Developing Female Clothing Coordination Generation System Using Eye Tracking Information

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Abstract. In this study, we examine the effectiveness of a female-clothing coordination-generation system using eye-tracking information for multiple users. In our previous study, only two subjects used an interactive evolutionary computation (IEC) system by utilizing the users eye-tracking information, which however poses two issues for actual application. First, the number of subjects simultaneously using the system was low. Moreover, they were given specific instructions on how to use the system in advance. To solve these issues, we review our previous method, and develop a female-clothing coordination-generation system using digital signage and verify its effectiveness. The experimental results demonstrate that the system can simultaneously create satisfactory clothing coordination for multiple users.

1 Introduction

Interactive evolutionary computation (IEC) is a method that allows the creation of improved objects using human sensibility. In IEC, the user inputs the evaluation values for the evolutionary computation (EC). EC is the algorithmization of the evolution of living things. Using evaluation values obtained from humans is effective for problems that emphasize human sensitivity [1].

IEC first randomly generates an initial population. Next, it presents the generated population to the user giving the evaluation. The user gives an evaluation value for each presented individual after which the IEC performs the EC based on the evaluation value and produces the next generation population. The generated population is presented to the user again and the process is repeated until a solution is obtained that satisfies the user.

The IEC can reflect human sensitivity. Therefore, it is applied in a wide range of fields such as art, engineering, education and gaming [1]. For example, some researchers have applied IEC to the generation of poster layouts [2] and to the fitting of hearing aids [3], confirming its effectiveness in various fields.

On the other hand, the IEC has a problem that the evaluation loads on the user who gives the evaluation value is large. Therefore, studies have been

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conducted to reduce the users evaluation loads. Conventional IEC was a method to evaluate all individuals generated in one generation in several stages. However, the user loses evaluation of the individual. As a result, the users psychological loads increases. Therefore, methods have been proposed for successful simplifying the process, such as a tournament-style evaluation method [4] and an interactive tabu search method [5].

However, since users are still comparing individuals and evaluating, the users evaluation load remains high. Therefore, to reduce the users evaluation load, some researchers have studied the use of biological information for IEC evaluation. Biometric information includes heart rate [6], brain function, and gaze information [7]. Nevertheless, the load on the user is still very high, because the user has to wear the measuring instrument every time to record the evaluation signal that he/she will input to IEC. As a solution to this problem, we proposed using gaze information that can be obtained with a contactless measuring instrument for evaluation of IEC [8].

In addition, an IEC with multiple users who input values to solution candidates has been suggested [9]. IEC system is supposed to be used only one user. Therefore, many IEC systems are designed to reflect the sensitivity of a single user. Thus, we consider that many can generate satisfying solutions by participating in the evaluation of solution candidates. If such a system is realized, it is also possible to create a consensus of multiple people and generate satisfactory design by many users. In order to acquire many votes in a short period of time, researchers proposed a system using digital signage as a medium for presenting individuals [9]. However, it is difficult for many users to vote simultaneously. To solve this problem, we propose using gaze information. We consider that it will be possible to collect evaluation given by many users at the same time by the proposed method.

If such a system is realized, it is possible to enjoy more events. For example, in an idle concert, it is possible to realize a system that reflects the taste of the audience in the idols costume. Then, the audience can enjoy the idle concert more. To realize this it is necessary to question the spectators and investigate their preferences. However, it is not realistic to take a survey an entire audience and reflect their opinions on costumes in real time. However, this could be achieved by a system that would allow the audience to "view" the customs, and then it would create new costumes based on the audience's preferences.

To realize such a system, we proposed an IEC using gaze information from multiple users and conducted an evaluation experiment that confirmed a certain reduction of the user's evaluation loads [8]. As a result, we confirmed that the evaluation burden of the user is reduced to some extent. In addition, individually, multiple users were satisfied by our system.

Based on the results of our previous research, in the present study, we verify the effectiveness of our system adding sensitivity of multiple users. We examine the satisfaction level of groups of two or more users and the difference in the judgement standards for clothing coordination between men and women. Moreover, to obtain as much objective evaluation of the system as possible, we refrain from explaining it to the users in advance.

