

A Proposal for Distributed Interactive Differential Evolution

In A Case of Creating Sign Sounds for Multiple Users

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ABSTRACT

Interactive Evolutionary Computation (IEC) is used for creating media contents suited to each user's feelings. To obtain media contents commonly suited to multiple users, distributed approach was employed in previous IECs based on Genetic Algorithm. This study proposes Distributed Interactive Differential Evolution (DIDE) by employing Differential Evolution (DE). Based on each user's subjective selection and scoring with Interactive DE, DIDE exchanges good solutions between users. Through the exchange, it is expected that the good solution for all users is obtained. A fundamental experiment was conducted with a simple DIDE system creating sign sounds for two users. Distance between DE vectors obtained by two users and fitness values were investigated.

CCS CONCEPTS

• Theory of computation → Evolutionary algorithms; • Information systems → Collaborative search;

KEYWORDS

Interactive Evolutionary Computation, Differential Evolution, multiple users, sign sound

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1 INTRODUCTION

Interactive Evolutionary Computation (IEC) is used for creating media contents suited to each user's preference and feelings. Such technology will enrich our daily life, because we can use and/or enjoy media contents suited to each of the users with the IEC. It is also important to obtain media contents commonly suited to multiple persons. For example, alert sound used in public space has to make many people to know dangerous situation.

To obtain media contents commonly suited to multiple users, distributed approach was employed in previous IECs [1]. In these studies, Genetic Algorithm (GA) was used. This study proposes a new

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Distributed Interactive Differential Evolution (DIDE) by employing Differential Evolution (DE) [3] as its evolutionary algorithm. Based on each user's subjective selection and evaluation with Interactive DE, the DIDE exchanges good solutions between users. Through the exchange, it is expected that the good solution for all users is obtained.

Main purpose of this study is to propose DIDE as a new approach of IEC. A simple DIDE system creating short melodies as sign sounds for two users is constructed. With the DIDE system, a listening experiment for creating "warning" sound is conducted for investigating fundamental efficiency of the DIDE. Distance between DE vectors obtained by two users and fitness values of created sign sounds are used as indexes.

2 DISTRIBUTED INTERACTIVE DIFFERENTIAL EVOLUTION

Distributed Genetic Algorithm (DGA) [4] is a variant of GA, which has several islands. In each of the islands, process of GA is performed: independent process of evolution is thought to be excellent from a viewpoint of maintaining diversity of GA individuals. Migration, an exchange of the individuals between islands, is performed in every several generations. DGA was applied for IECs where multiple human users participate in the system for playing role of the islands.

This study proposes DIDE searching media contents for multiple users. DIDE employs DE instead of GA in the previous IEC studies [1]. DE is known by its simple scheme and has higher performance than GA [5]. Target vector in a current population is compared with trial vector, and winner survives as target vector in the next generation. The best vectors are exchanged between the users: the worst vector is overwritten by it. We constructed a simple DIDE system for two users (Fig. 1). The system creates sign sounds composed of 8 music notes, and DE vectors have variables as key of the note from 59 to 85 covering 2 octaves and so on [2].

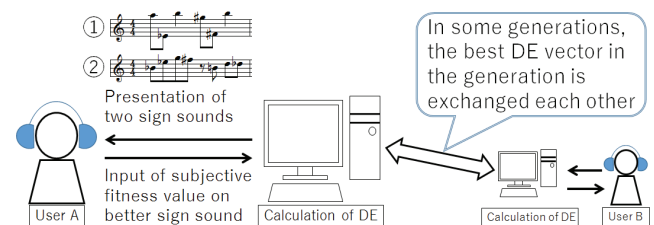


Figure 1: A schema of DIDE system creating sign sounds for two users.

3 LISTENING EXPERIMENT

Listening experiment was conducted for investigating efficiencies of the DIDE for creating sign sounds commonly suited to two users. The target of search was “warning” sound. 16 subjects participated in the experiment composed of 2 stages.

