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GENERATION OF SCENE FRAME OF MANGA FROM NARRATIVE TEXT

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ABSTRACT

Manga is the Japanese term of comic. This paper aims at the scene frames generation of Manga as the first step of the study, the automatic generation of Manga from a narrative text using a computer. Scene frames are generated using verbs showing actions of characters in a story and three kinds of importance degrees, the importance degree of an entire narrative text, the importance degree of a main story and the importance degree of the first appearance of a character in a story.

Experiments are performed for validation of the effectiveness of the proposed method. Ten subjects read scene frames generated by the proposed method and answer each questionnaire item with 5-point scale. Experimental results show that generated scene frames have enough information to understand and express a story, and that the proposed approach is appropriate for the generation of scene frames of Manga. And it is also found that the size of a scene frame changes at the important point of a story.

Keywords: **narrative comprehension, comic (manga), scene frame importance degrees, character's action**

1. INTRODUCTION

Manga is the Japanese term of comic and this term is used in this paper. Recently, Japanese Mangas have been paid attention to. For example, *International Manga Award* was founded by Japanese Ministry of Foreign Affairs in May 2007 [8], or the establishment of

museums for Manga is planed in several countries. Furthermore, many Japanese story Mangas are read in foreign countries or applications of Mangas to e-learning are also considered [6]. From this background, some automatic generation systems of Manga or some drawing support systems of Manga are studied using a computer [1][5][7][10]. However, the study on Manga drawing from a narrative text is not found yet, since it is not easy for a computer to draw Manga without changing narrative impressions and narratives authors' ideas. Furthermore, it is also difficult for a computer to acquire the method of drawing Manga by which author's idea of a narrative is given to Manga readers well. However, if a computer can support Manga drawing from the viewpoint that a computer presents the composition idea of Manga to a Manga drawer, then it is expected that applications of Manga cover many fields.

Usually, there are four tasks for drawing Manga, *plot*, *storyboard*, *draft* and *finish*. The most important and the hardest task among them is *storyboard*, i.e., the base of Manga drawing and composition design of Manga. The task *storyboard* is divided into two detailed tasks. The first one is the arrangement of scene frames in a page, called scene frames generation in this paper. The second one is the determination of composition in a scene frame. If a computer can perform the task *storyboards*, one of the main tasks in Manga drawing is accomplished.

The final purpose of the presented study is the automatic drawing of Manga from a narrative text using a computer, where the study premises that readers read printed Manga drawn by a computer. As the first step of the study, this paper aims at the scene frames generation for automatic Manga drawing from a narrative text. The scene frames generation is an important work in which scene frames locations and their sizes are determined as the design blueprint of Manga. In fact, if scene frames sizes are not assigned well and/or if scene frames are not arranged well, Manga becomes complicated and reading Manga is not fun for readers. Although readers may sometimes have different perspectives and interpretations for a narrative text, as the first step of the study, this paper considers some basic important degrees useful to understand interpretation that every reader has for a narrative text.

The construction of this paper is as follows. In Chapter 2 the outline of scene frames generation system is described and three kinds of importances are introduced. Chapter 3 shows subjects experiments in order to verify the validity of the scene frame generation described in Chapter 2. In Chapter 4, experimental results are shown and some remarks are discussed. Finally, in Chapter 5 conclusions of this study are described.

2. OUTLINE OF SCENE FRAMES GENERATION SYSTEM

Fig.1 shows the process of a scene frames generation system of Manga, where Manga is defined as follows: Manga is story development expressed by pictures and has continuity among pictures. Furthermore, Manga shows importance of its picture by sizes and shapes of picture frames.

After a narrative text is inputted to the system, the text is dealt with by the following four steps: (1) the preparation step of an inputted narrative text, (2) the scene frames generation step, (3) the scene frame importance calculation step and (4) the scene frames assignment/arrangement step. In step (1) morphological analysis and syntactic analysis are

performed for an inputted narrative text, and characters in a story are extracted. In step (2) scene frames are generated based on verbs expressing character's action. In step (3) three kinds of importances, *the entire narrative text importance*, *the main story importance* and *the importance of the first appearance of a character in a story*, are calculated. In step (4) generated scene frames in step (2) are assigned and arranged in Manga based on importances calculated in step (3). Then, the system presents scene frames sizes and scene frames arrangement as its output to a system user.

