suGATALOG: Fashion coordination system that supports users to choose everyday fashion with clothed pictures

Ayaka Sato[1], Keita Watanabe[2],
Michiaki Yasumura[3] and Jun Rekimoto[1,4],

[1] The University of Tokyo, 7-3-1 Hongo, Bunkyo, Tokyo 113-0033, Japan, [2] JST ERATO, Igarashi Design Project, [3] Keio University, [4] Sony Computer Science Laboratories Inc.
ayakasato@acm.org, watanabe@gmail.com, yasumura@sfc.keio.ac.jp, rekimoto@acm.org

Abstract. When deciding what to wear, we normally have to consider several things, such as color and combination of clothes, as well as situations that might change every day, including the weather, what to do, where to go, and whom to meet with. Trying on many possible combinations can be very tedious; thus, computer support would be helpful. Therefore, we propose suGATALOG, a fashion coordination system that allows users to choose and coordinate clothes from their wardrobe. Previous studies have proposed systems using computer images of clothes to allow users to inspect their clothing ensemble. Our system uses pictures of users actually wearing the clothes to give a more realistic impression. suGATALOG compares several combinations by swapping top and bottom images. In this paper, we describe the system architecture and its user interface, as well as an evaluation experiment and a long-term trial test to verify the usefulness of the system.

Keywords: Fashion coordinate, Clothes, Life-log.

1 Introduction

When going out, a typical activity is to decide which clothes to wear. When selecting clothes, we have to consider several things, including the type of clothes we want to wear, the colors, and their combinations, as well as other situations, such as the reason for going out, the weather, where to go, and whom to meet with. We normally decide by looking through our wardrobe or actually trying them on until we are satisfied. It is not a trivial task and is often time consuming. After putting on the clothes, we often realize that the complete combination or an aspect of the clothes, such as the length and shape, is not as we expected; therefore, we have to try other combinations. Such trials might continue until we are satisfied or until we run out of time. Moreover, after trying on several combinations, we might still be unable to decide. For these reasons, we are inclined to wear similar and "safe" combinations that we already know work well.

Based on our survey about the everyday attire of 54 people (including male and female, teenagers to hexagenerians), 83% tend to wear the same combinations of clothes often, 80% have clothes that they have hardly worn or have never worn, and 76% think the clothes they already own could be better coordinated. These results indicate that they have difficulty in coordinating the clothes that they have, and imply that computer-assistance clothing coordination would be helpful.

In this research, we propose suGATALOG, a system that coordinates the user's own clothes using their "wearing image." We define a "wearing image" as an image of what the user is actually wearing. In this system, a user first takes a picture of his/her attire with a camera attached to a mirror and splits this picture into two—a top clothes part and a bottom clothes part. Then the user coordinates his/her clothes using these separated pictures. This paper outlines a prototype system and reports the results of an evaluation experiment.

2 Related Work

Interest and demand in fashion coordination is increasing, and many services and products on the market support this activity. Systems using pictures showing only clothes [5, 6] can support the selection of daily clothes with using pictures of owing clothes. However, because these systems only present pictures of clothes, users still have difficulty imagining the final image when the clothes are worn. Systems using computer graphics allows users to interactively control a 3D model of themselves at home using a depth camera [3], or combine clothes according to the user's movements [2, 4]. For this system to be used at home, the user's body must be scanned in 3D, and it is unrealistic to prepare 3D models of all clothes that a user already owns. Systems using user's body enables users to change the color of the worn clothes in the digital mirror [1], or enables online social fashion comparisons in physical stores based on multi-camera perception [8]. These systems are useful as a shopping support system at apparel shops. However, it is not suitable for home use, because the required equipment is currently still complicated and takes up a large space.

3 suGATALOG

suGATALOG is a system that allows users to choose and coordinate clothes from their wardrobe using pictures taken in front of a full-length mirror in their room. Users can take a picture before going out or when checking their own reflection in the mirror. In this section, we will describe the design and implementation of our system. Our system has three main advantages over the previous systems:

- This system gives a realistic impression by showing pictures of the clothes that a user is actually wearing.
- By recording past combinations automatically, it helps a user to find a combination that the user has seldom worn or never tried.

• It does not require expensive or large equipment; therefore, it is easy to use at home.

