Constructing a Knowledge Base of Onomatopoeia-Action Relations for an Interactive Illustrated Storybook

Hiroki Uema[†] **Daiki Hashui**[†] **Mitsunori Matsushita**[‡]
[†]Graduate School of Informatics, Kansai University
[‡]Faculty of Informatics, Kansai University
mat@res.kutc.kansai-u.ac.jp

Abstract

This paper presents an interactive illustrated storybook for PCs and tablets, which can impart virtual actions to the characters and phenomena (e.g., "raining," "flowers swaying") in a story on the basis of onomatopoeias (e.g., "Para Para," "Byu- Byu-.") input by the user. In order to create a knowledge base for this system, we investigate the correspondence between the onomatopoeias and the characters/phenomena using tweets containing onomatopoeias. This paper describes the proposed system and the method for obtaining the above mentioned correspondence.

Keywords: Onomatopeia, Electric Storybook

1 Introduction

Smartphone and tablet devices have become increasingly popular in recent years. These devices make e-books increasingly usable and popular. Many types of e-books including novels, guidebooks, and comics have gone into circulation. Owing to the digitization of book content, moving a picture or characters with sounds on e-book devices is now possible. In addition, such content can be altered interactively via touch-sensible panels.

However, many e-books still contain only simple graphics, and the number of e-books with interactivity is quite low. Two reasons can be conjectured: one is that representation techniques suitable for e-books are not well established, and the other is the lack of tools for creating such representations smoothly. These problems pose difficulties for creators when they produce dynamic content [1].

As the first step to solve the problems, we are attempting to clarify a set of primitives for creating dynamic content. Some dynamic content, such as animated film (e.g., movies or animations) and videogames, is now popularly used on e-book devices. Although one could argue that animated films effectively exploit the advantages of e-books, this type of content is passive and lacks interactivity because users only view information presented by devices. In contrast, a substantial portion of video game content involves active content (i.e., their users communicate the content interactively). We believe that content producers can make use of the advantages of e-books by adding in content not only with dynamic elements but also participating elements such as video games.

On the basis of this perspective, the primary aim of the present study was to create interactive e-book content that involves user participation, such as the presentation of dynamic content by user key in. In this study, which is the first of several ongoing projects, we describe an onomatopoeia picture book system. The system provides interactive e-book content that can attach dynamic expressions to objects in the system by means of input onomatopoeias. In addition, we state how to create a knowledge base for this system, which contains the correspondence between the onomatopoeias and objects/phenomena. We provide a method to construct this knowledge base by collecting tweets that contain onomatopoeia via Twitter and to check the correspondence between the onomatopoeias and objects/phenomena.

2 Related Works

We propose the use of onomatopoeia to consolidate a new and easy-to-use method of expressing e-book content. Recently, onomatopoeia, which is a method of expressing human ideas relating to an object by the sounds with which it is associated, has attracted attention cross-sartorially. For example, it is studied in engineering as a potential method to express human ideas by auditory input provided to a computer.

"Moyamoya Drawing," which was proposed

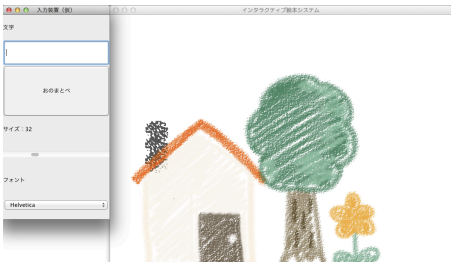

Figure 1. Onomatopoeia storybook system PC version

by Terashima, uses intuitive impressions in the manner of onomatopoeia [2]. The system uses an impression to select an effect for editing an image. This is intended to help beginners who are unaware of the details of the effect when they edit the image.

"Onomatoperori" allows the user to represent the impression of a meal by using onomatopoeia. The system helps the user by recommending an " appropriate " recipe [3]. Onomatopoeic words often used to represent the texture of the food (e.g., "fuwa fuwa," "kari kari") in Japanese are used to search for recipes.

Allowing the use of onomatopoeia to represent a meal that the user wants to cook improves user convenience. In this study, we use onomatopoeia to add movement to a picture in a dynamic e-book. Our proposed feature will help to generate dynamic representations in accord with the intuition of the user.

3 Packaging of Onomatopoeia Storybook System

The onomatopoeia picture book system that we propose changes the situation or moves objects (e.g., "House," "Tree," "Flower") when an onomatopoeic word is entered.

The picture book system is implemented as follows, a house, trees, people, and flowers are among the objects displayed in the picture book (See Figure 2). Changes of weather (e.g., rainy, windy, sunny) are also displayed. Onomatopoeic words associated with these objects and conditions were examined from the onomatopoeia-related term knowledge base that is prepared for the picture book system. More information on this knowledge base will be described later.

