ICED13
INTERNATIONAL CONFERENCE ON ENGINEERING DESIGN, ICED13
19-22 AUGUST 2013, SUNGKYUNKWAN UNIVERSITY, SEOUL, KOREA

THE DATABASE OF MOTION CONSTRUCTED BY FOCUSING ON MIMETIC WORDS—FOR DESIGNING A CREATIVE AND EMOTIONAL MOTION

Yohei KOGUCHI, Kaori YAMADA, Toshiharu TAURA
Kobe University, Japan

ABSTRACT
We have been developing a method to design a creative and emotional 'motion' that may resonate with deep feelings that are difficult to describe verbally. In our previous study, we proposed a method to design a 'motion' by blending 'base motions' from a database wherein motions were related to corresponding 'mimetic words'. Mimetic words may express motion and phenomena that are difficult to describe verbally. In this study, we attempt to investigate how people perceive the impressions of base motions using mimetic words; further, we attempt to validate the use of mimetic words. Experiment 1 was conducted to examine generalities in the process of relating mimetic words to base motions. Experiment 2 was conducted to examine generalities for evaluating the appropriateness of expressing each base motion by using related mimetic words. Results indicated that there is a tendency for subjects to perceive impressions from mimetic words while viewing base motions.

Keywords: creativity, emotional design, design method, motion design, mimetic word

Contact:
Yohei Koguchi
Kobe University
Mechanical Engineering
Kobe
6578501
Japan
125t323t@stu.kobe-u.ac.jp

1 INTRODUCTION

The development of computational technology has made it easy to accentuate objects through movement. In recent years, new dynamic forms of expression via computational technology have appeared. For example, logos employing computer-generated graphical movement on the Internet and promotional videos on TV are used widely to advertise products or corporations. Hence, design fields have widened their scope to include these dynamic objects. In this study, we have targeted dynamic designs, especially motion designs. We attempted to design a creative and emotional motion that could enhance the attractiveness of animated logos. Here, 'motion designs' refer to designing a change in the position of an object with respect to time and reference points.

How can we design these motions? For static design, the image of the new design idea that a designer has in his or her mind can be described. However, motion that does not exist yet cannot be captured easily in written form or with verbal descriptions. Humans have devised a variety of tools for designing motion behaviours for their own bodies and for products ranging from vehicles to robots to two-dimensional animated figures. However, producing the motions that we have designed requires experts who can operate relevant tools. Moreover, the conventional methods to generate these behaviours are based on visual or physical images created by the designer. We would like to create a tool to produce creative and emotional motions from vague images of motions that do not exist yet.

Music, another form of dynamic expression, can make a deep impression on us. Music differs from natural sound in that it is a fabricated creation and evokes feelings that go beyond ordinary human imagination. We assume that a creative design that differs from natural object and goes beyond the ordinary human imagination can produce emotional impressions that resonate with deep feelings. Moreover, music can be written in the form of musical scores for musical instruments. The playing of musical instruments arouses human feelings. We would like to create a tool, such as a musical instrument, to produce motions that resonate with people's deep feelings.

Based on the above considerations, a method for designing a creative and emotional motion and a computer system for implementation were developed in our previous studies (Taura and Nagai, 2010; Yamada et al., 2010; Yamada et al., 2011). A creative and emotional motion was generated by blending motions. Moreover, we attempted to support the selection of motions by focusing on mimetic words in the Japanese language. While onomatopoeic (sound-symbolic) words such as *kachi-kochi* ('tick-tock') and *pon* ('pop') imitate actual sound, mimetic (reality-symbolic) words such as *shiku-shiku* ('crying') and *kune-kune* ('wriggling') express appearance, movement, feelings, or other phenomena (Gomi, 1989). We believe that mimetic words are capable of expressing deep feelings; further, they can function similarly to musical scores, by which new music is created. Accordingly, we extended the database of motions so that motions are related to corresponding mimetic words (Yamada et al., 2012). This database is expected to help the designer express the image of the motion that is stored in his or her mind. However, the validity of the relationship between base motions and mimetic words has not been confirmed. Therefore, it should be clarified whether generalities exist in the usage of mimetic words to express the impressions of motions. In this study, we attempted to investigate how people perceive impressions of base motions using mimetic words; additionally, we attempted to validate the use of mimetic words.

