KEER2010, PARIS | MARCH 2-4 2010
INTERNATIONAL CONFERENCE ON KANSEI ENGINEERING AND EMOTION RESEARCH 2010

DESIGN OF SCENTS SUITED WITH USER'S KANSEI USING INTERACTIVE EVOLUTIONARY COMPUTATION

Makoto FUKUMOTO[*a] and Jun-ichi IMAI[b]

[a] *Fukuoka Institute of Technology, Japan*
[b] *The University of Electro-Communications, Japan*

ABSTRACT

This paper proposes an effective method to design scents suited with a user's Kansei using the interactive evolutionary computation (IEC). Effects of the scents are used for various purposes, and ready-made scents are often used. It is expected that more effective results can be achieved if we use the scents suited with the user's Kansei. Recent progress of technology enables us to create our favorite scents by blending several source scents. With "Aromageur", one of the such devices, a user can create scents by specifying a favorite blending ratio. With these devices, however, the user is required to optimize the blended ratio of the scents suited with their Kansei by try and error. The aim of this paper is to propose the method to optimize the blended ratio without such a load. We adopt IEC technique for the optimization. In the proposed method, instead of adjusting the blended ratio by the user manually, the user just evaluates and scores the blended scents. The blended ratio corresponding to each scent is regarded as an individual in the IEC algorithm. The algorithm imitates the evolution of creatures, and individuals having higher scores are tended to be selected and produce their offspring. It is expected that IEC finds the blended ratio of scents best or better suited with the user's Kansei after several generations. In this paper, we developed the IEC system and investigated the efficacy of the system through smelling experiment.

Keywords: *Scent, Aromatherapy, Interactive Evolutionary Computation, Kansei*

---

* **Corresponding author**: postal address: 3-30-1 Wajirohigashi, Higashi-ku, Fukuoka, 811-0295 Japan, e-mail: fukumoto@fit.ac.jp

1. INTRODUCTION

Effects of scents are used for various purposes such as creating a certain atmosphere, changing one's personal mood, putting one to sleep and aroma therapy. Aroma therapy is a representative use of the scents and is in a revival. R. Balz explains the reason why we pay attention to aroma therapy as "an expression of a growing disillusionment with chemical drugs and their many side-effects" [1]. When we use scents, ready-made scents are often used. However, it is expected that more effective results can be achieved if we can use scents suited with a user's Kansei.

Recent progress of information technology enables us to create our favorite scents by blending several source scents using special devices and computers. "Aromageur" manufactured by Mirapro Co., Ltd. [2] is one of such devices, which enables a user to create user's favorite scents by blending six source scents. With the Aromageur, a user can create scents by specifying a favorite blending ratio through software. As a previous study using the Aromageur, Zhang et al. have attempted to create a suitable scent for an atmosphere of a university in the field of Kansei engineering [3].

In the use of this device, however, there is a serious problem that users have to set the ratio of the source scents by themselves. Although some blending recipes are prepared in advance, the users are required to optimize the blended ratio to find the scents suited with their Kansei by try and error. Such optimization of the blended ratio must be a burdensome task for most of general users.

The aim of this paper is to propose a method to optimize the blended ratio without such users' load. We adopt Interactive Evolutionary Computation (IEC) [4] technique for the optimization. In the proposed method, instead of adjusting the blended ratio manually, the user evaluates and scores the blended scents created by the Aromageur. The blended ratio corresponding to each scent is regarded as an individual in the IEC algorithm. The algorithm imitates the evolution of creatures, and the individuals having higher scores are tended to be selected as parents and produce their offspring. It is expected that IEC finds the mixture ratio of source scents best or better suited with the user's Kansei after several generations.

In this paper, we propose an effective method to design scents suited with a user's Kansei using the IEC technique. We also construct the IEC system based on the proposed method. To examine the efficacy of the system fundamentally, the smelling experiment with the constructed system is performed.