Figure 2. Onomatopoeia storybook system tablet version

4 System Structure

In the current implementation, we have produced two picture book systems that run on an Android tablet or a PC. The user can input an onomatopoeic word by using a button arranged on the screen in the Android version or a drop-down list and text forms in the PC version.

The PC version consists of two windows: an interface window to enter onomatopoeic words, and a canvas window on which a picture is drawn by the system (See Figure 1). In the text form of the window for onomatopoeic input on the PC version, the "motion" or "status" of a picture displayed in the canvas window can be changed by filling in the 22 onomatopoeic words on the system and clicking the "onomatopoeia" button. Another set of 22 onomatopoeic words that can be applied to the system is shown in the drop-down list. The user can select a word from the list and enter it as input by clicking the "onomatopoeia" button.

The Android version is divided into upper and lower screens (See Figure 2); the upper canvas displays a picture, and the lower canvas allows the provision oqf a button that can be used to enter information about onomatopoeia. Furthermore, the picture can be moved by pressing the button indicated by the word onomatopoeia. Ten buttons are displayed on the screen. This allows button sizes that can be pressed simultaneously to display the corresponding objects (e.g., flower, person).

Both Android and PC versions of the above system have been developed. Each object in

the picture drawn is a separate layer, and multiple objects are displayed through overlaying. There is no difference in operation between the Android and PC versions (for entering onomatopoeia, to impart a dynamic representation corresponding to the input onomatopoeia for the associated objects).

5 Activity of System

In the two systems described above, some objects are placed on the canvas part in the initial state. For example, a painting of a "house, tree, and flower" is displayed on the canvas part in Figure 1. By entering an onomatopoeia associated with the picture on the screen, a user can cause a change (e.g., move the object that corresponds with the onomatopoeia or change the weather) in the picture book. For example, Figure 3 is an example of a change that occurs when the user enters the onomatopoeia of "za- za-." In the onomatopoeia picture book system, the weather in the default state is sunny. This can be changed to rainy weather by entering the weather-related onomatopoeia of "za- za-" therein.

The change in the behavior of the object to be drawn is determined on the basis of the correspondence between the onomatopoeias and the objects/phenomena. For example, when an onomatopoeia called "Moku moku" is entered, the system displays a situation wherein the object that is attached corresponds to the "smoke" drifting up a chimney. If a visual representation is difficult, such a system is expressed using the motion of objects that are not directly related to the input onomatopoeia. For example, the onomatopoeia of "byu-" corresponds to a change in the conditions of "wind" although "wind" cannot be viewed. Therefore, such effects are shown through the shaking of "flowers," the direction in which something falls, like the falling of "leaves" or "rain" (See Figure 4). In the current implementation, the mapping between the onomatopoeia and the behavior of each object is performed manually in advance. For the PC version, we were able to enter the onomatopoeia of 22 types of objects. Some examples of operations and associated onomatopoeia are shown in Table 1.

The intensity of an operation can also be adjusted by using different onomatopoeia. For example, both "Shito shito" and "za- za-" relate to

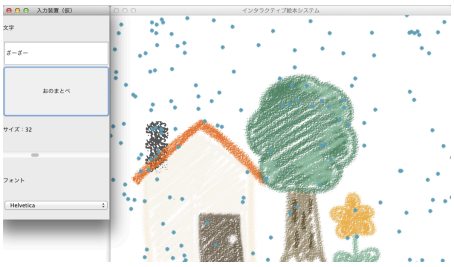

Figure 3. If user enter "za- za-"

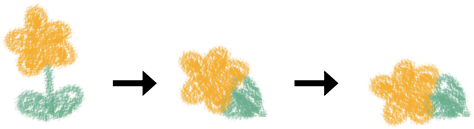

Figure 4. If user enter "pyu-"

"rain." However, there is a difference between the two; in this case, one produces a dull sound whereas the other does not. Here, sound symbolism of the onomatopoeia of these two types of rain can be used to differentiate between the degree of "rain." There is systematic relationship between sound and meaning as stated by Ohara [4]. By referring to this study, we correlated "heavy rain" with "za- za-" and "sprinkling rain" with "Shito shito." In this system, onomatopoeic text can be entered only one at a time. Therefore, to display simultaneous events, the user can input the order in which the onomatopoeias must occur. For example, wind and rain can be superimposed to occur simultaneously by entering "hyu-" immediately after " za- za-. " However, entering " San-san " (sunny) when raining is incompatible. Therefore, if the onomatopoeia above is entered as input; the events occur in sequence, i.e., "the sun comes out after the rain stops."