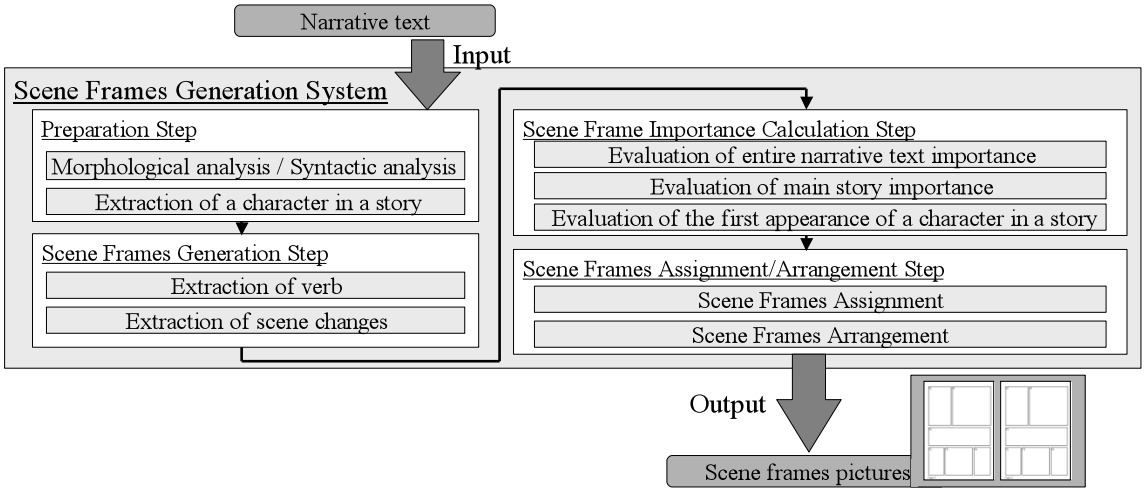

Figure 1: Process of scene frames generation system

2.1. Scene frames generation

In this study verbs expressing characters' actions in an inputted narrative and scenes expressed in a narrative are used for scene frame generation, where a scene is defined as the sentence group of a narrative text in which time does not pass and a place does not change.

When pictures are drawn based on a narrative, it is necessary to separate sentences in a narrative to some scenes according to the contents of a narrative. In the picture book generated by Kijima et al. [4], sentences are separated to some scenes according to changes of scenes. However, although a picture book is presented together with a narrative text, Manga shows its story with pictures and lines. Therefore, it is difficult to understand a story by only pictures showing scenes in Manga. In this paper the following approach is proposed. Verbs expressing characters' actions are extracted from sentences in a narrative and their actions are expressed by words in each scene frame. In Manga, view depictions without characters are usually assigned at the scene change so that readers can understand a story well. In this study the same approach is used: The view depiction is inserted at the scene change. Outputs of the scene frame generation step are (1) characters in a narrative text, (2) characters' actions in a narrative text, (3) words concerning to the actions, and (4) sentences in which the actions are expressed.

2.2. Importance degree calculation

A scene frame importance degree is considered as the factor for the determination of the size of a scene frame, where the scene frame with the large importance degree has the scene that an author wants to express through a story or to give readers strong impressions. The

following three kinds of scene frame importance degrees are considered in order to estimate the importance of a scene frame and to determine the scene frame size: (1) the importance degree of an entire narrative text, (2) the main story importance degree and (3) the importance degree of the first appearance of a character in a story.

The importance degree of an entire narrative text is defined as the importance degree of a word in a sentence to an entire narrative text. The main story importance degree is defined as the importance degree of a word in a sentence of a narrative text to the word that appears many times and meaningfully in an inputted narrative. This degree is used to determine whether a sentence corresponding to a drawn scene frame plays an important role in a narrative text or not. The importance degree of the first appearance of a character in a story is defined as the importance degree to give readers impressions that the character is one of important characters for the development of a story.