2. THE PROPOSED METHOD

Main purpose of this paper is to propose the method that creates the favorite scent for the user by using IEC and to construct the system. This chapter describes outline of the proposed method and algorithm of evolutionary computation.

2.1. Outline of the proposed method

With the proposed method, a user can obtain user's favorite scents in an easy way. Figure 1 shows the schema of the proposed method. The blended scents created from Aromageur

are sequentially presented to the user. The user subjectively evaluates and scores each of them with simple way like semantic differential method [5]. Based on the subjective evaluation values, the evolutionary computation creates better blending ratios. As an algorithm of evolutionary computation, Genetic Algorithm (GA) is employed in this study. The blending ratios are reflected as blended scents through Aromageur and its software.

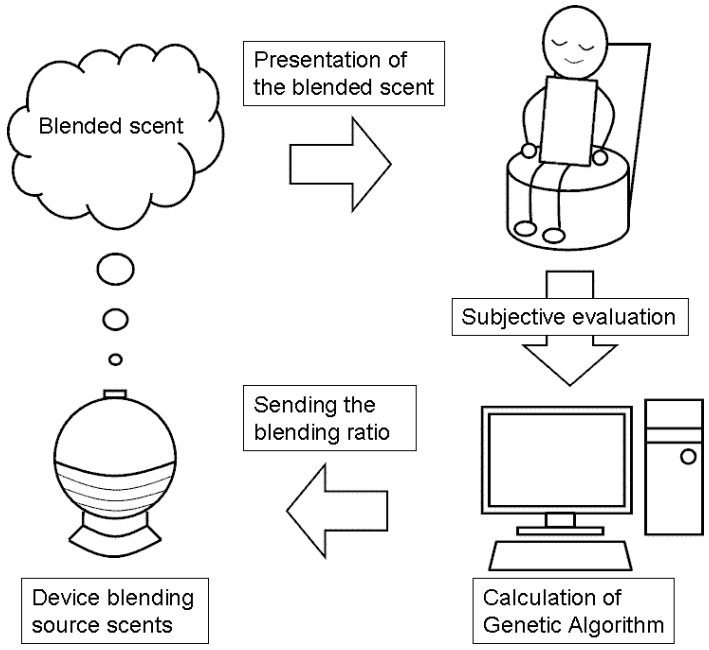

Figure 1: Schema of the proposed method

2.2. Genetic Alogorithm

GA [6,7], one of the evolutionary computations, imitates the evolution of the creatures in an environment to optimize certain pattern to ideal one. Typical GA is composed of several steps; creation of initial population (individuals), evaluation of individuals, selection of parents and creation of offspring with operations. Individuals in the population are dealt as patterns in GA, and individuals having higher fitness value tend to be selected as parents that create their offspring for the next generation.

The patterns in GA mean blending ratios of the source scents, and the patterns are dealt as genes of the individuals in GA. Figure 2 shows an example of genes in one individual. There are six source scents, and ratio (strength) of each source scent is written in the genes. Based on these values, the Aromageur blends the source scents through its software. As explained in the next chapter, these values are ranged from 0 to 100. The user subjectively evaluates and scores the blended scents, and the score of the individual is its fitness value.

Ratio of source scents

Scent1	Scent2	Scent3	Scent4	Scent5	Scent6
10	20	30	20	40	50

Figure 2: An example of genes in one individual

3. EXPERIMENT

To verify the efficacy of the proposed method and its system, fundamental experiment is performed with a method described as below.

3.1. Procedure

Nine males individually participate in the experiment as subjects. The subjects smell the presented scents created from the Aromageur and evaluate them subjectively. The evaluation value is conveyed by the subject verbally to the experimenter. The experimenter inputs the subject's evaluation value to the proposed system. The experimenter also inputs the gene data presented by the proposed system to the exclusive software of the Aromageur. The subjects evaluate the presented scents in seven point scale (*7*: extremely like ~ 1: normal or dislike). To evaluate the scents easily, a board with the seven point scale attached appropriate adjectives at odd numbers is presented to the subjects during the experiment.