Table 1. Correspondence of system operation and onomatopoeia

Input onomatopoeia	System operation
gasa gasa	Falling leafs(from tree)
gata gata	Bouncing a house
gira gira	The sun be vivacity/Be clear
san san	The sun be vivacity/Be clear
sa-	Rain(Weak)
za- za-	Rain(Gusty)
:	:

6 Onomatopoeia Related Term Knowledge Base

The onomatopoeia picture book system we propose in this paper allows a picture to be changed through onomatopoeic input. To achieve this, each onomatopoeic word must be clearly defined to correspond to either a "motion" or a "changing circumstance."

For example, the onomatopoeia for "uro uro" can mean both "walking" and "running" [5].

However, to find the onomatopoeia for "uro uro" associated with the word for "walk," or conversely, to find the words corresponding to the onomatopoeia "uro uro," certain associations must be made.

One way to do this is to obtain peoples' opinions through a questionnaire. However, such an approach would take time and is impractical.

Thus, we wish to find an alternative, automatic approach to finding relevant words corresponding to onomatopoeia and vice-versa.

6.1 Research Method of Onomatopoeia

The representation content of onomatopoeia can be examined using a Japanese onomatopoeia dictionary [5]. This dictionary contains around 4500 words, which are arranged by "sound" and "state" and the definitions indicate whether the onomatopoeia are based on sound or appearance. However, it is not sufficiently clear whether an onomatopoeic word corresponds to a situation or a movement of an object. In addition, identifying a newly created onomatopoeia is impossible.

In our opinion, there are about 4500 Japanese onomatopoeic words, and a corpus containing numerous onomatopoeic words is required to collect all related terms. For this purpose, a Web-based text corpus is preferable.

On the basis of the above discussion, a knowledge base was constructed to examine the relationship between words and onomatopoeia so as to prerecord related words corresponding to the onomatopoeia and the onomatopoeia itself. However, manually matching all 4500 Japanese onomatopoeia is a tedious task. Thus, we investigated the automatic construction of the knowledge base containing onomatopoeia-related terms.

We have speculated that this knowledge base may be used to determine the relationship between onomatopoeia and words by examining sentences that contain onomatopoeia related to a person performing informal communication, because we have focused on the use of onomatopoeia when a person speaks. Specifically, we collected the text that contains the onomatopoeia by using the Twitter mini blog service, and we checked for the co-occurrence frequency of words that occur together with the onomatopoeia included in the text. Further, we examined whether high co-occurrence frequency is related with onomatopoeia. Then, by creating a knowledge base, we developed mechanisms for examining the correspondence between related words and onomatopoeia.

6.2 Collect Tweets Containing Onomatopoeia

Because the proposed method is intended to be used for movements drawn in illustrated books, onomatopoeia are used in its implementation. We collected onomatopoeia that can express the movement of human. Onomatopoeia-related words that are basic movements of a person, e.g., "aruku (= walking)" and "hashiru (= running)," were used to create an onomatopoeia meter — 56 words that are described in the Japanese Onomatopoeia Dictionary.

Subsequently, morphological analysis was carried out using MeCab [6]. The collected tweets were divided into nouns, verbs, and adjectives, and the co-occurrence frequency of each word was determined.

In the case of part-of-speech determination by MeCab, symbols such as "@" were identified as nouns. In this study, we measured the co-occurrence frequency of related Japanese words and Japanese onomatopoeia.

Table 2 shows the co-occurrence frequency obtained using the onomatopoeia "bra bra."

7 Analysis of Related Terms Knowledge Base

As mentioned previously, we searched for onomatopoeia words related to "walk" to "run" using Twitter API 56 and collected sentences that contains the onomatopoeia. The collection of tweets was performed over 10 days, from December 11, 2012 to December 21, 2012, and we collected 265650 tweets.

We examined the degree of co-occurrence for the verbs "walk" and "run," and each onomatopoeic word for the word co-occurrence fre-

Table 2. Noun words co-occur with onomatopoeia “bura bura”

Co-occur noun word	Co-occurrence frequency
ん (n)	1146
今日 (kyou)	1108
の (no)	1043
笑 (warai)	716
朝 (asa)	677
さん (sann)	668
日 (hi)	599
こと (koto)	484
今 (ima)	619
街 (mati)	582
駅 (eki)	579
:	:

quency of tweets contains the onomatopoeia as well as related terms from the knowledge base.

Because the number of tweets collected was less than the number of collected onomatopoeia, the extra words were excluded from the analysis of 15 words (e.g., “pappaka,” “shanari shanari”) out of 56 collected onomatopoeic words. Moreover, it was confirmed that the maximum contents are of tweets containing “ta-,” the most tweeted phrase. For onomatopoeia such as “yokatta-” and “yatta-,” we could not collect tweets containing “ta-.” Thus, we excluded them from the analysis of the collected results. We analyzed a total of 40 words, excluding the 16 collected from 56 onomatopoeias.