2 THE METHOD OF DESIGNING A CREATIVE AND EMOTIONAL MOTION

We developed the method for designing a creative and emotional motion (Taura and Nagai, 2010; Yamada et al., 2010; Yamada et al., 2011). The method was constructed based on the strategies that follow.

2.1 Mimicry of natural objects

Humans have evolved within the natural environment, presumably with images of nature imprinted in their minds. Moreover, humans have created many artefacts that are based on or suggested by natural objects with motions that are both unique and charming (Chakrabarti et al., 2005). Therefore, we decided to use natural objects as a source for designing a creative and emotional motion. The motion obtained by mimicking natural objects is hereafter referred to as 'base motion'.

2.2 Emphasis on rhythmic features

In order to generate a more creative motion that extends far beyond the human imagination, we attempted to emphasise the rhythmic features of motion (i.e. changes in the quantity of movements and angular velocities). We focused on rhythm as the essence of the motion. Moreover, we attempted to emphasise the rhythmic features of a motion by increasing or decreasing intensity. Using this method, we expected that motions that extend far beyond the human imagination could be designed.

2.3 Blending of motions

According to studies on design creativity, concept blending is crucial to the creative generation of new concepts. Concept blending is based on combining two input concepts to yield a third concept. While a blended concept inherits part of its structures from the input concepts, it also includes emergent structures of its own (Nagai et al., 2009). Thus, we applied the notion of concept blending to the design of a creative and emotional motion, and we developed a method to blend base motions. A method that incorporates mimicry of natural objects, emphasis on rhythmic features and blending of motions is hereafter called 'Rhythmic Feature-based Motion Blending' (RFMBlending).

2.4 Transfer motions into a design target

RFMBlending was implemented for a design target. Although the motion of the design target was expected to be creative and emotional in itself, we assumed that it could be even more so if the entire target were to move in space (external motion) to complement the motion of the design target itself (internal motion). Both internal and external motions were designed using RFMBlending. The motions were transferred into a design target itself and an entire design target, and a creative and emotional design was generated.

The outline of the proposed method for designing creative and emotional motion is shown in Figure 1. A creative and emotional motion can be designed according to the following steps:

Step1) Acquire base motions by mimicking natural objects.
Step2) Emphasise the rhythmic features of these motions.
Step3) Blend the motions that are obtained in Step2.
Step4) Transfer the blended motions into a design target.

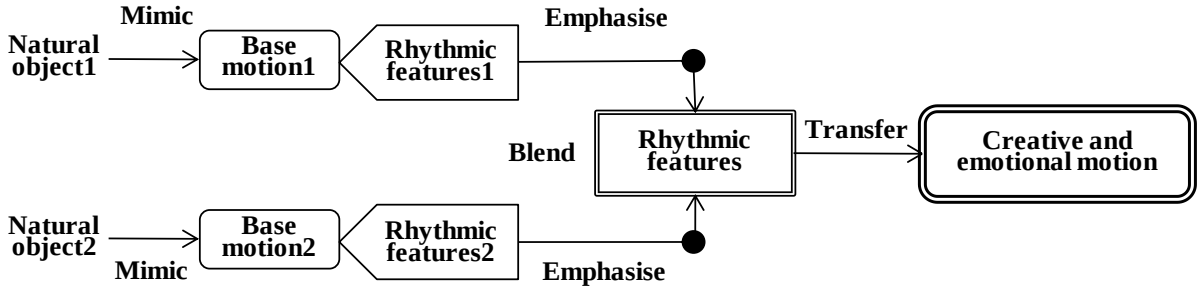

Figure 1. Outline of proposed method for designing creative and emotional motion

In our previous studies, we created a tool based on the method described above. A snake and frog were chosen as natural objects; nine linked spheres were used as the design target; and a creative and emotional motion was generated. Moreover, we found that motion tends to be imbued with more effective emotional impression as it extends beyond ordinary human imagination.

