethical approval from the Osaka Institute of Technology Life Science Experimental Ethics Committee (approval number: 2022-75).

5. RESULTS AND DISCUSSION

Table 1 shows the outcomes of a questionnaire survey conducted among participants in the experiment. The results indicate that the developed SAMURAI system has demonstrated a relatively positive impact in terms of work time; however, its performance in relation to user experience and ease of modification did not receive particularly high ratings. Positive evaluations primarily encompass the potential for cost savings in both labor time and associated expenses. On the other hand, critical feedback highlights concern regarding small text within the tool and a somewhat intricate process.

We will discuss the causes of this result. Firstly, the positive assessment of "ease of correction" can be attributed to the straightforward nature of the correction process. Users simply select the area they wish to modify and press a button to adjust the drawing style, obviating the need for prior knowledge. we believe that this simplicity likely contributed to the favorable rating. Conversely, the negative feedback concerning "user experience" and "user interface" can be ascribed to the two-step process required for users to make alterations to the illustration. This process necessitates the generation of a mask image followed by the conversion step, which may have led to a less favorable evaluation.

Table 1. The results of the questionnaire survey.

Question No.	**The content of the questionnaire.**	**Participant A**	**Participant B**
1	Will using the SAMURAI system save me time?	4	3
2	Will using the SAMURAI system make corrections easier?	3	1
3	Is the user experience of the SAMURAI system good?	2	2
4	Is the user interface of SAMURAI system good?	3	3
5	Did you find the tool fun to use?	3	3
6	Is the feedback on the SAMURAI system good?	3	2

Subsequently, we will discuss the quantitative assessment utilizing Keystroke-Level Model (KLM) analysis. Equation (1) outlines the results observed prior to the system's improvements, while equation (2) elucidates the outcomes following the implementation of enhancements. In these equations, 'P' designates mouse pointing time, while 'K' signifies keypress time.

$$P + K + P + K + P + K + P + K = 1.1 + 0.2 + 1.1 + 0.2 + 1.1 + 0.2 + 1.1 + 0.2 = 5.2 \quad (1)$$

$$P + K = 1.1 + 0.2 = 1.3 \quad (2)$$

Upon comparing Equation (1) and Equation (2), a notable finding emerges: under the current specifications, the correction process necessitates four mouse operations and four button clicks. However, through the integration of these functions, this process can be streamlined into a single operation. Furthermore, the time required for the task is significantly reduced, from 5.2 seconds with the current specifications to 1.3 seconds with the integrated function, signifying a fourfold difference. Consequently, by batch-processing functions from 'save' to 'completion,' it is anticipated that the workload for correcting a part of key animation can be reduced to one-fourth of the original time.

6. CONCLUSIONS

From this experiment, it was found that there were challenges related to ease of correction and the user interface in the keyframe support tool. Through KLM analysis, it became clear that changing the method to batch processing could lead to a 75% reduction in processing time. Furthermore, this experiment has raised two new concerns. The first concern is whether there is not much difference in workload when animation directors manually fill in the areas they want to correct. The second concern is that relying too much on AI for automation might lead to a lack of higher-quality artwork. Therefore, instead of having the animation director manually select the areas that need correction by visual inspection, the AI itself can determine where corrections are necessary. During this process, the input keyframe and the corrected keyframe can be compared to show the differences, providing insights to the assigned animator on what needs improvement. This approach is expected to save more time and encourage the growth of novice animators. Furthermore, it is crucial to present not just a single but multiple candidate key animations. This increases the likelihood of generating key animations that align with the user's expectations. Therefore, in the future, we will attempt to improve the system specifications to balance the efficiency of the workflow and the training of new animators. This will be done while enhancing the reliability of evaluations by adding new experiment participants.

REFERENCES

[1] What is the reason for the popularity of Japanese anime overseas? Introducing popular works among foreigners, https://we-xpats.com/ja/guide/as/jp/detail/9695/, (Viewed on July 8, 2023)

[2] What is an animation director? A detailed explanation of their job responsibilities and the three essential skills and qualifications required, https://www.anime.ac.jp/contents/column/2021/08/23/animation_director/, (Viewed on July 8, 2023)

[3] The single most important tip to become good at drawing anime, https://toyokeizai.net/articles/-/384527, (Viewed on July 8, 2023)

[4] ZHEGYU HUANG, HAORAN XIE, TSUKASA FUKUSATO, KAZUNORI MIYATA: AniFaceDrawing: Anime Portrait Exploration during Your Sketching, arXiv:2306.07476v1 [cs.CV] 13 Jun 2023

[5] KazukiYanagida, KenjiGyohten, HidehiroOhki, ToshiyaTakami:A Study of drawing characteristic lines automatically for line drawing generation using pix2pix, IPSJ SIG Technical Report, 2021

[6] Satoshi Iizuka, Edgar Simo-Serra, Hiroshi Ishikawa：Globally and Locally Consistent Image Completion, ACM Transaction on Graphics (Proc. of SIGGRAPH), 2017.

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