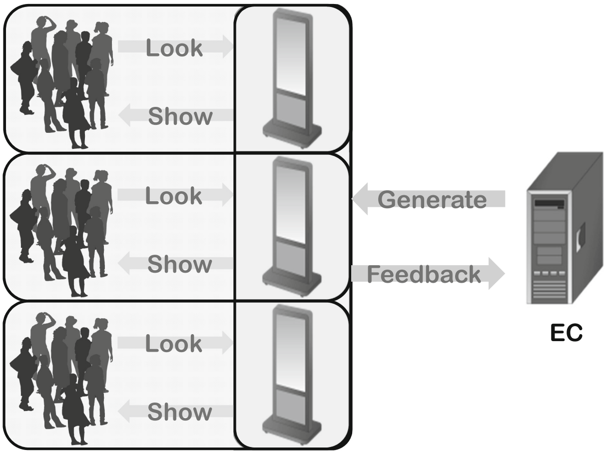


Fig. 1. Outline of the proposed system

2 Proposed System

We propose a female-clothing coordination-generation system using gaze information of multiple users.

Figure 1 depicts the outline of the proposed system. This system uses digital signage that is installed in multiple places allowing many people to simultaneously participate. First, the user stands in front of a digital signage. The system presents two kind of clothing coordinations which the user freely compares, to the digital signage. Next, the system calculates the evaluation value for each clothing-coordination from the users gaze information. If the evaluation values are given for all clothing coordination generated in the same generation, the system performs EC and creates the next generation of clothing coordination. The system repeats these operations a specified number of times. When the last operation is over, the system presents the clothing coordination ultimately generated that matches the preferences of the user.

We use the winner based paired comparison method (WPC) as the evaluation method of each individual, as in our previous study [8]. The WPC presents two designs to the user. The user compares these two designs and chooses his/her favorite one. Next, the WPC presents the chosen design by the user and another one. The user compares again. The WPC repeats these operations. The WPC method can maintain users interest as the evaluation method.

We use Human Vision Component B5T-007001 (OMRON, Japan) to acquire the gaze information. The measuring instrument acquires the position of the face, the angle of the face, and the angle of gaze. The system uses them to determine where the user is looking at. The system judges the users preference using the position of the gaze and the number of views as the gaze information.

Figure 2 shows candidate evaluation of the IEC. In Fig. 2, the system divides the interface into two areas. First, the system measures the position of the user's face, the angle of the face, and the angle of the gaze. Then, the system calculates the users viewing position from the data. The system determines the individual viewing from each position. Finally, the system chooses the most viewed individual for 5 s.

In Fig. 2, for example, the system records six views on the right and eight views on the left. In this case, the system judges that the user likes the left clothing coordination since the left clothing coordination is more often seen. The system leaves the left clothing-coordination and changes the right clothing-coordination for the next comparison.

Figure 3 shows the clothing coordination parts. The clothing coordination include four parts: hairstyle, tops, bottoms, and shoes. Each part has 8 or 16 designs and is encoded for EC by binary number in 3 or 4 bits [8]. The system expresses each clothing coordination in 14 bits. Therefore, the system can generate 16,384 female clothing coordinates.