3 OBJECTIVE

3.1 Mimetic words

As mentioned in Section 1, it is difficult to express verbally or in written form the feeling of dynamic motion. In this study, therefore, we focused on mimetic words because of our expectation that they will express the vague feeling of the motion that is rooted deeply in the designer's mind. Relating the words to base motions could help the designer search for an appropriate motion from the database of motions. Furthermore, we believe that mimetic words are capable of expressing new motions through the creation of new mimetic words, just as new music is created from scores.

3.2 The system for designing a creative and emotional motion by using mimetic words

We developed a computer system for designing creative and emotional motions by using mimetic words (Yamada et al., 2012). The outline of the system is illustrated in Figure 2. The system consists of a tool to extract the movements for base motions from natural objects, a database of base motions that are related to the corresponding mimetic words, and a tool to generate a creative and emotional motion. The designer can retrieve appropriate base motions for designing a motion in accordance with his or her imagination from the database by using classified mimetic words as keywords. Based on the selected base motions, a generating system will produce a new motion by blending base motions; furthermore, it will show the new motion to the designer.

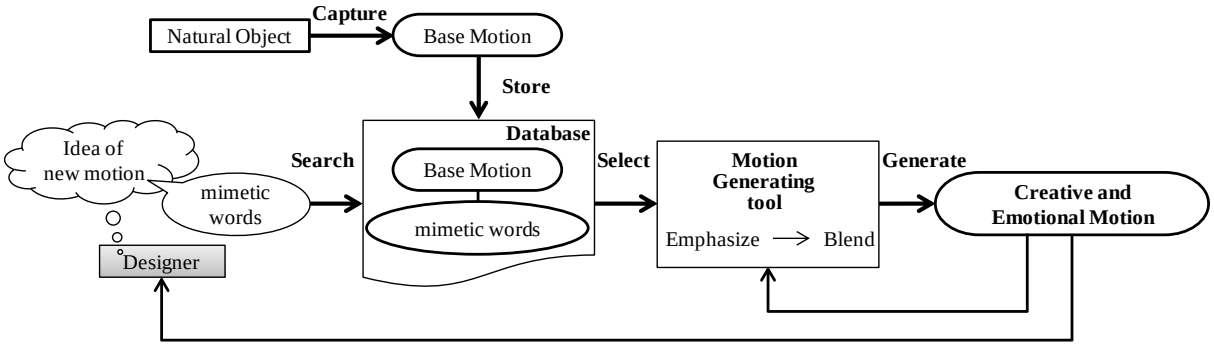

Figure 2. Outline of the system for designing a creative and emotional motion

3.3 Aim and research method

We attempted to investigate how the expressions of base motions with mimetic words are produced and perceived by people to validate the use of mimetic words for expressing motions.

Two relevant experiments were conducted. Experiment 1 was conducted to examine generalities in the process of relating mimetic words to base motions. Next, Experiment 2 was conducted to examine generalities for evaluating the appropriateness of expressing each base motion using the related mimetic words from Experiment 1.

4 DATABASE

4.1 Obtaining base motions

In our previous studies, to extract the movements for base motions from various kinds of natural objects, we created a tool to obtain motion data by capturing a video of a natural object and extracting its movements (Yamada et al., 2012). A total of 160 base motions were collected using the tool. The base motions were obtained from each video and from several categories of Fish or Aquatic living things, Reptiles or Amphibians, Birds, Mammals, Plants and Insects (i.e. 23 base motions from Fish or Aquatic living things, 18 from Reptiles or Amphibians, 27 from Birds, 30 from Mammals, 39 from Plants and 23 from Insects). The category was based upon *Animal Distribution Atlas of Japan* (2010). A state of extracting the movement of a natural object and an example of the base motion are shown in Figure 3.

