Human communication support by the taxonomy of subjective evaluations

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Abstract: It is difficult for designers to know how consumers interpret their intentions, since they have few interactions with consumers. We developed a communication support system between designers and consumers. In this paper we propose a method to model consumers' subjective evaluations by using impression words, e.g. “cool”, “comfortable”. The basic ideas of our method are (a) the taxonomy of subjective evaluations and (b) the estimation algorithm of subjective evaluations.

We build up the taxonomy of subjective evaluations for each person. It represents relationships between physical features of objects such as texture, shape and color and subjective impression words together with his own interests.

We will refer each person’s taxonomy as his KANSEI model. We have designed the modeling method to statistically learn the relationships through questionnaires below.

(1) How does the consumer feel about objects?

(2) Which physical feature caused such a subjective evaluation?

Then we build up each consumer’s KANSEI model and designers’. We can estimate his subjective evaluation through physical features. By comparing designers' model with each consumer's, we can also show the differences in the usage of using impression words.

Matchmaking is to retrieve objects which may cause consumers the similar impression with the key word and the key object. Referring to each consumer's model using physical features of objects as a search key, designers can efficiently select suitable consumers to recommend their objects.

We have examined our KANSEI model and matchmaking facilities in the shopping assistance application. Designers could check how consumers interpret their intentions on design. The facilities are useful to convey designers’ concepts to the consumers.

KANSEI model has a function of a communication infrastructure that mediates between designers and consumers.

Keyword: *Kansei communication support*

1. Introduction

When a person sees objects, each person interprets objects subjectively such as cool and smart. We consider there are individual differences among people’s subjective interpretations on objects. Caused by the individual differences, designers and clients often have difficulty communicating with each other.

We consider there are following problems on individual differences of interpretations among communication with designers and clients.[1][2]

1. It is difficult for a designer to understand his client's request by the impression words.
2. When designers exchange their ideas, it is difficult for them to communicate each one's interpretations.

We modeled each person's subjective evaluation process. Our basic ideas to solve above problems are following.

(1) We model each person's evaluation process [1][2] on the specific features of the objects with impression words such as "stylish" and "cool" and define it as "the taxonomy of subjective evaluations". We will refer each person's taxonomy as his KANSEI model.

(2) Referring each person's taxonomy, we find relationships between physical features on objects and their subjective interpretations.

Referring people's taxonomy, we will find the relevance among people's taxonomy based on relationships between physical features on objects and their subjective interpretations.

Based on these ideas, we have been developing a human communication support environment with multiple subjective evaluation process models. This paper describes the construction of subjective evaluation model and the communication support algorithm using it.

2. The taxonomy of subjective evaluations

2.1 The taxonomy of subjective evaluations

When we ask the person "How do you feel the sofa?", each one's subjective interpretations such as "cool" and "smart" may be different from others' even on the same object. (Fig.1) Thus we consider there are individual differences among people's interpretations on objects.

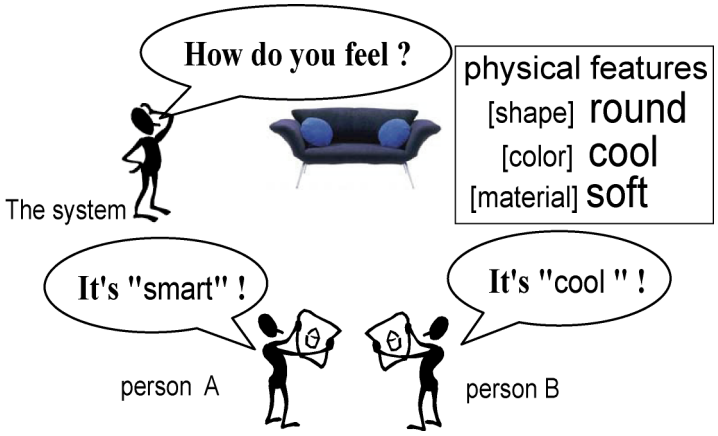


Fig.1. Individual differences of subjective interpretations

In communication with designers and clients, there are following difficulties which arise from individual differences of subjective interpretations among them.