Let the importance degree of an entire narrative text, the main story importance degree and the importance degree of the first appearance of a character in a story be $W_{Sentence}$, W_{Main}, and W_{Appear}, respectively. The importance degree of each scene frame $W_{Scene}(sf)$ is defined by expressions (1).

$$W_{Scene}(sf) = W_{Sentence}(sf) + W_{Main}(sf) + W_{Appear}(sf) . \quad (1)$$

2.2.1. Importance degree of entire narrative text

The importance degree of an entire narrative text is obtained using the Panoramic View System proposed by Sunayama et al. [11], where words evaluated by the Panoramic View System are assumed to be a verb, a noun, an adjective and an unknown word that is evaluated to be unknown by Chasen [3] and is a word not included in IPA dictionary *ipadic2.2*. These words are evaluated by the Panoramic View System from the following three points of view: (1) Evaluation as a basic keyword, (2) evaluation as a topic keyword among basic keywords and (3) evaluation as a feature word, i.e., a word characterizing topics.

Let the appearance frequency of word w in a narrative text be $frequency(w)$. The evaluation value of word w as a basic keyword $key1(w)$ is defined by expressions (2).

$$key1(w) = frequency(w) . \quad (2)$$

Higher-ranking words with large $key1(w)$, i.e., 5 words or less within 4% of the total number of words appearing in a narrative text, are defined as a topic keyword group.

Let a topic keyword group, the number of sentences including word w, and the number of sentences including words w_1 and w_2 be S, $n(w)$ and $n(w_1, w_2)$, respectively. The evaluation value of word w as a topic keyword $key2(w)$ is defined by expressions (3).

$$key2(w) = \prod_{s \in S'} \frac{n(w,s)}{n(s)}, \quad (3)$$

where if word w' not included in the topic keyword group is included in the word group of the higher ranking of $key2(w)$, i.e., the top 4% of $key2(w)$, then word w' is added to the topic keyword group as a new keyword. And $key2(w)$ is re-calculated. If words with the top

4% of $key2(w)$ are all included in the topic keyword group, then the evaluation value of a feature keyword is obtained as follows. Let a topic keyword group, the number of sentences including word w, and the number of sentences including words w_1 and w_2 be S, $n(w)$ and $n(w_1, w_2)$, respectively. The evaluation value of word w as a feature keyword $key3(w)$ is defined by expressions (4).

$$key3(w) = \prod_{s \in S} \frac{n(w,s)}{n(w)}. \tag{4}$$

The evaluation value as a basic keyword of sentence d, the evaluation value as a topic keyword of sentence d, and the evaluation value as a feature keyword of sentence d are obtained by the expressions (5), (6) and (7), respectively.

$$sentence1(d) = \sum_{w \in d} key1(w), \tag{5}$$

$$sentence2(d) = \sum_{w \in d} key2(w), \tag{6}$$

$$sentence3(d) = \sum_{w \in d} key3(w). \tag{7}$$

Although each sentence is evaluated and important sentences are chosen based on these three evaluation values in the Panoramic View System, in this study the importance degree of an entire narrative text is obtained by normalizing and adding these three evaluation values since it is considered that differences of these evaluation values among sentences have important meanings. The importance degree of scene frame sf generated from sentence d included in narrative text D is obtained as $W_{Sentence}(sf)$ by expressions (8).

$$W_{Sentence}(sf) = \frac{sentence1(d)}{\max_{d \in D} sentence1(d)} + \frac{sentence2(d)}{\max_{d \in D} sentence2(d)} + \frac{sentence3(d)}{\max_{d \in D} sentence3(d)}. \tag{8}$$

2.2.2. Importance degree of main story

Finding out meaningful sentences in a narrative text is important for understanding the story development and for determining the size of a scene frame of Manga. In this study sentences corresponding to a main story in a narrative story are extracted using Sagara's method [9] and the importance degree is set to the scene frame corresponding to the extracted sentence.