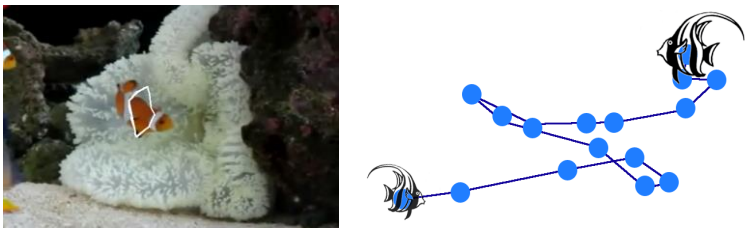

Figure 3. Extracting fish's motion and Example of the base motion

4.2 Classification of mimetic words

We classified them from the viewpoints of their meanings and similarities (Yamada et al., 2012). First, referring to the *Dictionary of Japanese Onomatopoeia* (2007), we picked up mimetic words that are used generally. Second, we classified these mimetic words according to the situations in which they were used. We chose mimetic words that were used to modify verbs since we were focusing on motion. Third, we classified mimetic words based on the categories of words. According to the *EDR Electronic Dictionary* (2005), verbs are classified into five categories (i.e. Movement, Change, Appearance, Action, and Phenomena). Examples of mimetic words are shown in Table 1. We chose mimetic words that modify the situations of verbs according to Movement, Change and Appearance. Consequently, we chose 52 mimetic words.

Table 1. A part of a list of classified mimetic words

Mimetic word	Situation	Word type	Category	
poka-poka	'warm'	Adjective	-	-
shiku-shiku	'cry'	Verb	Action	-
teku-teku	'walk'	Verb	Movement	Suitable
puka-puka	'float'	Verb	Appearance	Suitable
nyoki-nyoki	'extend'	Verb	Change	Suitable
pika-pika	'shine'	Verb	Phenomenon	-

Next, we classified 52 mimetic words into categories. In the classification, 8 college students were shown a video of a natural object and a list of the mimetic words; then, they were asked to relate each movement (video) to the 52 mimetic words. Finally, a cluster analysis was conducted. Ward's method (Ward, 1963) was employed as the hierarchical method. Figure 5 shows the obtained cluster (as a dendrogram). As shown in Table 2, the nine groups were identified with respect to the value of 10 and the Cluster Distance (horizontal axis). The highest-scored word in each group was recognised as a representative mimetic word; the words thus identified were *hira-hira* ('fluttering, swirling'), *noso-noso* ('moving slowly, clumsily'), *bata-bata* ('moving busily in small motions; flapping'), *choko-choko* ('walking or running with short steps, restless and constantly on the move'), *une-une* ('winding, meandering'), *fuwa-fuwa* ('something soft and light swells up or rises'), *sui-sui* ('moving smoothly and easily though something'), *yusa-yusa* ('swaying of something large and heavy'), and *pyon-pyon* ('hopping or skipping agilely').