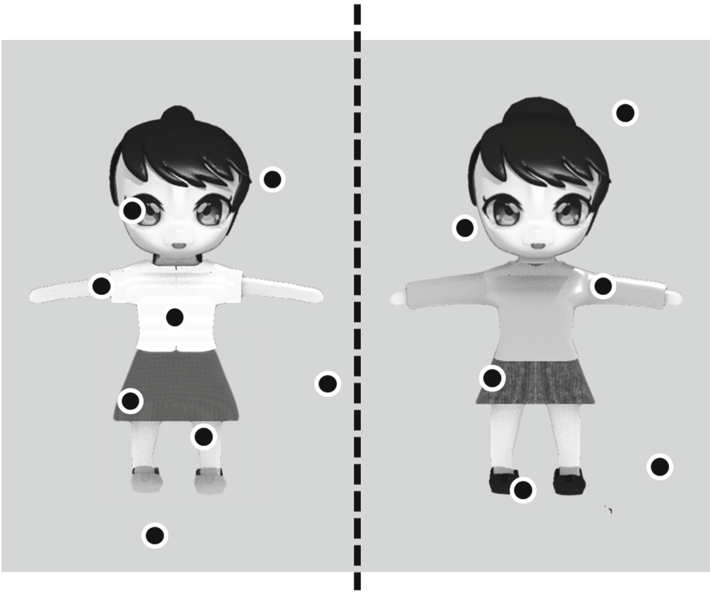


Fig. 2. Candidate evaluation of the IEC

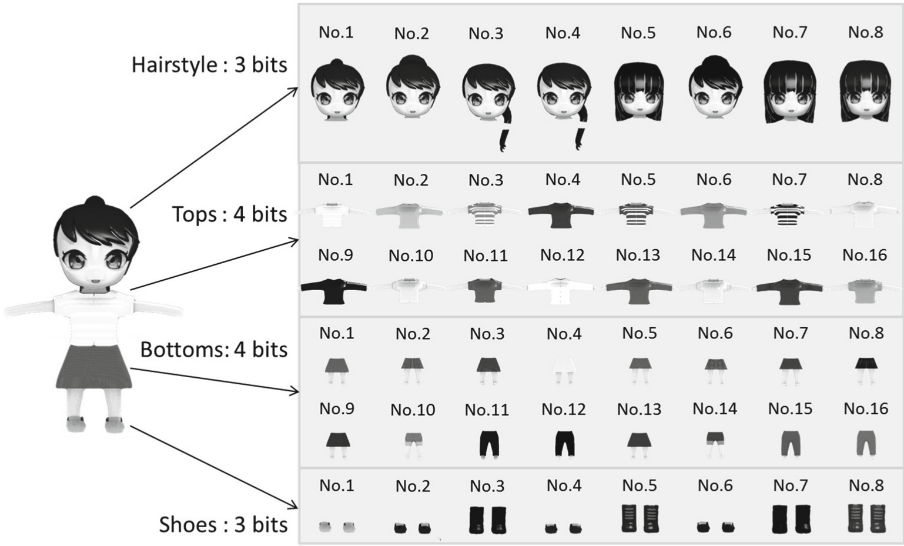


Fig. 3. Clothing coordination parts

3 Evaluation Experiment

3.1 Experiment Summary

We verify the effectiveness of the assumed situation using the female-clothing coordination-generation system. In the assumed operation situation, we set up signage at several places in the event venue. However, we set up the signage in one place for the experiment.

Table 1 shows the parameters of IEC. We set the mutation rate to 20%. As EC progresses and the solution starts converging, EC produces only similar genes. Then, the difference between the proposed clothing-coordination becomes difficult to discern, making the comparison difficult. This increases the users evaluation load, and the user becomes bored of evaluation. To avoid that, we set the mutation rate higher. Since this study sets 8 individuals and 5 generations, the subjects see 7 matches per generation, totaling 35 matches. In addition, the display time of clothing coordination in one battle is set to 5 s.

The subjects were 34 college students (21 males and 13 females). They are divided into group: four sets of two people, six sets of three people, and two sets of four people. The groups may contain both men and women.

In this experiment, all members of each group simultaneously evaluate the clothing coordination. At first, the subjects line up in front of the digital signage. Next, they watch a model displayed by the digital signage. We do not give any particular instructions at that time. While a subject uses the system, he/she talks about his/her favorite clothing-coordination. Finally, the subjects answer a questionnaire.

Table 1. Parameters of IEC

Population	8
Gene length	14 bits
Generations	5
Selection method	Roulette selection + Elite preservation
Crossover method	Uniform crossover
Mutation rate	20%
Display time	5 s

3.2 Results and Consideration

Figure 4 shows the satisfaction over the generated clothing coordination. Groups A, B, C, and D include two people, groups E, F, G, H, I and J include three people, and groups K and L include four people. The average satisfaction level for all groups is 3.65. Therefore, we confirm that a satisfactory design was produced to some extent. After the experiment, the subjects were able to freely compare their experiences and talk about the clothing coordination that chose, and they answered that they enjoyed the process and were able to easily use the system.