Let a set of words satisfying condition 1 shown in Table 1 be main keyword candidate $Set1$ and a set of words satisfying conditions 2-1 and 2-2 shown in Table 1 be main keyword candidate $Set2$. Furthermore, let $freq_{seg}(w)$, $mean_{seg}$ and var_{seg} be appearance frequency, the mean value of appearance frequency, and the variance of appearance frequency of word w in a paragraph, respectively.

Table 1: Main key word conditions

Condition 1	A word is used as a subject in more than two paragraphs.
Condition 2-1	A word satisfies expression (9), where (9) show that a word appears many times in more than one paragraph.
Condition 2-2	A word satisfies expression (10), where (10) shows that a word appears with the some meaning in more than two paragraphs.

$$freq_{seg}(w) \geq mean_{seg} + \mathrm{var}_{seg} \quad . \tag{9}$$

$$freq_{seg}(w) \geq mean_{seg} \, . \tag{10}$$

Let the appearance frequency of word w in $Set1$ as a subject in a narrative text be $subjectFreq_{text}(w)$. The evaluation value of word w in $Set1$ is obtained as $E_{Set1}(w)$ by expressions (11).

$$E_{Set1}(w) = \frac{subjectFreq_{text}(w)}{\max\limits_{n \in Set1} subjectFreq_{text}(n)}, \quad (w \in Set1) \tag{11}$$

Next, let the appearance frequency of word w in $Set2$ be $freq_{text}(w)$. The evaluation value of word w in $Set2$ is obtained as $E_{Set2}(w)$ by expressions (12).

$$E_{Set2}(w) = \frac{freq_{text}(w)}{\max\limits_{n \in Set2} freq_{text}(n)}, \quad (w \in Set2) \tag{12}$$

Then, $E_{Set1}(w) + E_{Set2}(w)$ is obtained for all words in a narrative text. Main keywords with top 3 high-ranking of $E_{Set1}(w) + E_{Set2}(w)$ are chosen in order to extract the main story from a narrative text. Assuming that these chosen main keywords key are topic keywords, importance degrees of sentences including these keywords are obtained by the Panoramic View System. Let the importance degree of sentence S including main keywords key for an entire text be $R_{text}(S, key)$, and let the importance degree of sentence S including main keywords key for the paragraph including S be $R_{seg}(S, key)$. The importance degree of main keywords key for S is obtained by expressions (13), (14) and (15).

$$\overline{R_{text}}(S, key) = \begin{cases} 0.5 - \dfrac{R_{text}(S, key) - Ave_{text}(key)}{Max_{text}(key) - Ave_{text}(key)} \times 0.5, & R_{text}(S, key) \geq Ave_{text}(key), \\ 0.5 + \dfrac{Ave_{text}(key) - R_{text}(S, key)}{Ave_{text}(key) - Min_{text}(S, key)} \times 0.5, & R_{text}(S, key) < Ave_{text}(key), \end{cases} \tag{13}$$

$$\overline{R_{seg}}(S, key) = \begin{cases} 0.5 - \dfrac{R_{seg}(S, key) - Ave_{seg}(key)}{Max_{seg}(key) - Ave_{seg}(key)} \times 0.5, & R_{seg}(S, key) \geq Ave_{seg}(key), \\ 0.5 + \dfrac{Ave_{seg}(key) - R_{seg}(S, key)}{Ave_{seg}(key) - Min_{seg}(S, key)} \times 0.5, & R_{seg}(S, key) < Ave_{seg}(key), \end{cases} \tag{14}$$

$$Story(S, key) = \overline{R_{text}}(S, key) + \overline{R_{seg}}(S, key), \tag{15}$$

where $Ave_{text}(key)$ is the mean value of $R_{text}(S,key)$, $Ave_{seg}(key)$ is the mean value of $R_{seg}(S,key)$, $Max_{text}(key)$ is the maximum value of $R_{text}(S,key)$, $Max_{seg}(key)$ is the maximum value of $R_{seg}(S,key)$, $Min_{text}(key)$ is the minimum value of $R_{text}(S,key)$, and $Min_{seg}(key)$ is the minimum value of $R_{seg}(S,key)$.