Search Stage: In search stage, the subjects were divided into 8 pairs for establishing DIDE structure exchanging DE vectors. The pair of the subjects evaluated sign sounds created by the DIDE system. The exchange of the best vectors was performed in the end of every even generation in “exchange condition”. “Control condition” without any exchange was also employed. Initial populations of both conditions were same and were created with random number in each subject. The subjects selected better sign sound in terms of warning impression from pair of sounds which were corresponded to target and trial vectors. Then, the subject scored the selected sound in 7-point scale: 1-point meant extremely NOT warning, 4-point meant neither, and 7-point meant extremely warning. The subjects made above tasks 104 times; 13 generations by 8 vectors. DE/rand/1/bin was employed as evolutionary algorithm, and parameters of DE were $F = 0.9$ and $Cr = 0.6$.

Evaluation Stage: In evaluation stage, the subjects scored 3 sign sounds composed by the subject himself or herself in the search stage with the same 7-point scale. The 3 sounds were the best vector in the initial generation and the best vectors in the 12th generation of exchange and control conditions respectively.

4 EXPERIMENTAL RESULTS

As result in the search stage, in both conditions, slight increases in the mean fitness value in accordance with generation were observed. Fig. 2 shows progress of distance of target vectors between 2 subjects in each pair. The distance is summation of Euclidean distances based on difference of key of each 8 notes; summation of 64 Euclidean distances of 8 vectors by 8 vectors. The analysis of the distance shows obvious difference between the conditions after the 5th generation, especially in the odd generations. Note that the exchange was performed in the end of the even generations.

Fig. 3 shows mean and S. D. of fitness values in the evaluation stage. The highest fitness was observed in the last generation in the control condition without any exchange. No significant difference was observed between each of fitness for sounds.

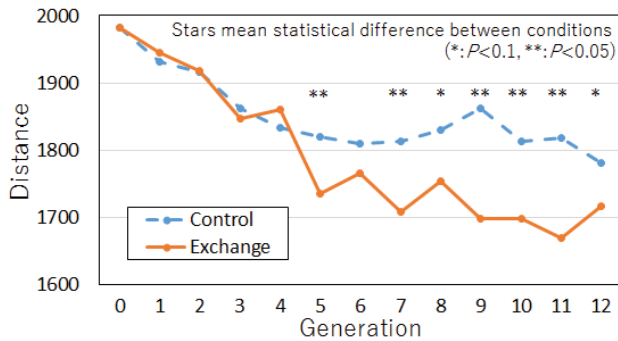


Figure 2: Euclidean distance between vectors created by pair of the subjects in Search Stage.

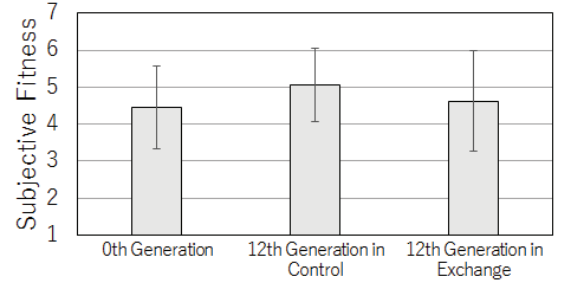


Figure 3: Fitness value for 3 sign sounds in Evaluation Stage.

5 DISCUSSION AND CONCLUSION

The analysis of distance of DE vectors showed a part of efficiency of the exchange in the DIDE in terms of creating similar patterns between the subjects in the pair. Obtaining relative smaller distance in the odd generations were natural because the best vectors were exchanged in the end of even generations. The exchange is considered as working well, because the trend of decrease in the distance was observed, and it was caused of the exchange of vectors having higher fitness.

We could not observe obvious difference of the fitness values in the evaluation stage. Control condition means general IDE, however, significant increase was not observed from the 0th generation. The complicated evaluation method including selection and scoring might interrupt precise evaluation of the subjects. Fitness in the exchange condition was also not higher. Applying IEC to multiple users may decrease satisfaction of each user, because IEC is originally for a personal use: it resembles to compromise for mass production. Even if this study is in the case, DIDE should create media contents having same quality as the ones by conventional IECs at lowest.

This study proposed the DIDE as new IEC approach for multiple users. We conducted the experiment with the simple system creating sign sounds for two users. As the efficiency of the DIDE, smaller distance was observed comparing with the control. However, no significant increase in fitness was observed. As next step, we will improve the method of subjective evaluation. After the improvement, we will compare the DIDE with conventional distributed IECs based on GA.

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