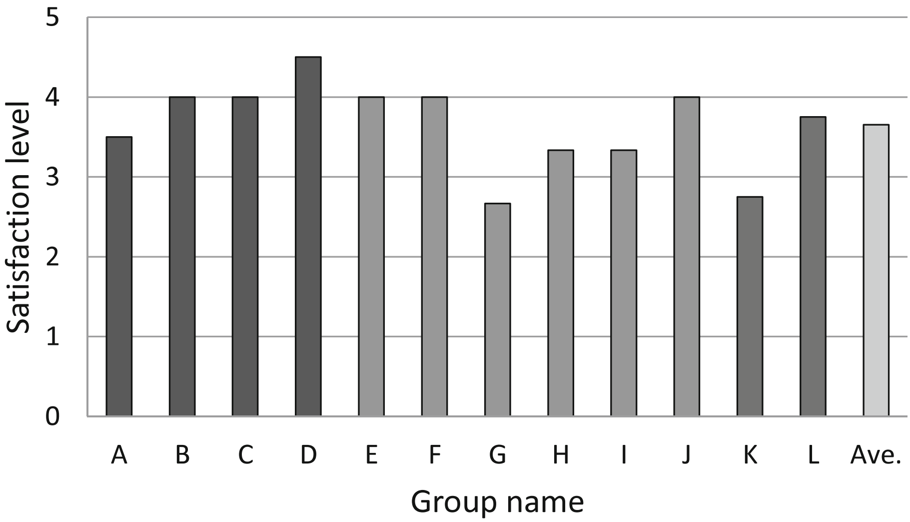
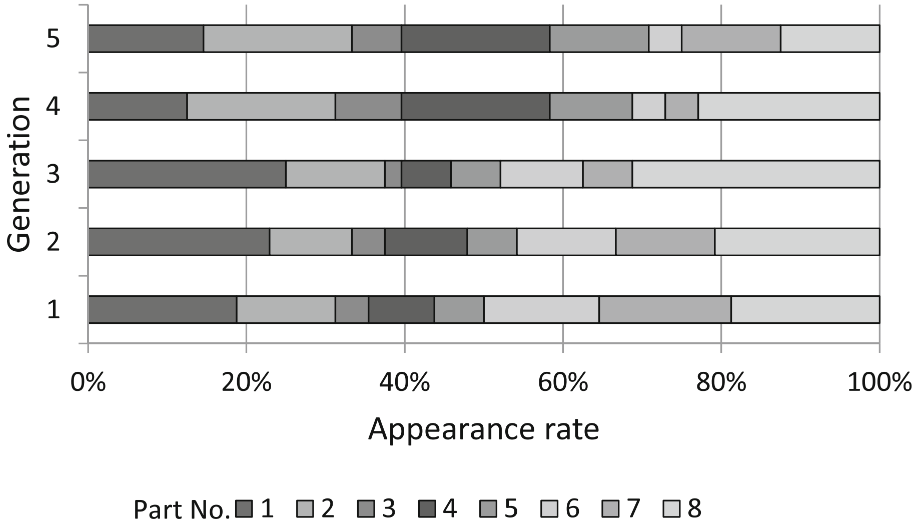
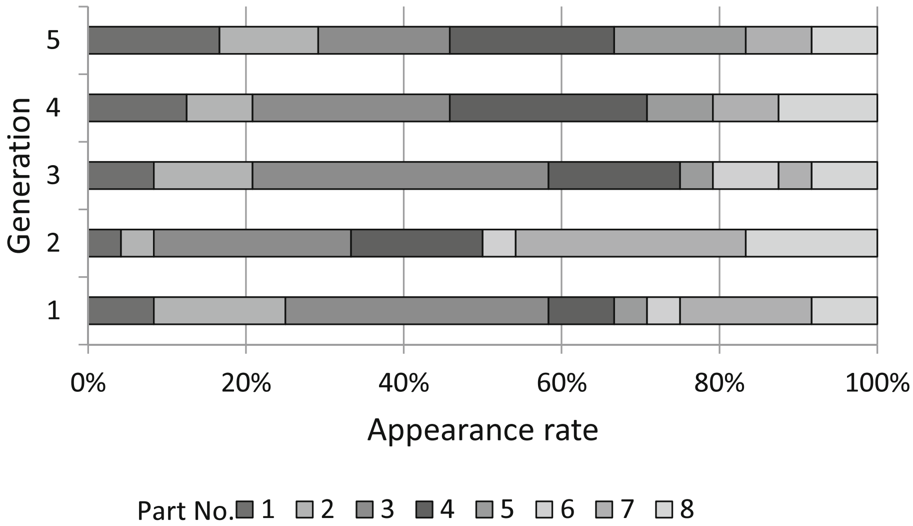


