A Proposal for Intervention by User in Interactive Genetic Algorithm for Creation of Music Melody

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***Abstract*—In the area of Interactive Evolutionary Computation (IEC), some previous studies have already proposed a method for creating music melody. However, in these methods, user's concrete intention or Kansei seems not to be reflected to the created melodies. This study focuses on this point: reflection of user's concrete intention and Kansei in IEC. While most of conventional IEC approaches accepted only user's evaluation by scoring or comparing solution candidates, the proposed method accepts user's operation for solution candidates as user's intervention. To investigate the proposed method for creation of music melody, listening experiments were conducted. In the experiment, the subjects listened to music melody created from the IEC system based on the proposed method. With the system, the subjects can control key of music note in melody by themselves when they wanted to change the melody. As result of experiment, the mean fitness value gradually increased in accordance with progress of generation, and significant differences between the first generation and other generations were observed. The experiment also investigated the efficacy of the user's intervention.**

Keywords-kansei; interactive evolutionary computation; genetic algorithm; music melody; intervention

I. INTRODUCTION

Recently, music pieces are easily created by development of information technology. However, it is still difficult for beginners to create music pieces suited to each user's preference and kansei. Psycho-physiological effects of music pieces are widely believed, and higher effects of music pieces are expected if we could obtain the music pieces suited to each of us. Based on these backgrounds, some previous studies aimed to develop information technologies creating the music piece suited to each user.

Interactive Evolutionary Computation (IEC) is known as effective approach that reflects user's preference and kansei to media contents. IEC is one of applications of evolutionary algorithms and reflects user's preference to created contents. IEC accepts user's subjective evaluation as fitness value in evolutionary algorithms and searches optimal solutions of media contents suited to each user's preference and kansei which is indefinite functions.

As examples of the previous IEC studies, IEC methods creating sign sounds suited to user's kansei were proposed [1], [2]. In most of the IEC methods, Genetic Algorithm (GA) is employed as evolutionary algorithm. Some previous studies proposed Interactive GA (IGA) for composing music pieces. Furthermore, recent IEC studies often employed other new evolutionary algorithms with expectations of higher performance for searching.

However, in these previous IEC approaches creating music and sound contents, users just evaluated the presented contents from the IEC system and could not actively concern with the creation of music and sound contents. Only with the subjective evaluation by the user, IEC is difficult to change the odd sounds in the contents because search in IEC is a stochastic approach. Additionally, good individuals obtained from IEC are often corrupted in general IEC. User's operation is also expected to amend the corruption by employing elitism strategy simultaneously.

The present study proposes an intervention method in IEC for creating music melody. By referring to a previous IEC study with user's intervention [3], in the intervention process, the user operates the music melody by changing keys of some music notes in each of music melodies. Previous some studies have proposed intervention methods in IEC [4]-[7], however, few studies have proposed direct operation for individuals in IEC. Furthermore, listening experiments were conducted to investigate the efficacy of the proposed IEC method.

II. PROPOSED METHOD

A. Interactive Genetic Algorithm

Genetic Algorithm imitates evolution of creatures for finding optimal solution in a certain problem. GA begins with creating a solution candidate. In most of GA approaches, values of individuals in initial population are defined randomly in a range of upper and lower limits. The individual is evaluated and fitness value is set. To create the population in next generation, parents of them are selected

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from current generation. The selection is performed based on fitness value of individuals. Gene of offspring is made by crossover of parents' genes. Mutation changes part of the gene of individual with constant probability. These steps are repeated until a new population is created [8].

IGA expands GA by obtaining user's subjective evaluation as evaluation value for each solution candidate. IGA is suitable for the problem including human factors that is hard to represent as a numerical formula. Therefore, IGA is applied in various fields including art and the kansei engineering.

B. Flow of the proposed IEC for music melody with user's intervention

Most of conventional IGA methods employed subjective evaluations for individuals in GA: change in GA individuals by user's operation as active intervention was not major method. The proposed method, the user intervenes in the GA individuals for melody creation. The intervention refers to the user's operation that is direct change in key of the music note.

Fig. 1 shows a flow chart of the proposed IEC. In general IEC, solution candidates are presented to the users, then the users subjectively evaluate them. In the proposed IEC for creating music melody, after the presentation, the users can operate the individual when the users want to.

Fig. 2 shows an example of the operation of individual in the proposed IEC. The presented music melody from the IEC system is changed its part of key of music notes. The change is performed by the user's operation. After finishing the operation, the user input the fitness value.