To keep air in the experimental room scentless during the experiment, air in the experimental room is ventilated continuously. Moreover, the experimenter immediately stops generating the scent after the subjects evaluate it. The subjects can take a rest during the experiment when they feel fatigue.

3.2. Set of GA

In GA, six individuals are set in all generations. Each of the subjects participates in ten generations in the experiment. The genes of the individuals in initial population (first generation) are generated by random values from 0 to 50. Maximum and minimum values of each gene are defined 100 and 0, respectively. As selection and operations in GA, roulette selection, one point crossover and mutation are adopted. In the crossover operation, genes of the parents are inherited to their child. The one point crossover operation is done 90%. Mutation changes the number of each gene 0~30 in 10%.

3.3. Source scents

Six source scents used in the experiment are lemon, lavender, fennel, rosewood, bergamot and orange, and their oils are set in the Aromageur device. According to the literatures relating to aromatherapy, they are relatively major scents in aromatherapy and used in various situations [1,8-10]. Some combinations of the source scents are included in conventional examples of blending scents in aromatherapy.

4. EXPERIMENTAL RESULTS

Figure 3 shows an example of the development fitness values of one subject. Average fitness value means average score of six scents in one generation, and maximum fitness value means highest score of six scents in the generation. Gradual increase of average fitness value was observed in accordance with the development of the generation, and average fitness value reached highest value in tenth generation.

Figure *4* shows the development of average and maximum fitness values between all of the subjects. These values are obtained by once calculating average and maximum fitness values in each subject. As shown in the graph, the change in the fitness values was observed.

Comparing between first and tenth generations, a little increase in these fitness values are observed, however, the increase are very small and are not significant. For each of the experiments, it took almost twenty minutes to one hour.