When a client requests "cool chair" with only this word, it is difficult for a designer to understand "which features cool means for the client?". Therefore the designer can't precisely understand which features the client wants with only impression words such as "cool" and "stylish".

There are also individual differences among designers' interpretations. Therefore, in collaborations they need to exchange their ideas which features relates stylish.

Designers often search reference materials from Internet by themselves. Then, image names and keywords which a supplier selects become a retrieval key. In this case, image names and keywords can't represent features of items precisely. If supplier assigns "cool" to a reference material, it may not be cool for designers because there are individual differences of subjective evaluations.

Thus we consider it isn't suitable for the efficient retrieval to use keywords selected subjectively by someone.

In this research we model each person's subjective evaluation process [3]on objects. We call the model each person's KANSEI model. In this section, we explain person's subjective evaluation process.

We assume each person's subjective evaluations process consists of following two steps bellow [3].

1.Viewing the objects to sense the physical features such as shape, color and material.

2. Interpreting objects subjectively such as "cool" and "smart" based on the physical features.

For the first and second steps, we can model the relationships between physical features of objects and an interpretation as the taxonomy of subjective evaluations. We will refer this as subjective evaluation model of the each person.

2.2 Components of the taxonomy of subjective evaluations

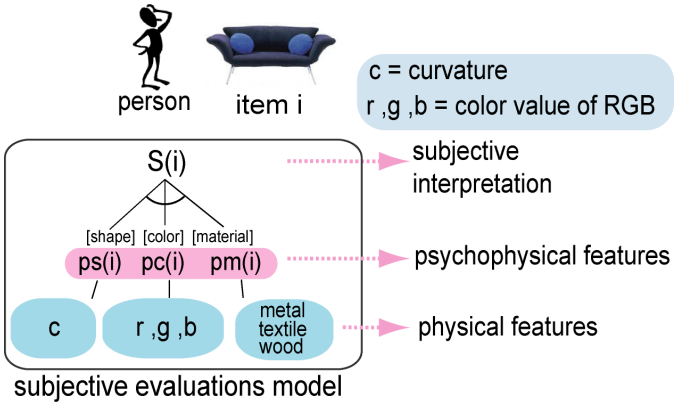


Fig.2 Subjective evaluation model

Each consumer's evaluation process on objects is hierarchically built up below.

Physical features are physical attributes of objects on shape, color and material of objects. We use curvature, RGB values and composition rate of materials to describe shape, color and material features, respectively. Thus, the overall features of an object takes multi-dimensional vector form. For instance in Fig.2, the physical features of i-th item is described (c, r, g, b, metal, textile, wood). Here, first, second to forth and fifth to the last elements denote curvature, color values of R,G,B and composition rate of metal, texture, wood respectively.(Fig.3)

We'll assume that our psychophysical level perception on shape, color and material can be described by some words. A person recognizes physical features of items not numerically but verbally such as "bright color", "simple shape" and "hard material" (Table1). Therefore there is a little individual difference in description of physical features. Initially, item suppliers fills these psychophysical features by words. Each consumer can examine and alter the initially give words through the interaction processes with the system afterwards.

Subjective interpretations are such as "smart", "stylish" and "elegant"(Table 2). It means each person's subjective interpretations on objects based on the physical features and psychophysical features. Subjective interpre-

tations represent wholly impression of objects.

Table 1. Example of psychophysical features

[shape]	[color]	[material]
intricate	bright	hard
simple	dark	soft
thick	vivid	organic
thin	dull	unorganic
angular	warm	heavy
round	cold	light
	deep	
	pale	

Table 2. Example of subjective interpretations

basic	elegant	refreshing
casual	lively	relaxed
chic	metallic	sharp
classic	natural	simple
colorful	pop	smart
cool	pretty	stylish

Person may give different interpretations even for the same item. In addition, there are more individual difference in subjective interpretations than psychophysical features. We assign subjective interpretations as S(i).

Initially the supplier fills sales concept for each item from the interpretation words (Table 2). By analyzing item image, the supplier can get RGB with an item. Referring item information, the supplier can get other information on materials, shape of items. Describing a subjective interpretation and physical features on each item, the supplier also constructs subjective evaluations process model.