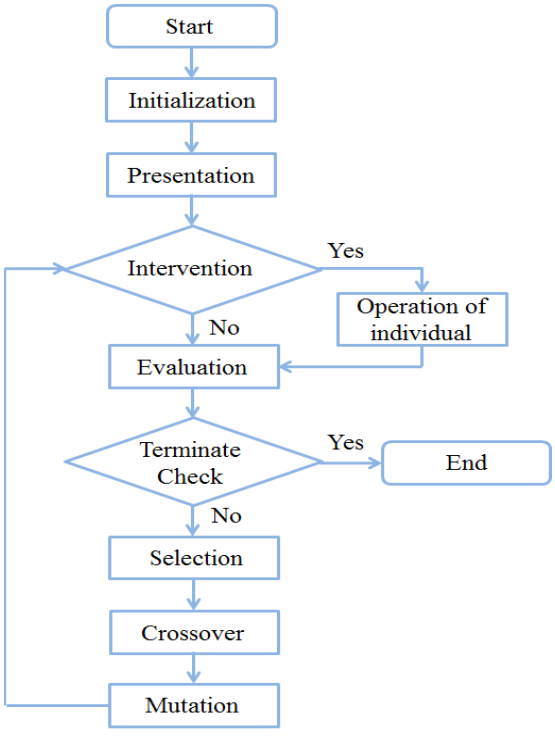

Figure 1. Flow chart of the proposed IEC

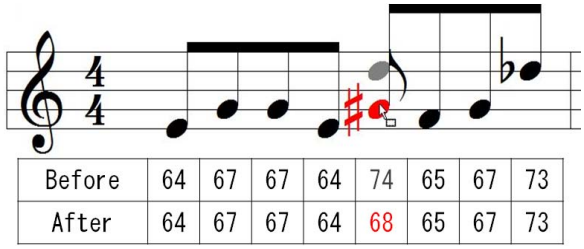

Figure 2. Example of user's operation as intervention and Correspondence between value in GA and music note

III. CONSTRUCTION OF IEC SYSTEM

The construction of IEC system was based on the proposed method. This system is used by a beginner of composition and the arrangement. About a sound to use as a melody, length of one note is eighth note and one musical bar is constructed from eight successive notes. Rest note was not used. The values in the individual are the number of the notebook number of the Musical Instrument Digital Interface (MIDI) format. In consideration of the user of the beginner, key is ranged in staff notation. Thus, note number is limited from 63 to 78.

Fig. 3 shows a correspondence between key and note number used in the system. As interface in the editing process of GA individuals, SONAR Home Studio 4 (Roland Co. Ltd.), MIDI Sequence Software, was used. In the experiment, to ease the user's operation in the intervention, number of music notes changed in the operation process was limited to up to 3.

IV. EXPERIMENTAL METHOD

Experiments were conducted with two types. Experiment 1 was performed for creating music melodies. Experiment 2 was performed for appraising the music melodies created in the experiment 1. Eight males participated in the experiments as subjects.

A. Experiment 1

The subjects evaluated the music melody presented from the IGA system with a headphone. The theme of the melody was both of bright and preference. In the experiment 1, two experimental conditions were conducted; condition A with user's intervention, condition B without the intervention. The condition B means a conventional IGA as a control condition. In both conditions, the subject evaluated GA individuals throughout 10 generations. In each generation, eight individuals were presented to the subject. All of the subjects participated in the both conditions, and the sequence of the condition A and B was randomized and counter-balanced.

The subjects participated in the experiment individually in a quiet room. The subjects evaluated the melodies with 7-point scale (1-point is "Extremely dislike and gloomy": 4-point is "Neither": 7-point is "Extremely like and bright") and input the score with a keyboard by themselves. The subjects could listen to the melody repeatedly. After the

input the score, next melody (GA individual) was presented to the subjects.

In the condition A, the subjects were permitted to edit the presented melody by using SONAR if they wanted: The subjects were told that they have NOT to edit the melody before the experiment. In the editing process, the subjects could change only three music keys. After the editing process, the melody was memorized and the subjects returned to process of inputting the fitness value of the changed melody.

Set of GA were as follows: 10 generations; 8 individuals in each generation; roulette shuffle selection; elitism strategy; one-point crossover; uniform mutation. The initial population was produced with random number in the range. Individuals with the highest fitness value were remained in the next generation. Probabilities of crossover and mutation are 95% and 5%, respectively. The mutation changes genetic value at random in ±2. These setting were applied to both conditions.

B. Experiment 2

The evaluation values obtained in the experiment 1 were considered as relative evaluation values in a same generation. Thus, to precisely investigate the efficacy of the proposed method, experiment 2 was conducted.

The experiment 2 was performed after the experiment 1 one day at shortest. The subjects evaluated four melodies obtained in different conditions and different subjects. The four melodies were best GA individuals, and two of them were picked up from the 10th (last) generation in both of the condition A and B in each of the subjects by themselves. Other two melodies were also picked from the 10th generation created in another subject. By comparing these four melodies, the efficacy of the proposed method could be investigated. The sequence of the four melodies was randomized and counter-balanced.

V. EXPERIMENTAL RESULTS

A. Results of Experiment 1

Fig. 4 shows progress of mean fitness values of condition A and B in the experiment 1. In this analysis, once mean fitness value between individuals in each generation in each subject was obtained. Then, the mean fitness value between the all subjects was calculated. The mean of the fitness values tended to rise with the update of the generation. Mean fitness values of condition A were almost higher than that of condition B.