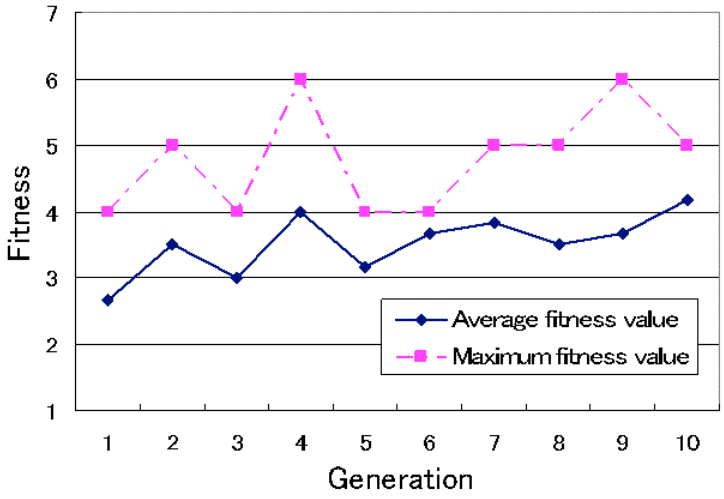

Figure 3: Average and maximum fitness values of one subject

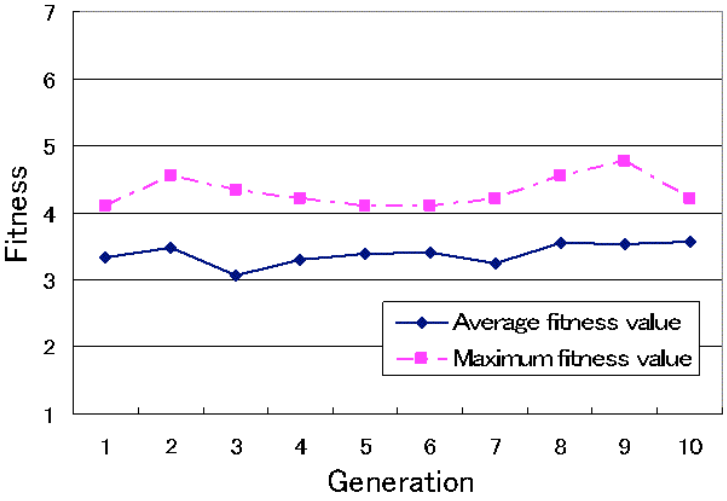

Figure 4: Average of fitness values between the subjects

5. DISCUSSION

Significant increases in fitness values were not observed in the experimental results. Main cause of that is considered as in a way to smell the scents. After the experiment, some of the subjects commented that they feel little difference between presented scents, therefore, the way of smelling the scents was considered as inappropriate. Furthermore, less variety of the created scents might cause little increase of the fitness values. Variety of the created scents is related to the set of source scents and the set of GA.

Originally, the field of previous IEC studies was mainly limited in the sense of sight and hearing. According to the Takagi's survey of IEC [4], the IEC study dealing with other senses is rare, and there was only one previous study dealing with the taste [11]. It might be severe for human to sense and evaluate precisely the contents regarding to taste and olfactory, therefore, the way to present the blended scent to the subject is needed to be improved. For example, in the evaluation of the scents in GA, tournament selection might be more appropriate to evaluate the scents than roulette selection used in this paper, because a user just compares two scents and selects better one in the evaluation with the tournament selection.

6. CONCLUSION

This paper proposed the novel method that creates user's favorite scent with GA. The scents are used in various ways and situations, therefore, fitting the scent to user's favor and Kansei is important. Moreover, we constructed the system with the Aromageur and examined the efficacy of the system fundamentally. However, the experimental results did not show the significant increase of favor for created scents with the proposed method. The experimental method and set in GA should be improved.

Although we could not observe the significant results with the constructed system, parts of the results showed possibility that the proposed method is effective for creating the scent suited with user's favor. We focus on the psycho-physiological effects of the scent on human, because the sense of olfactory is transmitted to human brain in a different way from other senses [12]. As future study, we will improve the proposed system and have comparing experiment with a control condition.

ACKNOWLEDGMENTS

This research was supported in part by Ministry of Education, Culture, Sports, Science and Technology, Grant-in-Aid for Young Scientists (B) and Grant from Computer Science Laboratory, Fukuoka Institute of Technology.

REFERENCES

1. Balz, R., The Healing Power of Essential Oils, Lotus Light Publications, 1996.
2. MIRAPRO Corporation, <http://www.mirapro.co.jp/gyomu/aroma.html>
3. Zhang, P., Mitani, A., Miyazaki, M., Development of Control System for Blending and Generating of Scent, Proceedings of Kansei Engineering and Emotion Research 2007, L-18, 2007.
4. Takagi, H., Interactive Evolutionary Computation: Fusion of the Capabilities of EC Optimization and Human Evaluation, Proceedings of the IEEE, Vol.89, No.9, pp. 1275-1296, 2001.
5. Osgood, C.E., Suci, G.J. and Tannenbaum, P., The measurement of meaning, University of Illinois Press, IL, USA, 1957.
6. Holland, J.H., Adaptation in Natural and Artificial Systems, University of Michigan Press, Ann Arbor, 1975.

7. Goldberg, D., Genetic Algorithms in Search, Optimization and Machine Learning, Addison-Wesley, Reading, MA, 1989.
8. Worwood, V.A., The complete book of essential oils & aromatherapy, New World Library, Novato, CA, 1991.
9. Davis, P., Aromatherapy An A-Z, Random House, 2005.
10. Price, S., Price, L. (eds.), Aromatherapy for health professionals, Elsevier, 2007.
11. Herdy, M., Evolutionary optimization based on subjective selection – evolving blends of coffee, Proceedings of 5th European Congress on Intelligent Techniques and Soft Computing, Aachen, pp.640–644, 1997.
12. Koeppen, B. M., Berne & Levy Physiology (sixth edition), Mosby Elsevier, 2008.