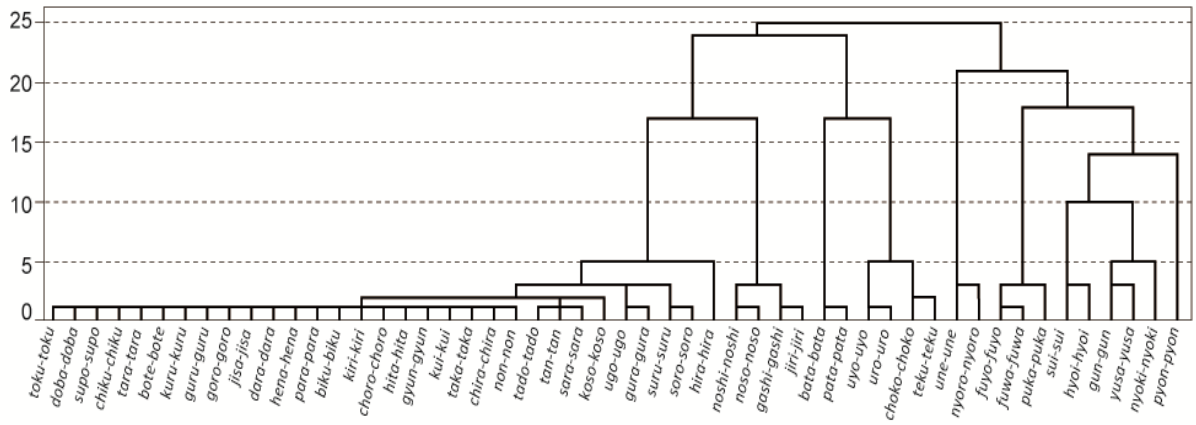

Figure 5. Results of cluster analysis

4.3 Relating mimetic words to base motions

We performed Experiment 1 to examine generalities in the process of relating mimetic words to base motions. In this experiment, the subjects (three college students) were shown each base motion and a list of representative mimetic words; then, they were asked to relate each mimetic word to the base motion. To verify the results, we confirmed the concordance rate of all combinations of two among the results that were obtained from three subjects, as shown in Table 3. We used kappa statistics to find the

concordance rate of two results. We found one combination (Subject B and Subject C in Table 3) with the highest concordance rate for all combinations. Statistically speaking, the concordance is modest ($\kappa = 0.46$). One relating mimetic words to base motions of the combination (Subject C's relating) was adopted to the database.

Table 2. Mimetic words in each group

Group	Mimetic words
1	***hira-hira,*** *toku-toku, doba-doba, supo-supo, chiku-chiku, tara-tara, bote-bote, kuru-kuru, guru-guru, goro-goro, jisa-jisa, dara-dara, hena-hena, para-para, biku-biku, kiri-kiri, choro-choro, hita-hita, gyun-gyun, kui-kui, taka-taka, chira-chira, non-non, tado-tado, tan-tan, sara-sara, koso-koso, ugo-ugo, gura-gura, suru-suru, soro-soro*
2	***noso-noso,*** *noshi-noshi, gashi-gashi, jiri-jiri*
3	***bata-bata,*** *pata-pata*
4	***choko-choko,*** *uyo-uyo, uro-uro, teku-teku*
5	***une-une,*** *nyoro-nyoro*
6	***fuwa-fuwa****, fuyo-fuyo, puka-puka*
7	***sui-sui,*** *hyoi-hyoi*
8	***yusa-yusa,*** *gun-gun, nyoki-nyoki*
9	***pyon-pyon***

Table 3. Concordance rate of all combinations

Combination	Concordance rate
Subject A & Subject B	31.57%
Subject B & Subject C	46.18%
Subject C & Subject A	37.24%

We reconstructed the database of 160 base motions that were related to the corresponding mimetic words. This database enabled us to refer to base motions by using mimetic words as keywords. For example, by retrieving base motions from the mimetic word *sui-sui* in the database, we were able to find some motions related to that word *sui-sui* (Table 4). Therefore, a designer can design a new motion that he/she wants to create by using this database.

Table 4. Results of searching for base motions referring to mimetic words

Name	Kind	Mimetic word 1	Mimetic word 2
Bee3	Insect	*sui-sui*	*bata-bata*
Black kite	Bird	*sui-sui*	*bata-bata*
Cat1	Mammal	*sui-sui*	*choko-choko*
Common Pheasant2	Bird	*sui-sui*	*choko-choko*
Dragonfly	Insect	*sui-sui*	*bata-bata*
Fish3	Fish or Aquatic living things	*sui-sui*	*pyon-pyon*

4.4 Evaluating the appropriateness of expressing each base motion by using the related mimetic words

Experiment 2 was conducted to examine generalities associated with evaluating the appropriateness of expressing each base motion with related mimetic words. First, 50 base motions were selected randomly from the database. Next, the subjects (i.e. six college students) were shown each base motion with the corresponding mimetic words. They were asked to answer whether the mimetic words suitably expressed each base motion; a three-point scale was used in which A meant 'suitable'; B meant 'neither'; and C meant 'not suitable'.

Examples of the results from the experiments are shown in Table 5. Kendall's coefficient of concordance showed that the results were significant (i.e. $W = 0.26$, χ^2 (72) = 113.05, $p = 0.0014$), while nearly 33% of the base motions were not linked to suitable mimetic words. Results indicated

that there is a tendency for subjects to perceive impressions from mimetic words while they view base motions.