Fig. 4. Satisfaction over the generated clothing coordination



(a) Male group

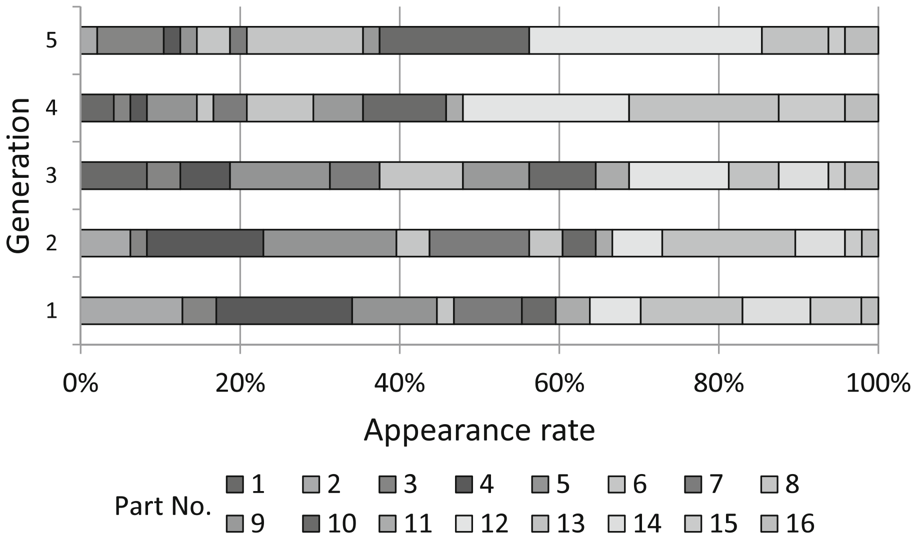


(b) Female group

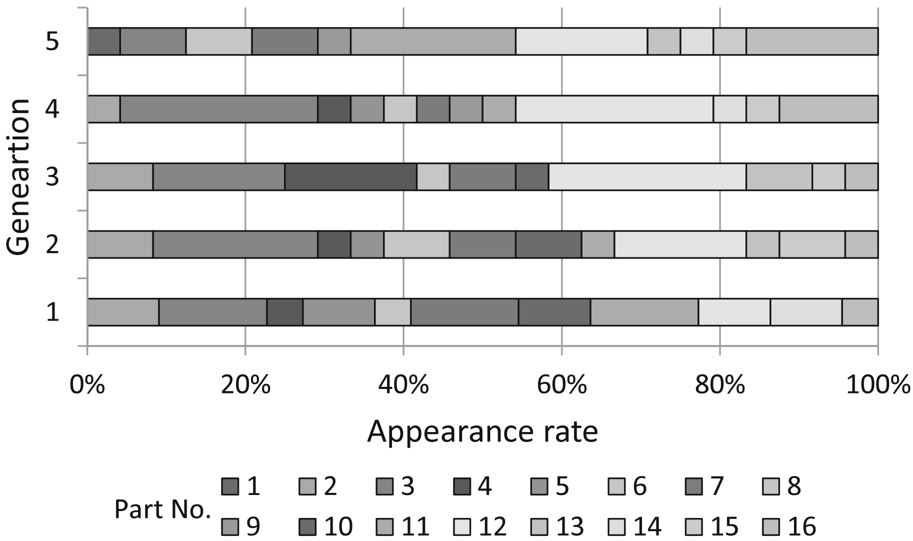
Fig. 5. Appearance rate of hairstyle parts

During the experiment, we confirmed the difference in reaction between men and women. Therefore, we examined whether differences in judgment standards between men and women could be confirmed for each clothing-coordination part.