Sentences whose ranking of $Story(S,key)$ is within 10% of the whole number of sentences in a narrative text are defined as a main story. The importance degree of main story W_{Main} is defined as the mean value of importance degree of entire narrative text $W_{Sentence}$ for the scene frame corresponding to the beginning of sentences of the chosen main story, and the importance degree of main story is defined as 0 for other scene frames.

2.2.3. Importance degree of first appearance of character in story

The event in which a character appears in a story at the first time is considered an important one for the development of a story. Therefore, in this study the scene frame in which a character appears in a story at the first time is drawn with the big size.

The scene frame in which a character appears in a story as a subject at the first time is searched from all generated scene frames. The importance degree of the first appearance of a character in a story W_{Appear} is defined as the mean value of importance degree of entire narrative text $W_{Sentence}$.

3. SUBJECTS EXPERIMENTS

Subjects experiments are performed in order to verify the effectiveness of the presented scene frame generation. In the experiments, *Hansel and Gretel*, *Town Musicians of Bremen*, and *The wolf and the Seven Young Kids* are acquired from Internet Electric Library *Aozora Bunko* [2] dealing with literary works whose copyrights have already lapsed. These works are used as narrative texts, where although these works are modified a little such as Chinese characters conversions, specification of speakers in a story, these modifications does not change the contents of stories. Table 2 shows the number of words, the number of sentences and the number of generated scene frames. The number of subjects is 10 graduate school students (male or female), where as for the experiments for *Town Musicians of Bremen*, the number of subjects is 11.

As mentioned before this study premises that readers printed Manga. Therefore, three kinds of explanations (subject, action, other information) of generated scene frames are printed out as shown in Fig.2 and are presented to the subjects in stead of pictures, where explanations are prepared by the experimenter. Assuming that pictures are drawn according to presented explanations, the subjects read them and answer questionnaires shown in Table 3 with 5-point scale, where free descriptions are allowable for each questionnaire item.

4. EXPERIMENTAL RESULTS AND REMARKS

Table 4 shows questionnaire results in the experiments, where this table shows the average scale of each questionnaire result and 95% confidence interval estimation of the population mean for subjects' evaluation of each questionnaire item.

As for Q1 in total, the average is 2.1, the upper bound is 2.4 and lower bound is 1.8. The similar results are obtained for each story. Then, these results show that the subjects understand each story by reading presented scene frames. As for Q2 in total, the average is 1.8, the upper bound is 2.2 and the lower bound is 1.4. The similar results are obtained for *Town Musicians of*

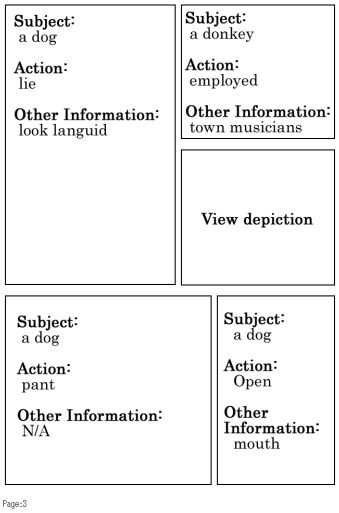

Figure 2: Examples of scene frames presented to subjects

Table 2: Numbers of characters, sentences and generated

Title	Number of characters	Number of sentences	Scene frames generated
Town Musicians of Bremen	4342	106	128
The Wolf and the Seven Young Kids	3759	100	115
Hansel and Gretel	10195	292	263

Table 3: Questionnaires

Q1	Do you understand a story by reading Manga?	Q2	Do you feel that generated scene frames are enough to express a story?
1: I understand it very well.		1: I feel they are enough very well.	
2: I understand it a little.		2: I feel they are almost enough.	
3: Neutral		3: Neutral	
4: I don't understand it very well.		4: I feel they are not enough.	
5: I don't understand it at all.		5: I feel they are not enough at all.	
Q3	**Do you feel that generated scene frames are tedious as a story?**	**Q4**	**Do you feel that the size of generated scene frame is appropriate?**
1: I feel they are very tedious.		1: I feel the size is appropriate.	
2: I feel they are tedious.		2: I feel the size is almost appropriate.	
3: Neutral		3: Neutral	
4: I feel they are not tedious.		4: I feel the size is no appropriate.	
5: I feel they are not tedious at all.		5: I feel the size is not appropriate at all.	
Q5	**Do you feel that the size of scene frame changes at the important point of a story?**		
1: I feel the size changes very well.			
2: I feel the size changes.			
3: Neutral			
4: I feel the size does not change.			
5: I feel the size does not change at all.			

