Attempt at modeling interest in an augmented living space that uses ubiquitous interface

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Abstract: We propose information services using ubiquitous technology with three functions. Three functions are as follows. (1) The function modeled from correspondence with the natural behavior and interest (taste) about an object (2) The function to observe and judge people's number and the situation on that occasion it is considered that may receive information (3) The function which tells information by the expression (transfer) method suitable for a situation which is easy to understand, and can observe the further interest (taste) from the method of the correspondence to the shown contents. In this paper, we applied this system to store space and evaluated modeling of a user's interest to goods.

Key words: *SmartHome,Augmented Live Sphere*

1. Introduction

Every human being has his/her own interests and preferences with regard to clothes and paintings (hereinafter, objects). It is also thought that we have a favorite mode of expressing any information exchanges regarding objects among humans.

Therefore, in order to achieve a human-friendly (fitting individuals' feeling toward objects and their mode of expression) information service, we aim to (1) estimate individuals' interests, preferences and situation without imposing a physical or psychological burden on users, (2) judge the number of people in the situation and surroundings, (3) achieve an information service environment that offers information according to each situation using ubiquitous technology as well as augmented reality technology. We call such an information service environment, "Augmented Living Sphere."

In order to fulfill the three tasks mentioned above, this study suggests a method of modeling (sensibility model) that can imitate sensibility on a computer screen. We focused on people's behavior toward objects and estimated individuals' interests and preferences toward objects and how they react (we call this, "sensibility" in this study) by acquiring and analyzing users' natural behavior (movement and actions). Those technologies were applied as the product recommendation system in this study. We also conducted an experiment on the modeling of interest and evaluated the efficacy of it.

2. On-line shops and shops in the real world

With the expansion of online media, the usage of online shopping has increased. In addition, according to Internet research, seven out of ten people have used online shopping and say that they would like to continue using it. Moreover, consumer products such as food and clothes are listed at the top of products recently bought online.

2.1 Problems regarding online shopping

We presumed that online shopping would be effective for Amazon, which handles books, but there is a difference between Web evaluation and real evaluation in the case of products such as clothes and food that cannot be judged based only on the superficial view.

[Preliminary Experiment]

Subjects: 6 university students

Experimental contents (WEB): 42

Experimental contents (clothes): 42

First of all, subjects evaluated their degree of interest in clothes presented on the Web (Figure 1) on a scale of 5 and marked them accordingly. Then, we asked subjects to take a look at each piece of clothing to compare the Web evaluation with the actual evaluation, and they evaluated according to a scale of 5, as mentioned above.

Fig. 1 Web evaluation screen

2.3 Preliminary experimental result

The figure shows the measured correlation coefficient of the Web evaluation value and the actual evaluation value of each image of the clothes. We can see a tendency of a positive correlation between the evaluation on the Web and the actual evaluation, because the figure indicates that the overall correlation coefficient is plus.

Figure 3 shows graphs that include the total error of the Web evaluation and the actual evaluation for each piece of clothing. Considering the fact that the total difference between Figure 3 and the value of the actual evaluation and the Web evaluation was -52, it seems that images of products on the Web tend to look more appealing than the real product, and the evaluations tend to decrease when one touches the real product. It is thought that this is because a subject predicts the texture from the visual information (images), but actually seeing the product turns out to be different from the expectation. Furthermore, the figure below shows contents that have a high correlation coefficient of more than 0.8 and a low correlation of less than 0.2.

Based on Table 2, products that have a high correlation coefficient are products with pale colors and basic designs like border patterns. The fact that products with a point design (patching or patterns on the hem) also had a high correlation, shows that the interest of users tends to depend on the point design.

As mentioned above, when one evaluates a product, the Web evaluation is not sufficient, because it tends to be a higher evaluation than the evaluation of the actual product. The evaluation is unreliable if a user does not see the product. Therefore, only actual evaluation was adopted in this study and Web evaluation was not used.