3.1 Approach

We focused our attention on the differences in usability between pictures showing only clothes and pictures showing worn clothes. Fig. 1 shows a comparison of images showing only clothes (Fig. 1-A, B, C) and images showing worn clothes (Fig. 1-A', B', C'). In A and A', the shape of the sweater is different, and the absence of a face, arms, and legs makes it difficult to imagine whether the clothes will fit the face, hairstyle, and the body. In B and B', the width of the skirt is different. In C and C', the width of the dress is different, and the relative length of the dress is difficult to judge without trying it on. Our approach is to coordinate clothes using images like A', B' and C' where the clothes are worn, so that a realistic image showing the clothes fitted on the user's own body and also showing the user's own face. We use this approach to coordinate clothes in a "wearing image" without changing clothes in reality.

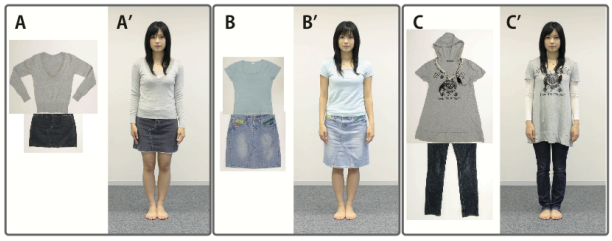

Fig. 1. Comparing pictures of clothes only (A, B, C) with pictures of clothes worn (A', B', C').

3.2 Brief overview of the system

suGATALOG consists of a web camera attached to a full-length mirror and a web application. A user takes a picture with the camera in front of the mirror, and the picture is uploaded and shown on the web application. The picture is split into two parts: a top part and a bottom part. The user can coordinate clothes using these pictures on the application without actually wearing the different clothes.

3.3 Functions

In this section, we describe the functions of the web application.

Shooting Function. The Shooting function takes a picture of the user. When the user clicks on the camera icon on the bottom left of the screen (Fig. 2), a video from the web camera pops up with a guideline indicating where the user should stand. The user stands in front of the camera according to the guideline shown on the screen, and a picture is taken after 5 or 10 s (selectable).

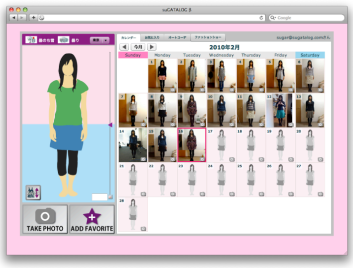

Fig. 2. An example screen of the calendar and the fitting room.

Calendar Function. The Calendar function displays a calendar showing pictures that were previously taken and uploaded on specific days (Fig. 2). Users can view their fashion ensembles for each day of the month, which enables them to review what they have worn previously.

Fitting Room Function. The Fitting Room function simulates ensembles using the pictures on the calendar. In Fig. 2, we named the left part of the screen as "fitting room." Each day of the calendar is divided in two parts at the center. If the user clicks on the upper part, that part of the fitting room is replaced by the clicked picture, and the same with the lower part. The picture is divided at the vertical center but the length of tops might differ, so users can adjust the length by using a slider. In this way, we coordinate different clothes by superimposing an adjusted tops picture over a bottoms picture. Fig. 3 shows the work sequence of simulating ensembles.

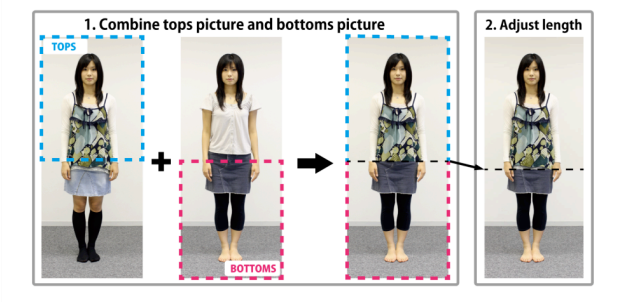

Fig. 3. To simulate an ensemble in suGATALOG, (1) select top and bottom pictures from the calendar and superimpose them, and (2) adjust the length of the top.

Favorite Function. The Favorite function saves and compares several ensembles. If the user clicks on the "ADD FAVORITE" button at the bottom of the fitting room portion of the screen, the ensemble shown in the fitting room is saved as a favorite. This function enables users to save their favorite ensembles and to compare several ensembles side-by-side.

