A Mobile Application for Interactive Exploratory Search of Apparel Products

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***Abstract*—Many people (especially women) tend to take relatively longer time for shopping, and therefore it is an interesting topic to develop enjoyable user interface for shopping. We discussed how to develop systems for apparel product retrieval inspired by psychology of women's shopping activity in our previous paper, and actually presented an implementation for personal computers. This paper presents a mobile application for apparel product shopping inheriting our previous study. The presented mobile application supports just three single-finger operations: tap, next, and shuffle. It shows pictures of products over and over while learning preferences of users applying interactive genetic algorithm. This paper presents the user interface design and processing flow of the presented application, and introduces our experiments.**

***Keywords*-Mobile application, Interactive Exploratory Search, Graphical User Interface.**

I. Introduction

Shopping psychology has been discussed with many studies. Economists mentioned [6] major reasons why people (especially women) spend a long time for shopping. We have been studying how to develop effective on-line shopping applications while adopting such shopping psychologies.

We discussed that collaborative filtering, one of the most well-known information recommendation techniques, does not always work well for apparel products, in our previous paper [2]. Instead, we mentioned that interactive preference learning mechanisms applying relevance feedback [9] or genetic algorithm [7] are effective for various information recommendation problems, and should be also effective for recommendation of apparel products. We also concluded more visual and interactive systems are better for this purpose, because users can enjoy a long time for shopping, and the system can gradually learn preferences of the users while their enjoyable time.

Based on the above discussion, we presented an interactive exploration system for apparel products [2] which aims to solve the above drawbacks. The system firstly displays various icons designed specific to this study, as the overlay of images which represent shapes, colors, and texture patterns of the products. When a user selects an interested icon, the system displays images of individual products. Users can press "prefer" or "delete" buttons to input their preferences to particular products. They can display a set of preferred products so that they can decide which products to finally purchase. Users can also replace a set of icons to be displayed by pressing "renew" button. The system selects a set of icons to be displayed in the next stage by applying an interactive evolutionary computation algorithm to reflect behavior of users. Users can freely look at various products based on their preferences or curious without making explicit queries.

The above mentioned system is supposed to use with personal computers and sufficient sizes of displays. On the other hand, recent evolution and popularization of smartphones extended the usage of digital applications and information accesses. There have been many studies on differences of information access behaviors between smartphones and personal computers. For example, a Web page [10] discusses that smartphone users tend to search for information during their spare times. On the other hand, it also mentions that personal computers are used rather than smartphones when users really want to purchase something. This result suggests that shopping applications for smartphones have not been satisfactory, and therefore it is important to discuss and develop them separately from personal computer applications. Another study [1] concluded that smartphone users tend to use each of applications in a very short time. It suggests that user interfaces of mobile applications should be simple so that users can master the operations in such a short time.

This paper presents a mobile application for interactive exploratory search of apparel products. There have been many research studies on mobile applications for shopping as well as commercial services. Traditional menu-based user interfaces have been often applied in early studies [3] [4], and then various methods such as text input [5] and vision [8] techniques have been then applied. Small number of simple finger-based operations are one of the features of the presented application against such existing studies on mobile shopping applications. Another feature is operations directly connected to interactive genetic algorithm applied to learn preferences of users.

This paper presents the user interface design and processing flow of the presented application, and introduces our experiment using this application.

II. Design Policy

We supposed the following policies for mobile applications on apparel shopping, and designed the user interface to satisfy them.

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Policy 1: Browse products with small number of operations.
Policy 2: Implement with single-finger operations so that users can pick up and operate a smartphone by a single hand.
Policy 3: Minimize the number of GUI widgets to utilize the small display spaces to show pictures of products as many as possible.
Policy 4: Prompt unexpected discovery so that users do not feel boring.
Policy 5: Support users' input for their sudden mind change.

Policies 1 and 2 are mobile application specific. Several previous studies concluded that many mobile applications are often used very shortly in spare time of users, and therefore we concluded that operations for mobile shopping should be simple. Based on this discussion, the presented application just supports three single-finger operations: tap, next, and shuffle. When the application shows a set of pictures of apparel products, users can tap particular pictures so that they can input their preferred products. They can also change the displayed pictures to the next set when they want to look at the new ones. The application usually shows similar sets of pictures based on preferences of users; however, they can shuffle the pictures so that users can gesture to reset their preferences.