We examined whether the fitness value of the subjects rose statistically. Wilcoxon signed-rank test was applied in the first generation and other generations. In the condition A, fitness values in the 2nd, 3rd, 7th, 9th, 10th generations outperforms the fitness value of the first generation (p<0.1). The fitness value in the 4th generation A was higher the fitness value in the first generation (p<0.05). In the condition B, fitness values of the 8th, 9th, 10th generations in the condition B outperforms the fitness value of the first generation (p<0.05).

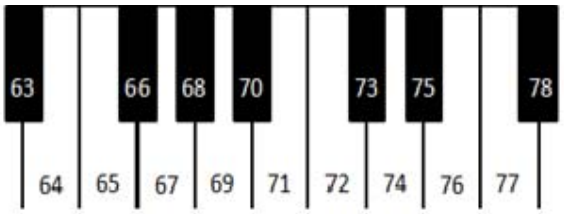

Figure 3. Correspondence between music key and note number

Number of interventions in the condition A was counted during the experiment. The mean number between the all subjects was 8.25 times. Maximum was 20 times and minimum was 3 times, respectively.

B. Result of Experiment 2

Fig. 5 shows mean of fitness values for the four music melodies in the experiment 2. The highest fitness value was obtained in the experimental condition A that the subject participated in. The higher fitness value was observed with the melodies the subject created than with the melodies another subject created.

To investigate the efficacy of the proposed method statistically, Wilcoxon signed-rank test was applied in the experimental condition A that the subject participated in and other condition. The result of statistical analysis showed the tendency that the fitness value in the condition A the subject participated in was higher than in the condition B the other subject participate in (p<0.1).

VI. DISCUSSION

In the experiment 1, the creating experiment with the proposed method, although fitness values in some generations were decreased from the prior generation, gradual increase was observed in comparison with the initial generation. Especially, in the 9th and 10th generations, fitness values were increased significantly in comparison with the initial generation. This result means that the proposed method successfully reflected user's kansei in generation of melody. Furthermore, in all generations, mean of fitness values in the condition A were higher than in the condition B. The operation by the subjects as intervention in IEC was considered as effective to create the music melody suited to each subject.

In the experiment 2, the evaluating experiment, the highest fitness value of the melody was observed in the condition A by the subject himself. This result shows the efficacy of the proposed method in part and the possibility of the proposed method to create the music melodies suited to user's preference and kansei.

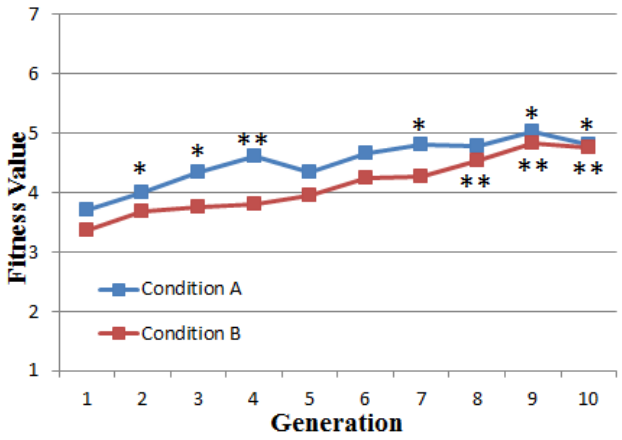

Figure 4. Average of fitness value of all subjects in experiment 1(*: p<0.1, **: p<0.05).

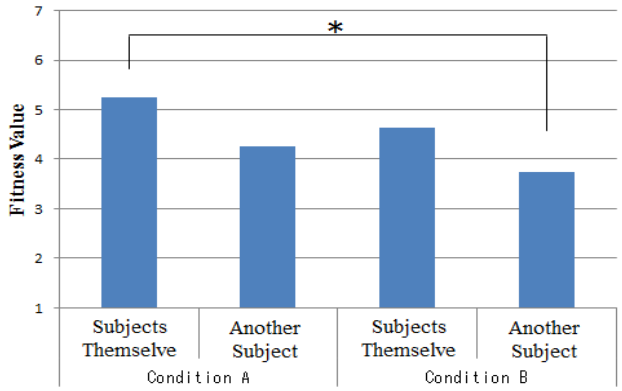

Figure 5. Average of fitness value of all subjects in the experiment 2 (*: p<0.1).

VII. Conclusion

This study proposed the intervention method in IEC for creating music melody. Furthermore, the efficacy of the proposed method was investigated through the listening experiments. The result of the creating experiment showed that the tendency of increase in fitness value with the proposed method. The result of the evaluating experiment limitedly showed the efficacy of the intervention in the creation of melody by the user. These results suggested that the proposed IEC method partly effective to create music and sound contents suited to each user's kansei and preference.

As further studies related to the proposed method, the system is improved for composing music piece. In detail, using music scale in the creation of initial population in GA and employing variety of music keys were candidates as improving methods. Furthermore, developing the interface that keeps and visualizes the created melodies from the proposed IEC system is needed for the users to easily evaluate and create the music melodies [9].

Acknowledgments

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