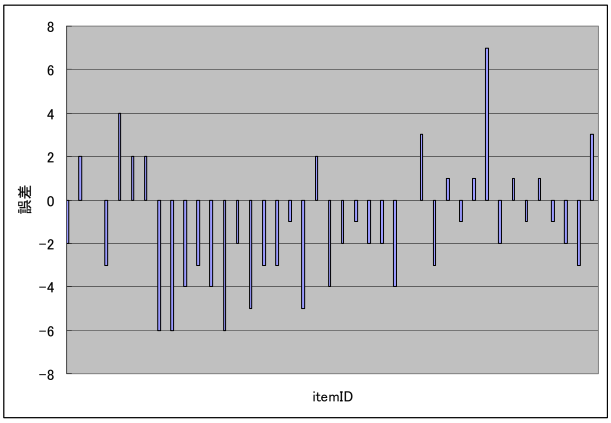

Fig. 3 Distribution of error of each item

Error: Difference from the Web evaluation based on the actual evaluation value as the standard

3. Related studies

3.1 Related studies

As examples of studies showing that the surrounding environment supports humans, there are “Percept room” by Tominaga, Softopia Japan [1], “Robotic Room” by Sato, University of Tokyo [2], [3], “Aware Home” by Essa, Georgia Institute of Technology [4] and a study by Kunifuji [5].

3.2 Problems regarding ubiquitous technology and augmented reality technology

(1) It does not deal with individuals’ interests or preferences

The service using ubiquitous technology and augmented reality technology mentioned above focuses mainly on detecting abnormalities of humans or products by means of physical data, such as human behavior or object location, as well as physiological data, such as body temperature. Accordingly, it does not deal with the model of the various values each person has and the ability to offer a service tailored to each person’s situation at a given time.

(2) Situations in the space is limited

In addition, since the technologies mentioned above are

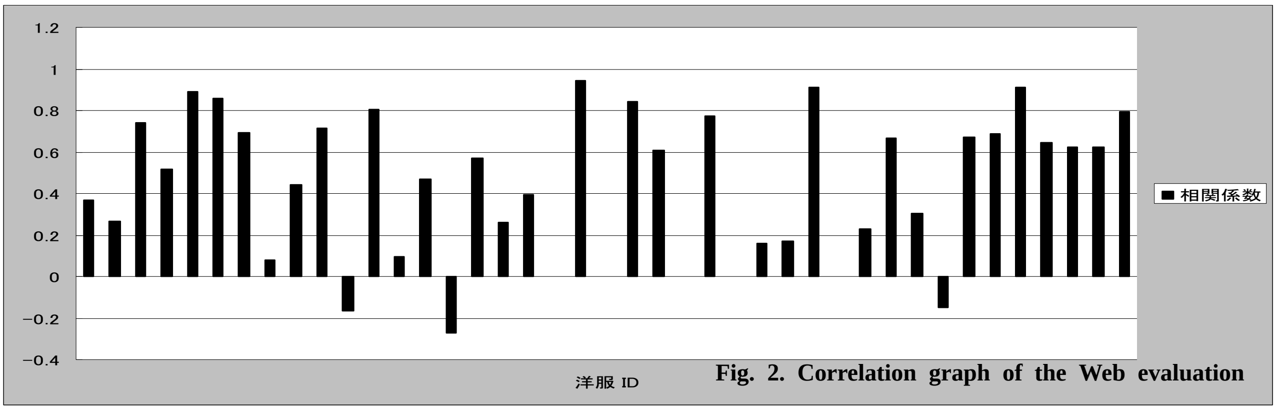

Fig. 2. Correlation graph of the Web evaluation and the actual evaluation in the case of clothes

designed for care support of bedridden people, and activity support of individuals, the service is offered to one person. Therefore, the place where information service is offered is limited in space in many cases.

(3) Mode of expressing information is limited

There are modes of expressing information to users such as a visual method using a monitor or an auditory method using an audio. However, there is no mode of expression that combines visual and other senses (multimodal) in the conventional ubiquitous information service, and conveying information to users in an easily understandable way is difficult.

4. The implementation method of augmented life sphere

The objective of this study is to estimate and create a model of individual's actions regarding objects and reactions to interests and preferences regarding the objects to solve the above-mentioned problems. This study also aims to convey information using the model, and to achieve an augmented life sphere where you can observe more interests and preferences from reactions to the contents of the presented information (For example, an individual may move to a place where there is an object in which he has an interest).

5. Application of the method

5.1 The behavior model of users during shopping

AIDA model has been known for a long time as a consumer's buying behavior model. Each factor of the AIDA model consists of the flow of shopping, such as "noticing a product (Attention)," "showing interest in it (Interest and Desire)," "touching, taking or buying it (Action)." Therefore, we assumed that the system can estimate the interest of users in a product (Interest, Desire) by observing "Action" when consumers are choosing a product by touching it or picking it up, accumulating the information as behavioral histories and analyzing them (Figure 4: We presumed that it is possible to estimate Interest and Desire by observing Action).