Auto-coordinating Function. The Auto-coordinating function coordinates several ensembles at a time. Generally, when selecting a combination of clothes, we select either tops or bottoms first, and then select the other. In a similar way, clicking on

either the tops picture or the bottoms picture in the fitting room, several combinations for the selected half will be shown. This function helps users to find new combinations easily, which requires time and effort without the system, and to find unexpected combinations, which they had never tried previously or which they thought would not match.

Fashion Show Function. The Fashion Show function presents the ensembles in a fashion show style. Fig. 5 shows the screen transitions of this function. Two randomly selected pictures from the calendar appear from both sides of the fashion show stage (Fig. 5-1) and move forward, like models walking on the stage. When they come to the front center, an animated curtain appears and disappears (Fig. 5-2), and their tops are switched, creating two different ensembles (Fig. 5-3). This function enables users to review what they have worn in the past and to find new combinations.

Fig. 4. Fashion show function.

4 Experiment

In this section, we describe the method, result, and observations of an evaluation experiment.

4.1 Experiment Method

We conducted an experiment to evaluate our proposed method for coordinating clothes. We compared three methods that can be used at home.

Method 1: Choose actual clothes and coordinate
Method 2: Use clothes-only pictures and coordinate on PC
Method 3: Use clothes-worn pictures and coordinate on PC (proposed method)

Method 1 is most typically used at home, Method 2 was proposed in a related work, and Method 3 is what we propose in this paper. In the experiment, 14 subjects (6 males and 8 females, with ages between 20 and 39) participated; they were all students who usually select clothes every day. Each subject brought five tops and five bottoms and created twenty-five combinations using these methods. We decided to use the subjects' own clothes so that they could coordinate clothes in their usual style. Participants first evaluated the realism of the ensemble image from each method, and then ranked the three methods.

Experiment 1: Comparing the realism of the ensemble. We conducted a survey with the questionnaire below on each of the 25 ensembles to verify how realistic subjects think the ensembles from each method are.

Q.1 Would you go out wearing this ensemble? [Yes / No]
Q.2 How much confidence do you have in your answer for Q.1? [Higher confidence 5 / 4 / 3 / 2 / 1 Lower confidence]

We asked these questions because asking "Do you think this simulation image looks real?" is too direct. By answering "Would you go out wearing this ensemble?," the subject would care about how others see him/her; therefore, he/she can answer the question in a normal situation. Regardless of the answer to Q.1, a higher value for Q.2 indicates that the ensemble is more realistic. We describe the experimental procedure for each method below.

Method 1: Coordinate by viewing actual clothes
First, we labeled clothes which the subject brought in (from 1 to 5 for tops and from A to E for bottoms), and hang them on the hanger rack. Then, the subject answers the questions for each of the 25 ensembles by selecting and overlapping the clothes on the hanger rack.

Method 2: Coordinate on PC using clothes-only pictures
First, we take individual pictures of each of the subject's 10 pieces of clothing, and then scan the pictures into the PC and add them to the application shown in Fig. 6-1. The operating instructions were given beforehand. Then, the subjects answered the questions for all 25 ensembles in the same order as Method 1.

Method 3: Coordinate on PC using pictures of clothes that a subject is wearing (our proposed method)
First, we take pictures of the subject wearing a combination of 1A (top: 1, bottoms: A), 2B, 3C, 4D, 5E. As with method 2, scan the pictures into the PC and add them to the application as shown in Fig. 6-2. The operating instructions were given beforehand. Then, the subjects answered the questions for all 25 ensembles in the same order as Method 1 and 2.

Fig. 6. Operation screen used in Method 2 (left) and Method 3 (right).

Experiment 2: Ranking of three methods. After Experiment 1, the subjects prioritized the three methods based on the strength of their convictions and gave the reasons for the rankings.

4.2 Results

Table 1 shows the results of Q.1, the degree of confidence that the subject would actually go out wearing the specified ensemble. We removed the combinations 1A, 2B, 3C, 4D, and 5E from each method, because the subjects have already tried them on in the experiment. The higher rate of confidence indicates that the subject is more convinced of the reality of when wearing that particular combination of clothes. Method 3, which used pictures of worn clothes, received an average score of 4.0, which is the highest average value of confidence for all combinations. Colored squares in Table 1 show the highest confidence rate for the three methods for each test subject, and Method 3 was ranked highest among the three methods by the most number of people (a total of 11). Table 2 shows the results of Experiment 2, the ranking of the strongest conviction on the Q.1 answer. The best ranked was Method 3, which uses pictures of worn clothes on the PC, the second place was Method 1, which uses real clothes, and the third place was Method 2, which uses only-clothes pictures on the PC.