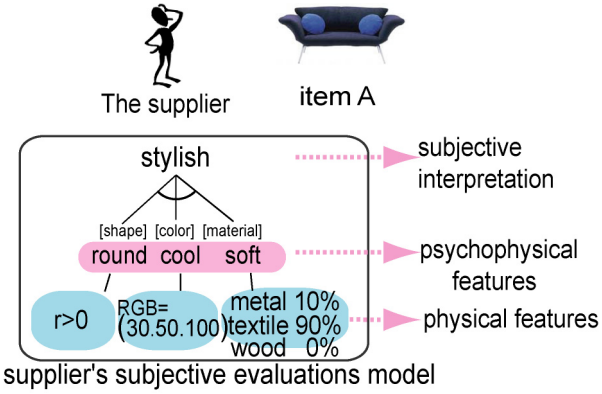


Fig.3 Subjective evaluations model for item A

For instance Fig.3, supplier's subjective interpretation for item A, "stylish", is assigned as S(i). Psychophysical features are assigned as ps(i)=round, pc(i)=cool, pt(i)=soft and physical features as r(i)=30, g(i)=50, b(i)= 100, metal=10, textile=90, wood=0, r=1.

Between different item categories, we cannot always expect that physical attributes are same style. Therefore we construct the model per category. Physical and psychophysical features are not suitable for directory comparing items. In this case we use subjective interpretations as a key to compare items between different categories.

In the same category we refer to physical features as a key to compare objects. We assume if multiple objects include same physical features, a person's interpretations of these objects are same.

On these ideas, we can build the subjective evaluations process model. It can show each person's

evaluation process based on the physical features of objects.

2.3 An algorism of constructing subjective evaluations model

In this section, we describe how we construct the subjective evaluations model. For constructing each person's subjective evaluations model, the system gets the data through following interactions.

(1) Selecting subjective interpretation on item (Fig.4)

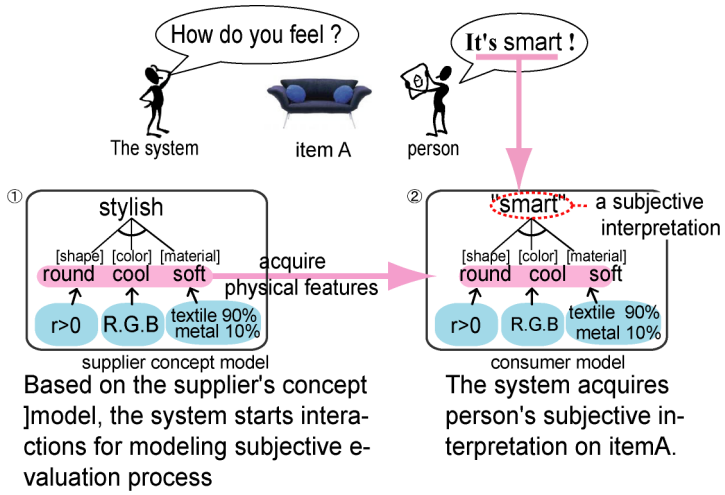


Fig.4 Acquisition process of subjective interpretations

The system asks a query to a person to get his subjective interpretation. The person has only to choose an impression word as his interpretation from the list of subjective interpretations listed in the item web page. For instance, when he chooses "smart" as his interpretation, "smart" is assigned as S(i).

(2) Selecting physical features on items (Fig.5)