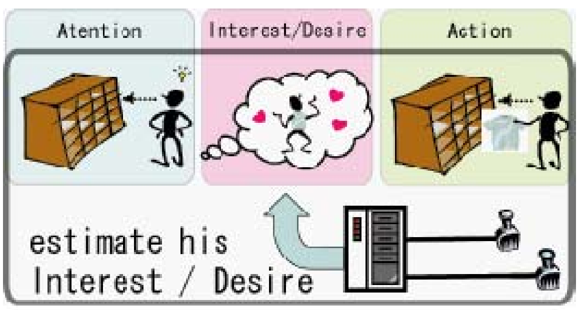

Fig.4 We presumed that it is possible to estimate Interest and Desire by observing Action

5.2 Smart shop environment

As an example of augmented life space, we constructed Smart Shop, a space that imitates a clothing store. We created a model of user's interest in objects based on the information of users' actions and how they reacted after they saw the presented information. Then we built a prototype system that offers a product recommendation service using the model. An RFID reader was placed in the shop and each user was given RFID so that each individual could be identified and the current position detected. Moreover, a camera censor detected the movement of their hands and made it possible to detect how they acted toward a product (Figure 5 Individual identification by RFID, and detecting actions toward a product and position by means of hand / roof camera).

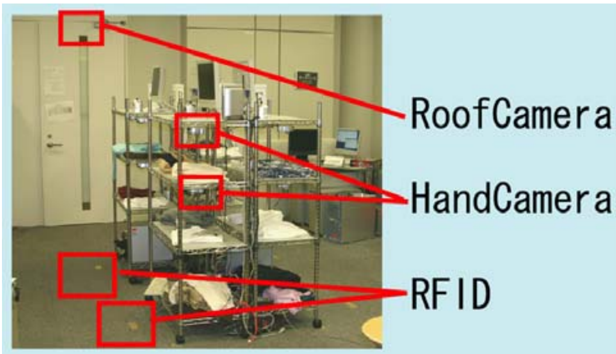

Fig. 5 Infrastructure of smart shop

5.3 Handling of the evaluation value

The time a user took for some action (picking up a product or touching it) toward product *n* is described as *tn*. However, since the time each user spends on an action toward a product varies according to the individual, the total time of touching clothes in the shop is described as *Ts* and the duration the individual stayed in the shop as *Ta*.

$$Tn = \frac{tn}{Ts} \quad \cdots \quad (1)$$

$$Tn2 = \frac{tn}{Ta} \quad \ldots \quad (2)$$

We measured the ratio of user actions toward a specific product during the time in the shop, calculating the early evaluation of the product by means of the formulas above. Then, in case *Tn* (ratio) and *Tn2* were defined as (1), (2), we experimented with what kinds of states or habits of subjects could be detected by *tn*, *Ts*, *Ta*, *Tn* and *Tn2*. We are planning to utilize the normalized value as the interests of users' evaluations, and recommend them.

6. Evaluation experiment

To confirm the efficacy of the suggested system by asking subjects to actually buy in Smart Sphere, we verified the following hypothesis.

Hypothesis 1: Subjects spend more time on a highly evaluated product

We have already mentioned that we estimated Interest and Desire based on Action. Therefore, we measured the duration of actions in this experiment and hypothesized that there is a correlation between the duration of actions and the degree of interest in a product.

6.1 The real experiment of purchase

We conducted the experiment on subjects as follows in Smart Shop.

Experimental Method

1. Divide subjects into three groups (A, B and C)
2. Clothes for the experiment were divided into three groups (p, q, r: 14 pieces of clothing in each group)
3. Tasks regarding two pairs of contents were given to each subject group as mentioned below, and they implemented them according to the instructions (The other pair was later used as teacher's data).

・Subjects take the action of choosing clothes in the shop (one subject at a time).

・Subjects are not allowed to bring clothes back (the action of purchasing was omitted in this study).

・If a subject has interest in a particular piece of clothing, he must pick it up.

・Subjects have to go around the shop and look at all products (14 pieces of clothing).

We asked subjects to avoid ambiguous actions such as "Just touching" or "Just looking," to investigate the correlation between interest and interaction time with a product. We measured the duration that subjects were holding clothes in which they were interested and the ID of clothes.