Table 1. Result of Experiment 1—comparison of degrees of confidence. M is male subject and F is female subject.

Subjects / Method	M1	M2	M3	M4	M5	M6	F1	F2	F3	F4	F5	F6	F7	F8	Average	Male Average	Female Average
Method 1	3.5	3.7	3.9	3.3	2.9	4.1	4.2	4.2	3.4	3.9	4.0	4.0	3.9	2.9	3.7	3.6	3.8
Method 2	3.7	4.2	3.6	3.4	3.4	3.9	4.2	3.8	3.2	3.9	4.1	3.2	3.9	3.0	3.7	3.7	3.6
Method 3	4.2	3.9	3.9	3.1	3.9	4.4	4.5	4.3	3.8	4.9	3.8	4.2	3.9	3.4	4.0	3.9	4.1

Table 2. Result of Experiment 1—comparison of degrees of confidence.

	Method 1	Method 2	Method 3
1st	1	1	12
2nd	11	2	2
3rd	2	11	0

4.3 Observations

As shown in Table 3, we carried out an analysis of variance of a two-way layout with repetition to determine whether a difference in confidence rates existed among the three methods using the R. We confirmed a significant difference among the three methods with a 0.1% level of significance. We also confirmed that significant differences were present between male and female participants with a 5% level of significance from Table 3. Based on the average of the confidence rates of males and females in Table 1, females are more confident in their judgment.

The total average of confidence rate was 3.77 and the standard deviation was 1.03. To verify the effect of the operating order of the three methods, performed a two-way layout analysis of variance on the method and the order. As a result, the p-value was 0.69 and the level of significance was 5%. Therefore, we consider that the order of the methods had no effect on the results.

Table 3. Analysis of variance (ANOVA) table.

	DOF	Variation	Unbiased variance	F-value	p-value
Method difference	2	18.37	9.1869	8.9502	0.0001426
Gender difference	1	4.54	4.5433	4.4262	0.0356892
Residual error	836	858.11	1.0264		

Method 1 was the second best in giving the users confidence regarding their clothing choice before going out. However, it received the lowest average of confidence among all three methods. In this method, subjects can actually pick up the clothes to see the colors and texture and to feel the fabrics. On the other hand, they are too close to their image in the mirror to see the combination objectively. This method took longer than 100 seconds per ensemble on average, and this method requires large body movements compared to other methods.

Method 2 received the least confidence in judgment. With this method, several ensembles can be compared side-by-side on the PC, and this enables the user to see them objectively. From the interview, we concluded that pictures showing only the clothes made it difficult to imagine wearing selections. Further, one of the interviewees said that all combinations seemed to fit together because of the flatness of the clothes. These comments indicate that the simulation using clothes-only pictures enables the user to coordinate colors, but it makes it difficult to imagine wearing the ensembles.

Method 3 received the highest result in confidence. The biggest reason could be that it produces a stereoscopic effect when the clothes are worn on the user's own body. In addition, the ensemble can be seen objectively as in method 2. Users discover that some combinations surprisingly fit and they choose to wear the new ensembles. Most people determined that this technique gave them the highest degree of confidence about going out wearing the selected ensemble. However, tops with lower hems could cause part of the top to remain with the bottom part of the photo, thereby causing confusion for the user. In fact, if the photo showed the hem of another top in the bottom portion, the evaluation was lower than a photo where the photo does not show extraneous fabric.

5 Trial Use

suGATALOG is designed for long-term use at home. Here, we initiated a long-term trial use of the system. Two males and two females participated in this trial for three weeks. Each participant registered for the web application and set up a web camera on their room mirror to take pictures while standing at the same location. They used the web application from their own PC's web browser. We interviewed each participant after the trial, and we report the comments from the interview below. The Fashion Show function was not yet available at the time of this trial.