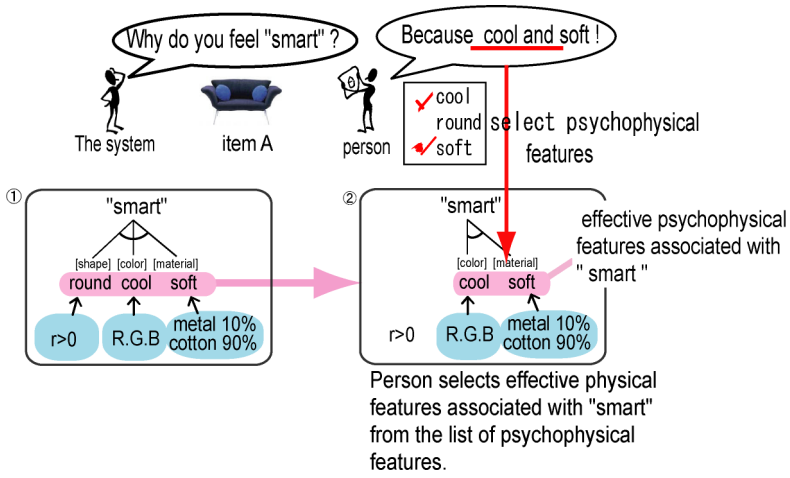


Fig.5 Selecting psychophysical features as a reason of interpreting subjective evaluations

The system also asks a query to the person to get the major reasons of the subjective interpretation as a combination of the physical features. The person has only to choose some of the appropriate reasons from the list of physical features listed in the item web page.

For instance, when he chooses "cool and soft" as his reasoning, a link among cool, soft and smart is remained.

(3) The check of relationships between subjective interpretations and physical features on items (Fig.6)

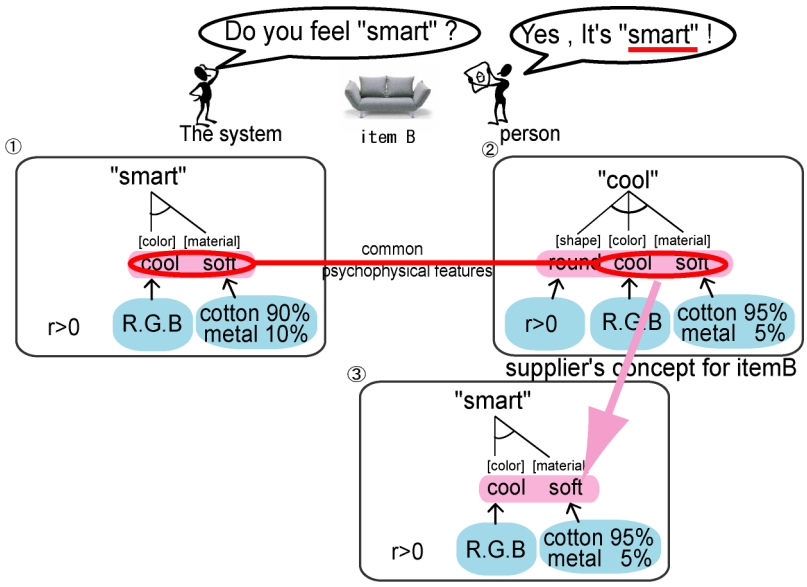


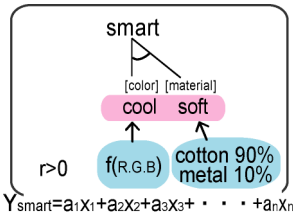
Fig.6 The check of relationships between a subjective interpretations and psychophysical features

The system modeled the person's subjective criteria on items for evaluating them. For instance, the system may assume that "the person evaluated the item as smart since they are cool as well as soft". Thus, the system finds a relationship between subjective interpretations and physical features.

In order to examine the assumption between subjective interpretations and physical features on objects, the agent asks a query. For instance, the agent retrieves some items that include the same physical features as item A. The agent asks "Do you feel new item to be smart?" When the person answers that "It's smart", the agent can be sure that the he felt the item smart because physical features are "cool and soft".

Doing the interactions mentioned above, the system can get the person's subjective evaluations and construct the relationships between each person's subjective interpretation and physical features of objects as "the subjectiv e evaluations model".

2.4Analysis rules of subjective evaluations model



x_1:R, x_2:G, x_3:B, x_4:material1, $\cdots x_n$:Shape

Fig.7 Analyzed subjective evaluations model

By doing above interactions, we can get data on subjective evaluations of each person. We assume correlation between subjective interpretations and physical features. Therefore, by using canonical correlation analysis (CCA), We assume we find correlation between them.

We do CCA to subjective interpretations and physical futures. By this, we can get one equation par one subjective interpretation (Fig.7). Substituting physical features of items, this equation give adaptation ratio on one sub-

jective interpretation of each item.