Policy 3 is also mobile application specific, and also based on our previous discussion [2] on apparel shopping. In the previous study, we concluded that users (especially women) tend to look at many products simultaneously while apparel shopping, and therefore it is better to show many pictures of products in a single display space. Therefore, we did not prefer to use GUI widgets in a small display space of mobile devices.

Policies 4 and 5 is derived from our previous development on shopping application. It is basically effective if the applications suggest products while learning preferences of users. On the other hand, it is often boring for users if the systems always suggest similar products, and therefore it is often more satisfactory if they sometimes suggest unexpected types of products. Based on this discussion, we apply interactive genetic algorithm to learn preferences of users and appropriately select products to show, and effectively perform the mutation mechanism to sometimes suggest unexpected types of products. Shuffle operation controls the probability of the mutation operation so that users can intensively gesture to reset their preferences.

III. User Interface Design and Processing Flow

This section describes technical detail of the presented application. The application shows sets of pictures of products, and replaces them according to users' operations. The applications learns preferences of users by applying a genetic algorithm so that it can preferentially show preferable products. Also, users can perform shuffle operations so that the application selects different kinds of products. This section describes user interface design and processing flow of the presented application.

A. Card metaphor for user interface design

Figure 1 shows snapshots of the mobile application developed in this study. This application is based on the user interface design with a card metaphor shown in Figure 2.

The application firstly displays pre-defined number of pictures of products. Users can keep preferred products to a favorite list, or change the set of pictures. We expect the users can enjoy looking at many products and select favorite products by repeating the above process.

The application just supports the following three finger operations on the display.
Tap: Users can add their preferable products into a favorite product list by just tapping the pictures of the products.
Next: Users can see the next set of pictures of products by just swiping the display from left to right, as card game players see the next card by picking up the top card on a pile.
Shuffle: Users can randomize the pictures of products to see unexpected products, as card game players mix all the cards by shuffling on a table.

Figure 1. Snapshot of the presented application.

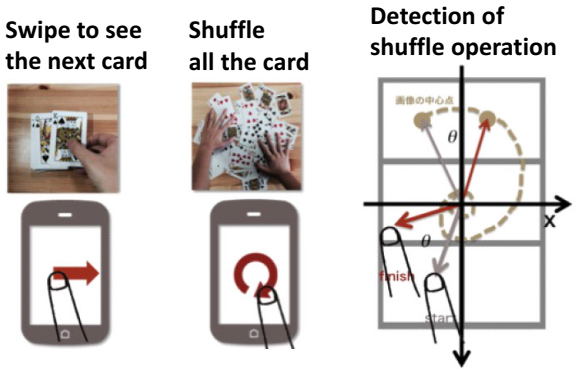

Figure 2. User interface design with a card metaphor.

Figure 1 (Left) shows a snapshot of initial display, and Figure 1 (Right) shows a snapshot while shuffling the pictures. Figure 2 (Left) shows metaphors of next and shuffle operations. Figure 2 (Right) illustrates how to detect the shuffle operation. Our implementation converts the touched position from orthogonal coordinate system to polar coordinate system, and calculates the rotation angle of the finger operation.

The application calculates the rotation angle θ illustrated in Figure 2 (Right) while shuffle operations are performed. Our implementation shows animation of pictures of products: It moves the pictures to the center of the display space while $0^\circ \leq \theta \leq 360^\circ$, and then rotates them if $360^\circ \leq \theta$. This animation looks as if the pictures are gathered into the center and then mixed.

The application calculates the rotation angle by the following equation:

$$\theta = \cos^{-1} \frac{\boldsymbol{s} \cdot \boldsymbol{f}}{|\boldsymbol{s}||\boldsymbol{f}|} \tag{1}$$

where $\boldsymbol{s}$ is the starting position of the shuffle operation, and $\boldsymbol{f}$ is the current position, supposing the origin of the coordinate system is the center of the display space.

Our current implementation calculates the possibility of mutation.

B. Product selection by interactive genetic algorithm

We implemented a product selection mechanism applying a modified interactive genetic algorithm. Our implementation treats products in the favorite list as parent genes. It generates children genes by crossover of the parent genes, when a next operation is performed. Also, it applies mutation when a shuffle operation is performed, while the mutation ratio is calculated from the rotation angle of the shuffle operation.

Our implementation supposes that each product has several categorical variables to specify the features of the products. Our current dataset has four categorical variables, "classification", "color", "brand", and "detail". The technique simply encodes these variables to genes.

Following is the processing flow of interactive product selection applying a modified interactive genetic algorithm.