Table 5. Examples of the results

Base motion	Mimetic word	Subject A	Subject B	…	Subject F
Motion1	*bata-bata*	C	B	…	C
Motion1	*pyon-pyon*	B	A	…	B
Motion2	*sui-sui*	A	A	…	B
Motion2	*fuwa-fuwa*	C	C	…	B

5 APPLICATION TO THE DESIGN OF MOTION

A case study that challenged the authors of this study was used in our attempt to generate a motion using mimetic words. Thus, we generated the design target's external motions by using RFMBlending and the database. First, we selected a mimetic word—*bata-bata*—and searched for it in the database. Three base motions were searched; more specifically, each base motion was obtained from a butterfly, hamster, and bee. In the same way, we selected the mimetic word *sui-sui* and three base motions, using a penguin, fish and cat for each base motion. Next, as mentioned in Section 2, base motions were emphasised and blended to generate a new motion. All of the base motions were emphasised, and each pair of base motions, wherein one base motion was related to the mimetic word *bata-bata* and the other was related to the mimetic word *sui-sui*, were blended; subsequently, three new motions were generated.

Finally, we transferred the generated motion into a logo, or design target. The logo was decomposed into three parts and the three new motions were transferred to each part of the logo. Figure 6 shows the images of the six base motions and the logo. Generated motion for the logo is illustrated in Figure 7.

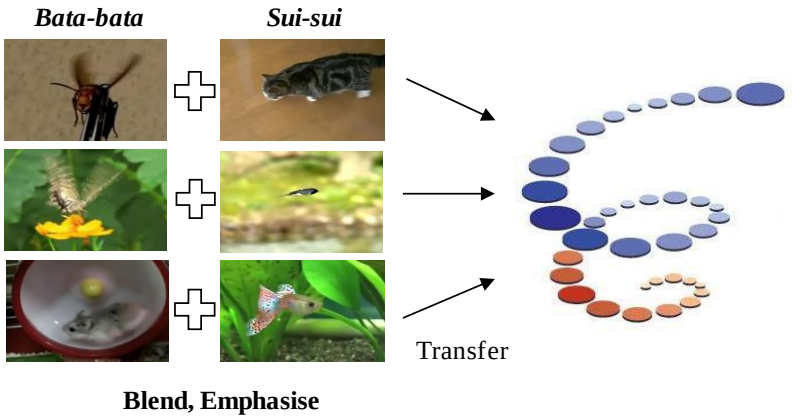

Figure 6. Images of searched base motions and a logo for the design target

6 CONCLUSION AND FUTURE WORKS

In this study, we attempted to investigate how the impressions of base motions from mimetic words are produced and perceived by people; we attempted also to validate the usage of mimetic words. Experiment 1 was conducted to examine generalisations that could be inferred from relating mimetic words to base motions. In this experiment, the highest concordance rate was 46.18%. It indicates that mimetic words can be related closely to base motions. Experiment 2 was conducted to examine generalities for evaluating the appropriateness of expressing each base motion with related mimetic words. The results indicate that there is a tendency for subjects to perceive impressions from mimetic words while they view base motions. In this experiment, Kendall's coefficient of concordance showed significance for the results. On the basis of the results obtained from the two experiments, a case study to create a new motion was conducted by using the database of 160 base motions with corresponding mimetic words.

In the future, more mimetic words and motions of natural objects should be added to the database; further, relating base motions to mimetic words more suitably should be considered. Additionally, further research should be conducted to develop a method to generate more creative and emotional

motions by using mimetic words. In particular, we would like to develop extremely creative and emotional motions by expressing new motions from new mimetic words, just as new music is created from unique scores.