3. Estimation algorism of the subjective evaluation process

We model each person's subjective evaluation process on objects. In this section we propose communication support algorism with the taxonomy of subjective evaluations.

3.1 Estimation algorism with the taxonomy of subjective evaluations

To clear up above difficulties which arise from individual differences of subjective interpretations among designers and clients, we do following estimation algorism with the taxonomy of subjective evaluations.

① To understand the client's request, the designer refer to client's taxonomy of subjective evaluations with a subjective interpretation as a key. Designers can get physical features relating to subjective interpretations for client. By this, designers can estimate what the client want.

② When designers need to exchange their ideas which features relates "stylish", they refer each designer's taxonomy of subjective evaluations. By comparing physical features, designers understand imaging features of other designers intuitively.

③ In order to search reference materials easily on the Internet, we propose support system of collecting materials. Reference materials on the Internet have physical features. On the Internet materials have some physical features chosen by suppliers. When a designer searches stylish materials, the system refers designer's taxonomy and assumes dominant factor of interpreting as "stylish". The system retrieves estimated dominant factor as a key.

Therefore the designers can search materials efficiently and appropriately among great deal of daters. There are two types estimation algorithm whether categories of objects are same or not. We describe the algorism in section 3.2 and 3.3.

3.2 Estimation algorithm of subjective evaluation process in the same item category (Fig8)

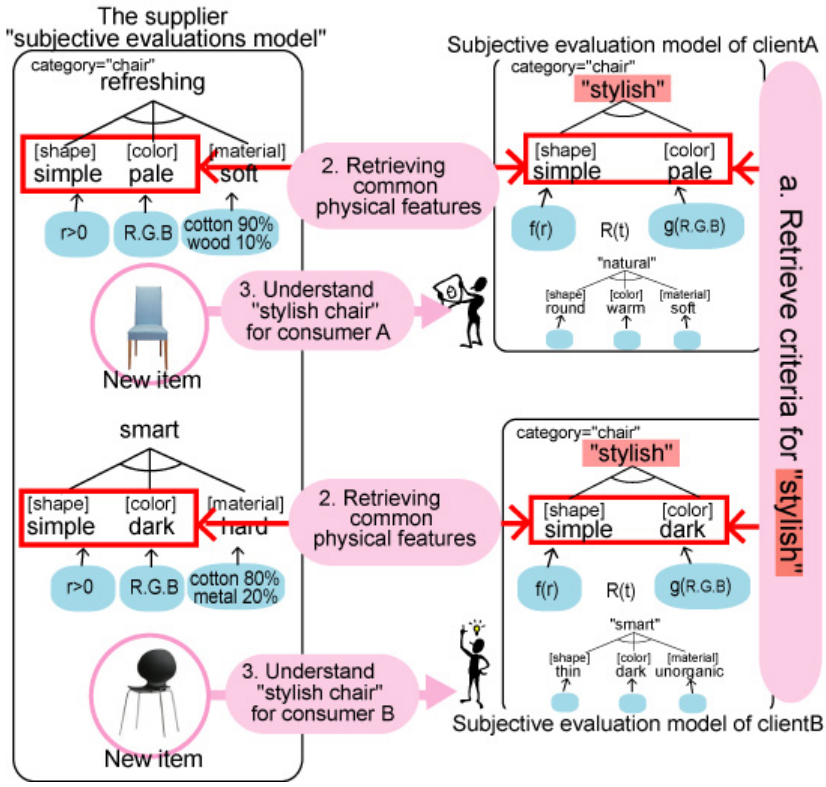


Fig.8 Estimating subjective evaluation process in the same item category

When a client requests “cool chair”, a designer refers client’s subjective evaluation model.

Retrieving the taxonomy for “stylish”, a designer can estimate below. For a client A, a table is “stylish” if it has “simple shape ”and “pale color”, while for a client B it is so if it has “simple shape” and “dark color”.

