Music Melodies Suited to Multiple Users’ Feelings Composed by Asynchronous Distributed Interactive Genetic Algorithm

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ABSTRACT

This article aims to compose music melody suited for multiple users’ feelings by employing parallel Distributed Interactive Genetic Algorithm (DIGA). In the DIGA, each user proceeds into a general Interactive Genetic Algorithm (IGA) process by evaluating solution candidates subjectively. In some generations, individuals in IGA are exchanged between the users. With the exchange, each of the users is affected by other users’ feelings. As a result, obtaining good solutions suited for all users is expected. The authors conducted listening experiments for investigating the efficiency of the DIGA for composition of a music melody. Two experimental conditions with and without the exchange were employed. Ten people participated in the experiment as subjects, and were paired for the IGA task. The experimental results showed that a higher fitness was obtained in the final generation and similar melodies were obtained with the exchange.

KEYWORDS

Asynchronous, Composition, Distributed Interactive Genetic Algorithm, Interactive Evolutionary Computation, Interactive Genetic Algorithm, Music Melody, Multiple Users

1. INTRODUCTION

In the area of product design, there is movement to add human feelings on the products for emphasizing value of the product. Along with the movement, engineering researches have been investigating human feelings from various perspectives. However, it is still difficult to model human feelings as an engineering model, therefore, it is still unsolved problem that making products suited to human feelings.

This problem is related to optimization: a product is represented as parameters, and solving the problem is considered as same as searching optimal solution of the parameters. Important thing in the search is how to evaluate the parameters constructing the product. Since human feelings are difficult to model and are like a black box, it is effective that solution candidates during the search are evaluated by human users subjectively. Interactive Evolutionary Computation (IEC) (Takagi, 2001) is a kind of Evolutionary Computation (EC), which is used for finding optimal solution in various problems. While EC is applied for computational and/or mathematical problems, IEC is generally applied for finding optimal or better solutions of media contents suited to each user’s feelings through interactions between human and computer system.

A representative example of IEC is an Interactive Genetic Algorithm (IGA) that derives the optimal or better solutions using Genetic Algorithm (GA). GA is an evolutionary algorithm that models the process of evolution of living organisms. IGA uses human feelings such as preference and

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impression as an evaluation function. The evaluation process is performed by scoring or selection by the human user.

According to Takagi’s survey (2001), IEC was applied for various optimization problems related to sense of sight, hearing, and smelling. Fundamental use of IEC is to find optimal or better solutions suited to each individual user. In terms of expanding the ability of IEC, some recent studies applied IEC into problem of multiple users. Previous studies proposed IEC reflecting multiple users’ feelings on computer graphics (Akase & Okada, 2014; Takenouchi, Tokumaru, & Muranaka, 2008; Takenouchi, Inoue, & Tokumaru, 2014; Sakai, Takenouchi, & Tokumaru, 2014; Ogawa, Miki, Hiroyasu, & Nagaya, 2001; Miki, Yamamoto, Wake, & Hiroyasu, 2006) and sounds (Fukumoto & Hatanaka, 2017; Nomura & Fukushima, 2016). There were several methods for gathering evaluations of multiple users (described in a section 2.3 in detail). Miki et al. have proposed parallel Distributed IGA (DIGA) that is the extension of IGA in terms of using several islands where IGA processes are performed in each of the users in parallel (Ogawa, Miki, Hiroyasu, & Nagaya, 2001; Miki, Yamamoto, Wake, & Hiroyasu, 2006).

We have applied the DIGA for composing music melodies (Fukumoto & Hatanaka, 2017; Nomura, Fukumoto, 2016). In this method, each of multiple users performs IGA tasks respectively. Once we constructed the DIGA with synchronous model (Fukumoto & Hatanaka, 2017), after that, asynchronous model was also constructed (Nomura & Fukushima, 2016). Purpose of this study is to investigate the efficiencies of the DIGA for composing music melody in comparison with general IGA without any exchange of solution candidate between the users. To investigate the efficiencies, listening experiment was conducted.

2. GA, IGA, DGA, RELATED WORKS

2.1. Genetic Algorithm and Interactive Genetic Algorithm

GA is a searching method of optimal solution of a certain problem and is a model of evolution of living things. The process of evolution of living things in the natural world is that individuals with higher fitness among population in the current generation principle have higher chance to survive and be parent of the next generation. Modeling this evolutionary process is the concept of GA. Figure 1 is a flow chart of GA. In general GA, solutions candidates (called phenotype) are expressed as individuals with chromosomes (called genotype).

A group of individuals is called a population, and among individuals forming a generation, individuals with higher chance to survive and be parent of the individual in the next generation. Then, through GA operations such as crossover and mutation, the next generation is constructed.

IGA expands GA’s searching ability by obtaining user’s subjective evaluation as fitness value for each of solution candidates. Details of each process in both of GA and IGA are as follows.

- **Initialization**: GA and IGA begin the search with a creation of an initial population composed of many solution candidates. In most of cases, values of individuals in the initial population are defined with random number in a range of upper and lower limits.
- **Evaluation**: GA function returns fitness value of individual by calculating its chromosome. In IGA, the human user subjectively evaluates the individual by scoring or selection.
- **Selection**: To create the population in the next generation, parents of them are selected from the current generation. The selection is performed by according to fitness value of individuals: individuals having higher fitness value get higher chance to be parent.
- **Crossover**: Crossover is one of the GA operations. Gene of offspring (individual in the next generation) is defined by crossover of parents’ genes.
- **Mutation**: Mutation is another GA operation. It changes part of the gene of individual its value.
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