Bremen and *Wolf and the Seven Young Kids*. These results show that the subjects feel that generated scene frames are enough to express each story. Then, it is found that generated scene frames have enough information to understand and express a story and that the proposed approach is appropriate for the generation of scene frames of Manga. However, as for Q2 in *Hansel and Gretel*, the upper bound is larger than 3.0 and the evaluation is rather lower. Some subjects feel a little that generated scene frames are not enough. According to free description, they feel that the scene frame concerning to *House of Cake* in *Hansel and Gretel* is not enough. *House of Cake* is the peculiar description in *Hansel and Gretel*. Then, it is necessary to consider the procedure of the generation of scene frames concerning to peculiar description of some story.

As for Q3 in total, the average is 2.2, the upper bound is 2.5 and the lower bound is 1.8. The similar results are obtained for each story. Then, these results show that the subjects feel generated scene frames are tedious. It is found that although the subjects feel that generated scene frames are enough to express a story, they also feel that generated scene frames are tedious. It is necessary to consider some approach for the combination of redundant scene frames.

Table 4: Experimental results

		Q1	Q2	Q3	Q4	Q5
Total	Upper bound	2.4	2.2	2.5	3.3	2.6
	Average	2.1	1.8	2.2	3.0	2.3
	Lower bound	1.8	1.4	1.8	2.7	1.9
Town Musicians of Bremen	Upper bound	2.9	2.9	3.0	3.6	2.4
	Average	2.2	2.1	2.4	3.0	2.0
	Lower bound	1.5	1.3	1.7	2.4	1.6
The Wolf and the Seven Young Kids	Upper bound	2.1	1.3	2.8	3.1	3.0
	Average	1.7	1.1	2.0	2.6	2.3
	Lower bound	1.4	0.9	1.2	2.1	1.6
Hansel and Gretel	Upper bound	2.8	3.2	2.8	4.1	3.3
	Average	2.2	2.1	2.1	3.6	2.7
	Lower bound	1.6	1.1	1.5	3.0	1.8

As for Q4 in total, the average is 3.0, the upper bound is 3.3, and the lower bound is 2.7. However, as for Q5 in total, the average is 2.3, the upper bound is 2.6, and the lower bound is 1.9. The similar results are obtained for *Town Musicians of Breamen* and *The Wolf and the Seven Young Kids*. Although some subjects feel that the size of generated scene frame is not appropriate, they feel that the size of a scene frame changes at the important point of a story. According to free descriptions in questionnaire for *Hansel and Gretel*, some subjects have comments: There are scene frames including many words. Then, they feel that the size of a scene frame is not appropriate. It is necessary to consider the size of a scene frame depending on the number of words included in a scene frame. The decrease of words should be also considered.

Although there some problems to be considered in a future, it is found that generated scene frames have enough information to understand and express a story, and that the proposed approach is appropriate for the generation of scene frames of Manga. And it is also found that the size of a scene frame changes at the important point of a story.

5. CONCLUSIONS

This paper proposes the generation approach of scene frames of Manga from a narrative text based on the following considerations: (1) A scene frame is generated based on a verb showing the action of a character in a story, and (2) a scene frame is generated using three kinds of importance degrees, i.e., *the importance degree of an entire narrative story*, *the importance degree of a main story*, and *the importance degree of the first appearance of a character in a story*.

Subjects experiments are performed in order to verify the effectiveness of the generation approach of scene frames of Manga. Experimental results show that generated scene frames have enough information to understand and express a story, and that the proposed approach is appropriate for the generation of scene frames of Manga. And it is also found that the size of a scene frame changes at the important point of a story.

Future works include the scene frame generation of peculiar descriptions of a story and consideration of words in a scene frame.

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