3.3 Estimation algorism for subjective evaluation process between different categories (Fig.9)

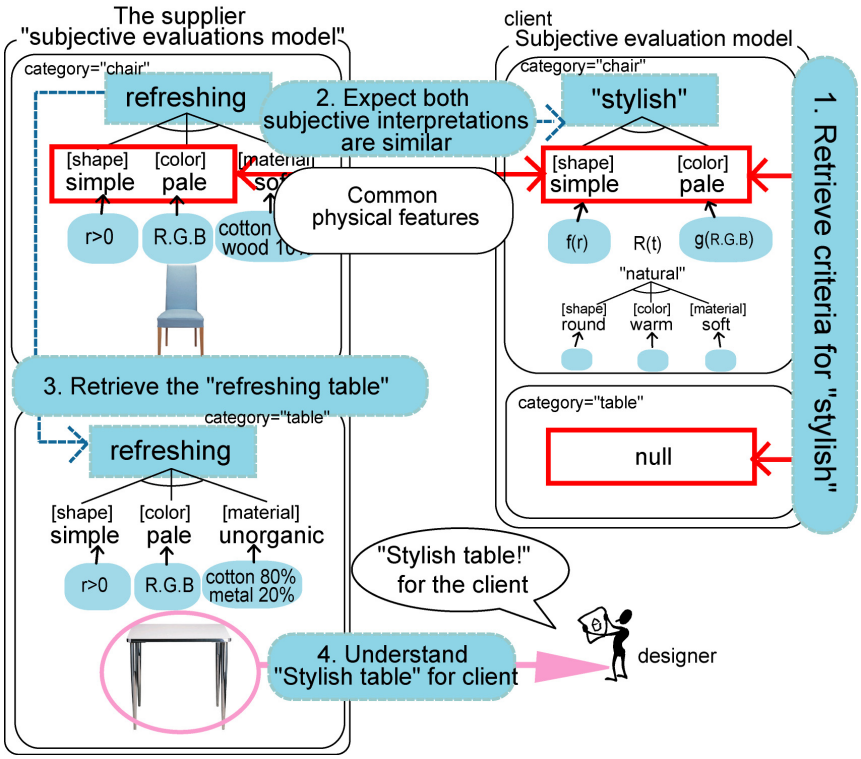


Fig.9 Estimating subjective evaluation process in the different item categories

If a client did not give any supervision to specific category items, the system lacks a portion of his subjective evaluation model. We can extend our estimation algorithms to partially organized subjective evaluation model using the correspondence relationship between a subjective evaluation of the client and that of designer. We may expect that the same words in the evaluation model are consistent for all through the categories within the same person.

Referring such correspondence, we can retrieve suitable items for recommendation candidates even from unfamiliar categories where the client builds the few evaluation models.

Let us show the process of estimation using subjective interpretations in the different item categories (Fig.9).

1) If a preferred category has no evaluation model for some specific impression word, e.g., “stylish table”, designer searches for another category which has the same impression word in the client’s model, e.g., “stylish chair” (since the meaning of the word “stylish" is consistent within his evaluation models).

2) The designer examines the corresponding subjective interpretation in supplier's evaluation model which is correlated with the same set of physical features, e.g., “refreshing chair” with “simple shape” and “pale color”.

3) The designer searches for specified category which has the same subjective interpretation in the supplier's model, e.g., “refreshing table for the supplier”.

4) Then the designer understands a meaning of “refreshing table” for the supplier includes that of “stylish table” for the client.

Retrieving items with “simple shape” and “pale color” as a retrieval key, the designer may get plural results, e.g., “refreshing table” and “calm table”. In this case we consider logical sum of “refreshing” and “calm” for designer includes “stylish “for the client.

signer includes “stylish “for the client.

5.Experiment and evaluation

In this chapter, we have examined the accuracy and availability of each consumer’s subjective evaluations process models built by our algorithms.

In our experiment we built up subjective evaluations model for each of the thirteen people, males and females in 20’s. We have examined our idea on interior items, e.g. sofas, chairs, lights and tables, sixty items for each. We have defined the slots and their values of physical features and psychophysical features for each item as a supplier.