6.2 Experimental results

Table 2 Correlation coefficient of the actual evaluation and the time subjects held a product

ID	Correlation between time and the actual evaluation
1	0.43604477
2	-0.39694787
3	0.718319931
4	0.910609667
5	-0.450827976
6	0.510292095

Table 3 The actual evaluation and interaction time of Subject ID 1

ID	Image ID	Time	Ratio	The actual evaluation
1	126	9970	0.114243	4
1	213	4010	0.045949	2
1	238	6920	0.08733	4
1	240	7180	0.090611	3
1	242	4650	0.053283	3

Table5 Evaluations of each user of Cloth ID233

ID	Image ID	Time	Ratio	The actual evaluation
1	233	6170	0.077865	2
3	233	10770	0.195109	3
4	233	8240	0.067914	2
5	233	14190	0.15107	3

Table 2 shows us the correlation between the action time and the actual evaluation. According to Table 2, only one person showed a correlation between time and actual evaluation and others showed disorder. Some of the experimental data are also shown on Tables 3 and 5.

For example, it seems that there is relatively strong correlation between time and actual evaluation of Subject ID1 based on Table 3. Judging from other tables, however, we can see that there is a need to develop the behavioral or interest model, considering both aspects of the difference in interaction by products and humans.

On the other hand, there were few purchasing actions of subjects, from 2 to 11 times for 28 products (second action toward the same product was excluded). Therefore, it is difficult to create a model that is perfectly adjusted to individuals. Accordingly, this study aimed to normalize the evaluation value from the pattern by looking for subjects who showed similar behavioral patterns.

Figure 6 is the result of cluster analysis with Ward method using $\overline{tn}$ and the actual evaluation value. Based on Figure 6 and the experimental results, subjects in this study were divided into the following groups:

Group1: ID1,5,6,4

In general, they are the type of people who take action as soon as they take an interest in something and objects include both those that they evaluated well and badly. ID4 had a strong tendency to pick up products, even if he was not interested in it.

Group 2: ID2,3

They are people who concentrate on one product. They take action only if they have a strong interest in a product. They tend to touch a product for a longer time.

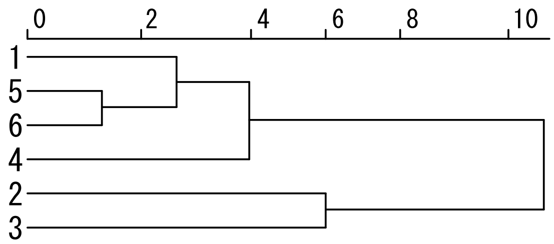

Fig. 6 Results of cluster analysis of users

7. Conclusion and future plan

This study shows that it is important to acquire individuals' behavior history before creating an interest / behavior model adjusted to individuals. We tested grouping as a trigger to create a model from a few behavior histories. As future challenges, we will examine how to predict evaluation value as well as shopping history precisely to improve the accuracy of the interest / behavior model of individuals. Moreover, the information that an individual purchased something is accurate, but "the action of looking for something" is inaccurate. Therefore we are planning to implement an experiment as it is considered possible to adjust the model by active observation (clicking a product recommended on display or moving to the place where a recommended product is).

Furthermore, if an effective result is found regarding Hypothesis 1, it is presumed that the probability of having an interest in a recommended product would be proportional to the number of actions (Hypothesis 2). If Hypothesis 1 is correct, we can hypothesize that the probability of having an interest in a recommended product would increase with an increase in the number of the teacher's data. We utilized algorithm and collaborative filtering, which have been put to practical use by Amazon as the recommendation engine, when we created the system in this study. [6] Here are the reasons why we utilized collaborative filtering.

・It is the most practical method.

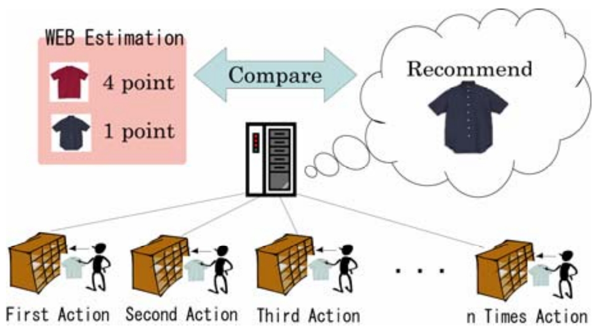

Figure 7 Product recommendation method and confirmation method in Smart Shop

・Unlike a purchasing history, this system is easy to handle because even a newcomer can obtain substantial data in a short period of time.

・It is easy to apply with regard to newly arrived products depending on the item layout, such as shelf placement.

Furthermore, it was a prerequisite in this study for a subject to pick an item up. However, it is believed that the recommendation accuracy would improve by incorporating actions such as touching and the prediction of interest by visual detection [7]. These remain unsolved as future tasks.

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