Figure 5 shows the appearance rate of hairstyle parts in the evolution process of IEC. In the male group, all parts appeared in each generation, and the appearance rate did not significantly change. Moreover, female groups have parts



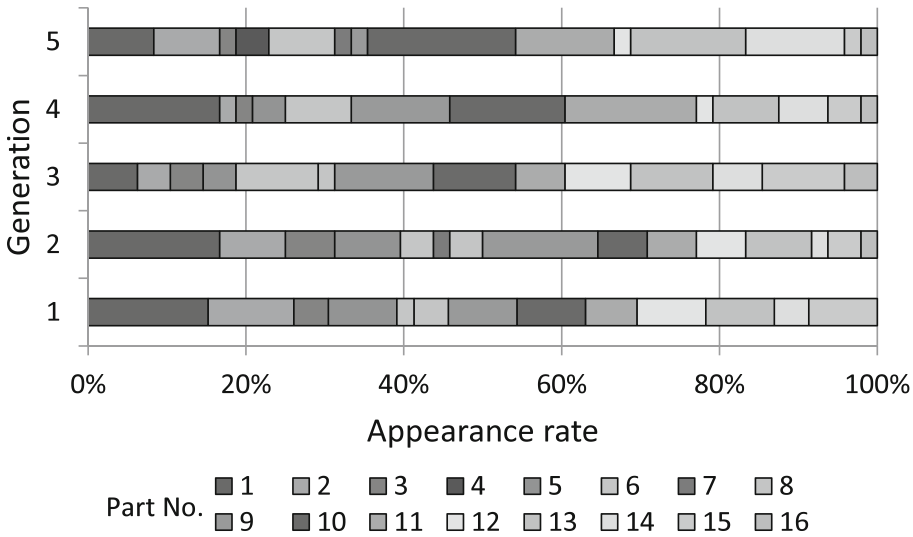
(a) Male group



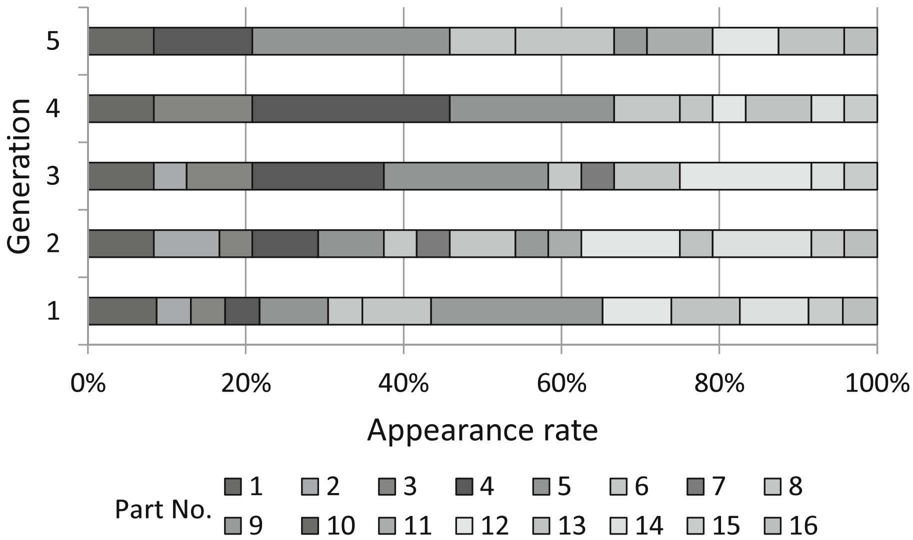
(b) Female group

Fig. 6. Appearance rate of tops parts

that disappeared after generations and parts that displayed an increased appearance rate. Figure 6 shows the appearance rate of tops parts in the IEC evolution process. A trend was not observed in the appearance rate of each part in each generation for male group. The female group has parts in which the appearance rate increased or decreased with passing generations. Figure 7 shows the