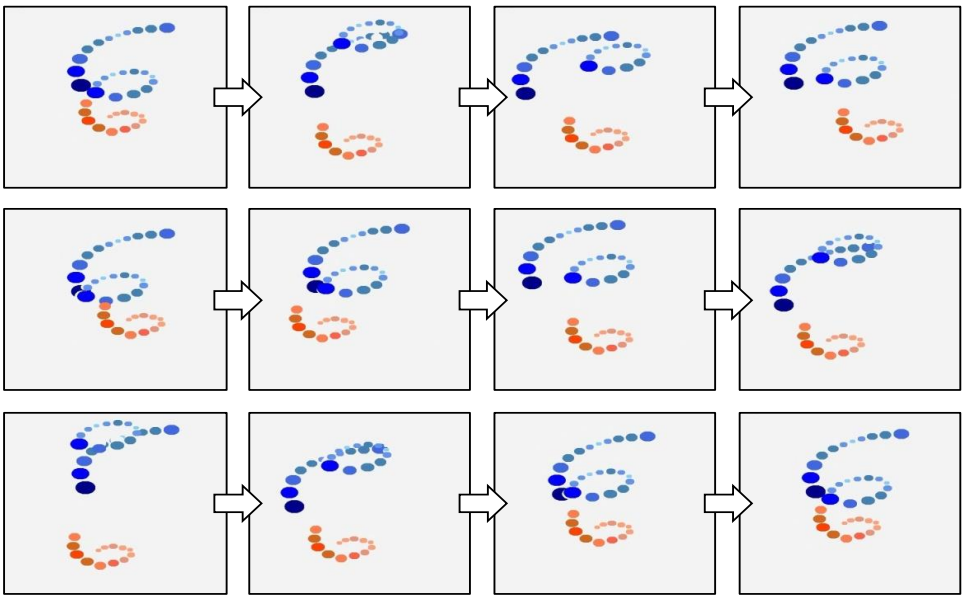

Figure 7. Generated motion for the logo by blending bata-bata and sui-sui

REFERENCES

Chakrabarti, A., Sarkar, P., Leelavathamma, B., and Nataraju, B.S. (2005) 'A functional representation for aiding biomimetic and artificial inspiration of new ideas' *Artificial Intelligence for Engineering Design, Analysis and Manufacturing*, Vol.19, No.2, pp.113-132

Gomi, T. (1989) *An Illustrated Dictionary of Japanese Onomatopoeic Expressions*, Yokohama, The Japan Times

Ministry of the Environment (2010) *Animal Distribution Atlas of Japan* [on line], http://www.biodic.go.jp/kiso/atlas/pdf/ (19th December 2012)

Nagai, Y., Taura, T. and Mukai, F. (2009) 'Concept blending and dissimilarity: factors for creative concept generation process', *Design Studies*, Vol.30, No.6, pp.648-675

National Institute of Information and Communications Technology (2005) *EDR Electronic Dictionary*, CPD-V030, on CD-ROM

Ono, M. (2007) *The Dictionary of Japanese Onomatopoeia*, Tokyo, Shogakukan (in Japanese)

Taura, T. and Nagai, Y. (2010) 'Designing of Emotional and Creative Motion', in Fukuda, S. (ed), *Emotional Engineering: Service Development*, Berlin, Springer-Verlag, pp.377-387

Ward, J.H., Jr. (1963) 'Hierarchical Grouping to Optimize an Objective Function', *Journal of the American Statistical Association*, Vol.48, No.301, pp.236-244

Yamada, K., Taura, T. and Nagai, Y. (2010) 'Design of Emotional and Creative Motion by Focusing on Rhythmic Features', in Taura, T. and Nagai, Y. (eds), *Design Creativity 2010*, London, Springer-Verlag, pp.139-146

Yamada, K., Taura, T. and Nagai, Y. (2011) 'Design and Evaluation of Creative and Emotional Motion', *Proceedings of 8th ACM Conference on Creativity and Cognition (C&C 2011)*, Atlanta, Georgia, USA, 3th-6th November, on USB-Memory

Yamada, K., Taura, T. and Nagai, Y. (2012) 'Study on the use of Mimetic Words in Motion Design', *The 2nd International Conference on Design Creativity (ICDC2012)*, Glasgow, UK, 18th-20th September, on USB-Memory