Regarding the Shooting function, three participants said that taking pictures was troublesome. Our system requires users to use a web browser on a PC, and this may

have been inconvenient for participants to turn on the PC and run the application. The only participant who did not think it was inconvenient ran his computer all the time. Having a PC that always runs is important for the usability of this method. Regarding the Calendar function, all participants said that they started to think about fashion more often. This may be because the Calendar function allows them to view what they wore every day. One male said that he realized he was wearing similar colors even when he was wearing different clothes; therefore, he started to consciously select different colors. In fact, after wearing different gray shirts for three days, he wore a yellow shirt, and he wore similar colors less frequently after those three days. Regarding the Fitting Room function, one female participant said that she used to think her choices were not good enough after she had left the house, but she became more confident about her choices with this system, probably because she could view her ensemble choices objectively. Being able to mix and match with one click, she could coordinate until she was satisfied without changing clothes in real life. On the other hand, one male participant said that he could not choose one combination from various options by himself. Regarding the Favorite function, we found out that only one participant used it for more than three times, based on trial data. This function is used to compare several ensembles, but participants were using the system mainly in the morning when they are in a hurry. Regarding the Auto-coordinating function, one female participant found this function useful for comparing several ensembles when she has a specific piece of clothing that she wants to wear. After using this function, another female participant started to wear clothes that she rarely wore. In fact, she wore those clothes twice more during the trial. One male participant actually wore some combinations he never thought of before. These comments indicate that our system triggers participants to wear combinations they have never tried.

6 Discussion

6.1 The Process of Recording Pictures

We intended our system to record candid pictures in usual poses, such as when checking one's self in a mirror so that the recording process would not be an additional task to do every day. However, the results from the trial suggested that it was a bothersome task for most of the participants. Our future work is to make this recording process simpler and easier; for example, taking pictures automatically when the wardrobe door is closed [7], or attaching sensors and a camera on the front door and taking pictures before the user walks out. Attaching a camera on the front door enables the system to coordinate the clothes with shoes as well.

6.2 Application Ideas

All the pictures were uploaded on the web; therefore, they can be accessed from anywhere. This feature can be useful when shopping at apparel stores to coordinate

previously purchased clothes with clothes at the store. This can also be used by shop assistants to recommend clothes that would work with customers' existing clothes. Picture images also include hairstyle, make-up, and body shape, which can be used at hair salons to cut the same hairstyle or apply the same makeup style. It can also be applied to support a weight-loss diet using the differences in body shape during a span of time.

7 Conclusion

We proposed and implemented suGATALOG, a fashion coordination system that allows users to choose and coordinate their clothes. Our system uses pictures of clothes that the user is actually wearing, and this enables users to try various combinations easily without actually changing. We conducted an evaluation experiment to verify the usefulness of the system by comparing three methods of coordinating: using actual clothes, using clothes-only pictures on the PC, and our proposed method of using pictures of clothes that the user is actually wearing on the PC. The result revealed that our proposed method for coordinating clothes was superior to other methods in achieving realism.

References

1. C.-M. Cheng, M.-F. Chung, M.-Y. Yu, M. Ouhyoung, H.-H. Chu, and Y.-Y. Chuang. Chromirror: a real-time interactive mirror for chromatic and color-harmonic dressing. In CHI '08 extended abstracts on Human factors in computing systems, pages 2787–2792, April 2008.
2. F. Cordier and N. Magnenat-Thalmann. A data-driven approach for real-time clothes simulation. In Proceedings of the Computer Graphics and Applications, 12th Pacific Conference, pages 257–266, May 2004.
3. S. Hauswiesner, M. Straka, and G. Reitmayr. Free viewpoint virtual try-on with commodity depth cameras. In Proceedings of the 10th International Conference on Virtual Reality Continuum and Its Applications in Industry, pages 23–30, December 2011.
4. J. Hoshino and F. Saito. Building virtual fashion simulator by merging cg and humans in video sequences. In Transactions of Information Processing Society of Japan, pages 1182–1193, June 2000.
5. SONY. MyStylist. www.jp.playstation.com/scej/title/my/stylist(access date 2013.2).
6. H. Tsujita, K. Tsukada, K. Kambara, and I. Siio. Complete fashion coordinator: a support system for capturing and selecting daily clothes with social networks. In Proceedings of the International Conference on Advanced Visual Interfaces, pages 127–132, May 2010.
7. H. Tsujita, K. Tsukada, and I. Siio. A wardrobe to support creating a picture database of clothes. In Adjunct Proceedings of the 6th International Conference on Pervasive Computing, pages 49–52, May 2008.
8. W. Zhang, T. Matsumoto, J. Liu, M. Chu, and B. Begole. An intelligent fitting room using multi-camera perception. In Proceedings of the 13th international conference on Intelligent user interfaces, pages 60–69, January 2008.