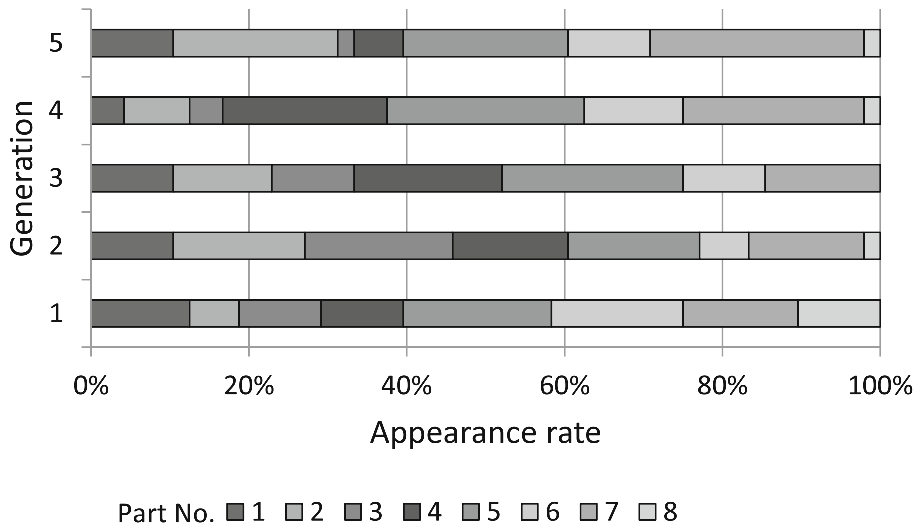
(a) Male group



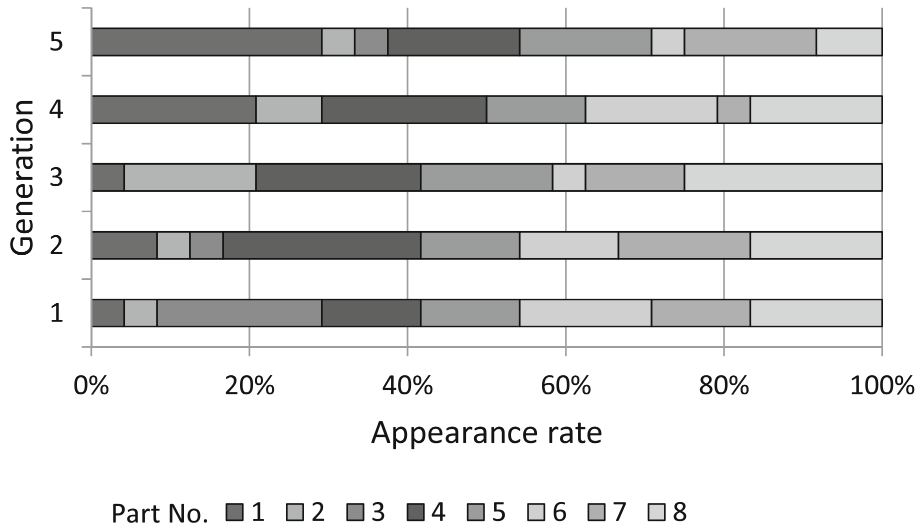
(b) Female group

Fig. 7. Appearance rate of bottoms parts

appearance rate of bottoms parts in the evolution process of IEC. We also confirmed the same trend between the bottoms parts and tops parts. Figure 8 shows the appearance rate of shoes parts in the evolution process of IEC. We could not confirm gender differences regarding the appearance rate of shoes parts.



(a) Male group



(b) Female group

Fig. 8. Appearance rate of shoes parts

Also, we focused on the state of the subject during the experiment. As a result, the following was confirmed.

1. Men give many comments on the entire clothing-coordination.
   For example, "This coordination is nice", "Overall bright color clothes are nice".
2. Women often commented on the design of parts in clothing-coordination.
   For example, "This hairstyle is nice", "This shirt is cute".

We confirm that male subjects observed the whole of the clothing-coordination and judged their preferences by intuition. From the results of the questionnaire, many male answered that five seconds was too long for comparing the clothing-coordination. On the other hand, we confirm that female first chose one favorite part and then judged their remaining preferences based on that part. From the results of the questionnaire, more female said that five seconds is too less time for comparing clothing-coordination.

Therefore, we confirmed that in male and female, there is a difference in the method of selecting their judgment standards for clothing coordination.

4 Conclusions

We examined the IEC system using the gaze information of multiple users. We experimentally verified the effectiveness of the system for the assumed situation under realistic conditions. The experimental results, we confirmed the effectiveness to some extent even under the environment assuming the actual use situation. We also confirmed the difference in judgment standards for clothing-coordination between male and female. In the future, we will analyze gaze information and verify the relationship between gaze information and preference.

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