1) Initialize the algorithm. Select constant number (currently 6) of products randomly, as parent genes.
2) Repeat 3) to 5).
3) Display products corresponding to the parent genes. Await tap operations.
4) Treat constant number (currently 12) of recently favorited products as the new parent genes.
5) Repeat the following processes.
    a) Crossover. Generate a child gene from a pair of randomly selected genes.
    b) Mutation. Randomly modify values of children genes with pre-defined probability.
    c) Matching. Select one product for one child gene. If there are two or more products corresponding to the child gene, randomly select one of the corresponding products. If there is no corresponding products, select a similar product.

For mutation, our implementation usually applies a constant probability (currently 0.1, and adjusts the probability when shuffle operations are performed.

For matching, our implementation sets priority of categorical variables to select one corresponding product. We set the priority as "classification", "color", "brand", and "detail" with our current dataset. If there is no corresponding products, we select one of the products those three variables except "detail" correspond to the current child gene.

IV. Experiment

We implemented the application and executed on SONY NW-Z1000 with Android OS 4.0.4, and conducted a user experiment with 6 participants who were female university students. This experiment aimed to evaluate the effectiveness of our user interface design; especially we were interested in how shuffle operation and mutation process improve the satisfaction of users.

We prepared two implementations of the application: one supported the shuffle operation, while the other did not support. We asked participants to play with the two implementations alternatively. Three of the participants firstly used the implementation with shuffle operation, while the other participants firstly used the other implementation. We then asked them to answer the following questions in five-point Likert scale. Figure 3 shows the statistics of answers for these questions.

- Q1: Which implementation is preferable for you?
- Q2: Did you feel the difference of product selection by the application according to the rotation angle of shuffle operation?
- Q3: Did you feel necessary to control the change of product selection according to the rotation angle? (asked to participants who positively answered to Q2.)
- Q4: Is this metaphor intuitive and easy to understand?
- Q5: Is this metaphor easy to operate?

Also, we asked to select one or more choices for the following question. Table I shows the choices for this question, and number of participants selected each of the choices.

- Q6: Which situations do you want to play with this application?

Finally, we asked the participants to write down any feedback regarding this experiment.

Figure 3 shows totally good results, except just one participant rated "2" for Q2. We heard that the participant had the same rotation angle while multiple shuffle operations every

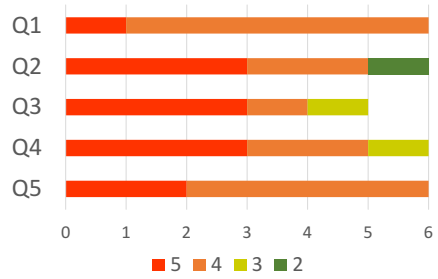

Figure 3. Statistics of answers for the five questions.

Table I
CHOICES FOR Q6 AND NUMBER OF PARTICIPANTS SELECTED THE CHOICES.

	Choice	Number of participants
(a)	I want to specify clothes to put on tomorrow.	0
(b)	I want to purchase particular products.	0
(c)	I have a spare time and want to look at products without any targets.	5
(d)	I want to just look at something while working with other tasks.	5
(e)	I get a money and therefore want to purchase something.	2
(f)	I want to release my stress.	4

time, and therefore could not see the difference of product selections. Another participant also mentioned that it seemed difficult to understand the relationship between the rotation angle and difference of product selection. On the other hand, many participants mentioned that they could easily master to use the application thanks to the simple user interface design. Based on the results, we would like to discuss how we can make easier to understand the mutation mechanism, while keeping the simpleness of the user interface design.

Table I shows that many participants suggested to use this application when users do not have particular needs or demands to purchase products. In addition, several participants mentioned that "this application is useful to browse many products and narrow down interest of users before they actually purchase something" and "we can recognize our own preference while using this application." These comments also suggest that the presented application is suitable to use when users do not want to immediately purchase something, but just want to look for preferable products or think of their own preferences.

V. CONCLUSION

This paper discussed what kinds of shopping applications on mobile devices are desirable, and presented a mobile application for apparel product shopping. This application is based on simple user interface design supporting only three single-finger operations and no GUI widgets, since many people use mobile applications very shortly and therefore simple applications are often preferable. We applied interactive genetic algorithm to suggest products over and over while learning preferences of users. Our experiment demonstrated the effectiveness and remaining issues of the user interface design and product selection mechanism of the presented application.

We would like to customize the implementation and parameters of interactive genetic algorithm with larger number of products, and then conduct larger scales of user experiments.

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