In the analysis, we examined whether the results included the words “walk” or “run” to identify co-occurrences and the correspondence degree of co-occurrence frequency.

Table 3 shows the co-occurrence rank of “walk” and “run” in terms of the number of co-occurrences of each onomatopoeic word. On examining the co-occurrence frequency, it was found that “walking” or “running” co-occur with 39 onomatopoeic words out of 40. It was ranked among the top 10 with regard to co-occurrence verbs, accounting for 29 out of 40 onomatopoeic words.

These results confirm that our approach obtains co-occurrence related (e.g., “walk,” “run”) and onomatopoeic words.

However, only the onomatopoeia “taji taji” did not co-occur with “walking” or “running” (See Table 3). This is presumably because it is often used in the sense of “appearance of falter” and “appearance of a people have trouble,” but is not commonly used in the sense of walking.

Table 3. Number of co-occurrences between onomatopoeias and verbs

Onomatopoeia	**Walk**	**Run**	**# of verbs**
tyoko tyoko	65	97	3291
hura hura	14	71	3125
uro uro	40	137	2619
bura bura	19	180	2138
bata bata	260	61	1976
sassa	79	221	1583
tototo	256	195	1332
yoro yoro	20	79	1267
noronoro	9	12	1241
teku teku	2	77	1184
to-n	293	672	1160
noko noko	20	221	1091
yoti yoti	4	104	1059
dota bata	139	58	1035
wata wata	587	98	1042
yobo yobo	16	80	1028
tobo tobo	1	36	1002
noso noso	7	56	960
bata bata	74	23	862
toko toko	3	19	819
pappa	363	267	747
tatatata	79	91	600
yota yota	3	26	593
hyoko hyoko	4	24	567
suta suta	2	49	549
:	:		
seka seka	11	79	299
dadadada	-	135	280
taji taji	-	-	266
rattatta	121	66	256
sutakorasassa	97	131	250
nosi nosi	9	30	220
nossi nossi	2	65	139
syanari syanari	2	-	104

8 Conclusion

In this study, we focused on “onomatopoeia” as a means for performing on the basis of the human sense. We proposed an interactive picture book system that uses onomatopoeia as the input to operate dynamic content with interactivity of user participation. In the proposed system, the painting system can be modified by entering onomatopoeic expressions that are sensuous to the user.

To realize such a system that uses ono-

matopoeia, the ways in which onomatopoeic words and their contents should correspond must be examined. Therefore, we proposed a method to determine the co-occurrence frequency of related words and onomatopoeic words by using sentences that contain onomatopoeic words collected from Twitter.

In the future, we will improve the interface of the onomatopoeia picture book system, such that it constantly evolves, e.g., corresponding to other onomatopoeia. While striving to achieve input methods based more on the intuition of the user, we will continue to conduct research with the aim of improving the accuracy of the onomatopoeia-related word knowledge base.

References

[1] Mitsunori Matsushita and Natsumi Imaoka. Kinetic onomatopoeia generation system for creating an attractive digital comic. In *Proceedings of the 25th Annual Conference of the Japanese Society for Arti cial Intelligence*, number 1C1-OS4a-3, pages 1–4, 2011.

[2] Hiroki Terashima and Takanori Komatsu. Moya-moya drawing: Proposing a drawing tool system which can utilize users' expressed onomatopoeias as an drawing effect. In *Proceedings of the 6th International Conference on Soft Computing and Intelligent Systems and the 13th International Symposium on Advanced Intelligent Systems (SCIS-ISIS2012)*, pages 494–497, 2012.

[3] Kanwipa Lertsumruaypun, Chiemi Watanabe, and Satoshi Nakamura. Onomatoperori: Search engine for cooking recipes by impression of their tastes or textures using japanese onomatopoeia. In *Proceedings of the 6th International Conference on Soft Computing and Intelligent Systems and the 13th International Symposium on Advanced Intelligent Systems (SCIS-ISIS2012)*, pages 2349–2350, 2012.

[4] John J. Ohala. Sound symbolism. In *Proceedings of the 4th Seoul International Conference on Linguistics [SICOL].*, pages 1–6, 1997.

[5] Masahiro Ono. *Giongo Gitaigo 4500 Nihongo Onomatope Jiten (Onomatopoeia Dictionary)*. Shogakukan, 2007.

[6] Taku Kudo. Mecab : Yet another part-of-speech and morphological analyzer. *http://mecab.sourceforge.net/*, 2005.