We have also assigned subjective interpretations to each item. For describing subjective interpretations, we selected a set of popular impression words from Kobayashi’s work [4][5]. We also selected a set of popular objective words for describing colors, shapes and materials of the items. People did the above interactions in order to build up the subjective evaluations process models.

In our experiment, each person interacted with our sys-tem showing his subjective interpretations for items as learning examples together with reasons in order to build up his subjective evaluations model. In our experiment, we asked the consumer to give the degree of his interpretation as well. We have examined the three points below in order to verify the accuracy and availability of subjective evaluations process model.

(i) Differences of subjective evaluations process for each person

(ii) Correlation among each layer of a subjective evaluations process model

(iii) Accuracy of subjective evaluations process model by statistical learning

5.1 Differences of subjective evaluation process

We have examined data derived from interactions. From the data, even for the same chair, person’s subjective interpretations are “pop”, “casual”, “pretty” by 5,3,2 people, respectively (Fig.10). We found individual differnces among them. On the other items, we got similarly results.

Therefore we need to build a subjective evaluations model for each person.

subjective interpritations	head-count
pop	5
casual	3
pretty	2
stylish	1
elegant	1
smart	1

Fig.10 Individual differences of a subjective interpretations

5.2 Correlation among each layer of a subjective evaluation model

We tried to construct the subjective evaluations model by using canonical correlation analysis (CCA). We assume there is correlation among physical features, psychophysical features and subjective interpretations. We regard them as canonical variables. We have applied CCA to derive a linear mapping function which represents the relationships among them.

By giving some physical features to the mapping function, we can estimate suitable subjective interpretation.

Thus, we can refer this mapping function as a subjective evaluations model. For instance, there is correlation among “casual and cool”, “bright color, pale color and simple shape ” and physical features. (Fig.12).

5.3 Accuracy of simulating subjective evaluation process

By using the analysis rule in section 3.4, we constructed a specific person's model. We measured precision ratio and recall ratio on subjective evaluations model. Precision ratio is measured with top the best twenty items. Recall ratio is measured with the best thirty items. Table.3 shows the precision ratio and recall ratio.

As shown in Table.3, since the total numbers of suitable items for each retrieve are approximately ninety, our sys-tem achieved good precision ratio and recall ratio.

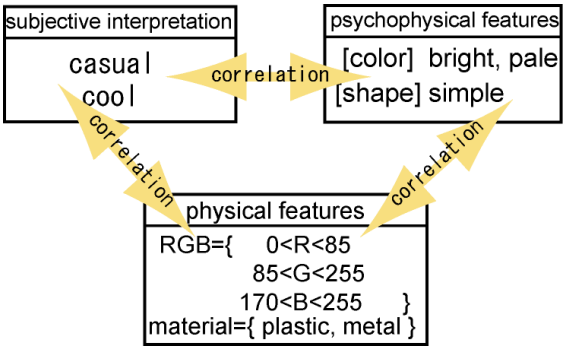


Fig.11 Correlation between subjective interpretations and features

Table.3 Precision ratio and Recall ratio of subjective evaluations model

subjective interpretations	precision ratio	Recall ratio
casual	95%	30.6%
refreshing	90%	29.6%
cool	70%	32.5%

In addition, we examined new chair which are excluded in the learning examples. We have predicted the suitableness of each new item to the persons on his specific subjective evaluations model. Our system's predictions have matched with the examinees evaluation in 80% of trials.

Thus, we can expect that the person's subjective evaluations can be modeled by statistical learning. The more iterated supervision makes the more accurate estimation for simulating the person's subjective evaluations. We have also examined the average accuracy of statistical learning for all consumers by canonical correlation analysis. We get the similar results with the experiment above.
Thus our algorithm provides suitable information service.

5 Conclusions

(1) We modeled each person's evaluation process on the specific features of the items with impression words by statistical analysis and defined it as "the taxonomy of subjective evaluations". Based on each person's subjective evaluation model, designers can understand which features client want.

(2) Utilizing subjective evaluation model, we could estimate person's evaluation process on the specific features of the materials. The designer can communicate each other's image precisely.

(3) We proposed support system of collecting materials to search reference materials easily on the Internet. By the system, designers can get reference materials which they want easily.

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