◆ **Research Paper**

Similarity Comparison between Real Product and Graphic Image through Human Sensibility Evaluation

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Abstract

This paper deals with the difference between human sensibility collected from real product and that through graphic image(photographs and graphic images on CRT monitor) on the same automotive interior. The objective of this study is to verify the possibility that, if there are some restrictions in collecting human sensibility through real product directly, they can be overcome by using graphic image instead, making it easy to collect and analyze human sensibility so as to reflect consumers sensibility in the design of automotive interior, and also comparing the result between real product and graphic image on CRT monitor in order to confirm the potentiality of developing a remote human sensibility survey system through Internet. Therefore two experiments were conducted and the object for experiments was limited to automotive interior.

The analysis results showed that there were significant differences between graphic image and real product in case of total interior and IPC(Instrument Panel Center) and no significant difference in case of display panel. Also, there were no significant difference when the subject group was female(housewife). To conclude, we can infer, in case of display panel, that it is possible to replace real product with graphic image to extract similar results on human sensibility and to collect human sensibility through Internet.

1. Introduction

If a specific product is more preferred or purchased than others, it can be assumed that customers purchasing the product share similar sensibility with one another on the product. Therefore, it is important to collect and analyze consumers sensibility for the purpose of catching the universal sensibility on target objects and applying it in the course of product development and environment improvement[13]. To differentiate some products from others which have the similar performance and quality level is mainly influenced by the design which appears on the outer surface, and this design includes interface related with usability.

The design and the interface on products are closely related to humans feeling, and the users satisfaction on these is personal, flexible, and dependent on the complicated sensibility which is difficult to express clearly. Therefore, it is impossible to develop such products as satisfy consumers without any understanding and research on humans feeling and sensibility[10]. Especially, it can be said that automotive is a typical example of human-machine interface which can be found easily

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around our lives, therefore consumers sensibility must be collected and analyzed first, then it must be applied in designing automotive interfaces. Namely, not only functional factors such as broad visual field for supplying pleasant driving environments, easy and convenient manipulation, and simple and effective information retrieval, but also human sensibility ergonomics factors such as drivers safety, requirements for sensibility, and usability for various components must be considered, when automotive interfaces are designed[15].

Therefore, in this paper, two experiments were conducted to make it easy to collect and analyze consumers sensibility so as to reflect it on designing automotive interior by analyzing the difference between real product and graphic image(photographs) on the same automotive interior, also to make it useful to collect and analyze consumers sensibility by confirming the possibility of developing a remote human sensibility survey system through analyzing the relationship between real product and graphic image on CRT monitor.

In the next section, we describe the background for this research. In section 3, we explain the similar researches. In section 4, we depict the experiment methods for consumers sensibility desires survey and the analysis about results of these experiments. Finally, section 5 shows our conclusion with the plans for further work.

2. Research Background

Questionnaire methods are widely used for surveying and analyzing consumers sensibility desires. Thus questionnaire methods are very important, and researches related these have been progressed actively[16]. On the other hand, the objects for questionnaire can act as an important factor in collecting human sensibility, but so far researches related these are insufficient.

If the size of objects is proper, can be contacted easily, and can be observed directly, and so on, it is easy to collect human sensibility using the questionnaire. But, to the contrary, it is very difficult to expect good results no matter how the questionnaire methods may be excellent, in case human sensibility is collected without observing objects directly. Therefore, to solve the problem above, consumers sensibility can be collected and analyzed through graphic image instead of real product as an one of indirect methods, but it is difficult to find similar studies related this.

Hence, in this paper, the differences(relationships) according to the kinds of objects(real product, photographs, and graphic images on CRT monitor, respectively) were analyzed in surveying consumers sensibility desires.

And on the basis of these results, the possibility of replacing real product with graphic image was evaluated. Furthermore, the potentiality of developing a remote human sensibility survey system through Internet was appreciated. The experiment for surveying consumers sensibility desires was implemented on automotive interior in that automotives are prevailed all over the nation and drivers are very sensitive to safety, interface, and sensibility.

3. Previous Researches

Examples that human sensibility ergonomics was applied in designing automotive interior run as follows: Tanoue et al.(1997) studied the design of total automotive interior[2], Jindo and Hirasago(1997) studied the speedometer of combination meter among the automotive interior and showed that the most preferred number of meter cluster is four or six from a design point of view[17]. Jeong et al.(1997) presented the mathematical model to develop a procedure that transform consumers feeling or images of a product into the products design elements[7], Kang et al.(1998) studied the design method on automotive IP(Instrument Panel) considering drivers cognitive characteristics[15].

Also, examples that human factors was applied to automotive interior design are as follows: Firstly, McGrath(1974, 1976) studied the position of general control apparatus of automotive and the evaluation of their performance[8][9], Green(1988) and Wickens(1987) studied the ergonomic design of display panel and the principles of cognitive interface design on display panel[3][14], Boles and Wickens(1987) studied the display types of analog, digital, and verbal type and showed the reaction time was the fastest at analog display type, also suggested the guideline for designing display panel[4], Kee et al.(1997) studied the design method for improving readability of display panel[5], Kim(1998) studied the ergonomic design method of automotive IP(Instrument Panel) considering drivers frequency-importance and performance[12], Also, Kee(1998) studied the color design of combination meter in passenger car for improving readability[6].

As mentioned above, there are a lot of researches related the design of automotive interior by applying human sensibility ergonomics and human factors approaches, but it is difficult to find the similar studies like comparing the similarity(difference) between real product and graphic image of the automotive interior in performing human sensibility evaluation.
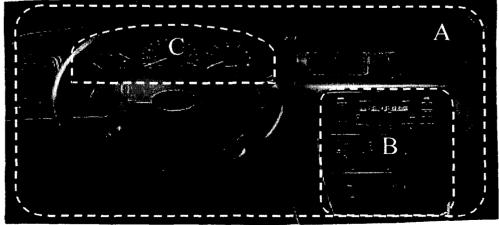
4. Experimental Design

4.1. Experiment I: Comparison between Real Product and Photograph

4.1.1. Experiment Overview

In this section, experiment was implemented to support the universal validity on the following two assumptions. First, time, spatial, and economical constraints can be overcome considerably, if there is no significant difference between real product and photograph on the basis of the results after collecting and analyzing the consumers sensibility through questionnaire method on the automotive interior. Second, exact and effective results can be achieved by adopting sensibility adjectives that have no significant difference, in case suitable sensibility adjectives are selected for the next experiment(questionnaire).

The object for consumers sensibility desires survey was limited to automotive interior, and it was divided into three sub-areas(parts) such as total interior(A), IPC(B), display panel(C), respectively. <Figure 1> shows the divided three sub-areas. And the C-automotive made by the T-motors company in Japan was selected as an object product.

Total of 54 subjects with three sub-groups(21 company employees, 24 self-sustainers, and 9 housewives, respectively)were selected and age was ranged from 25 to 39.

<Figure 1> Detailed Sub-Areas of the Automotive Interior used for the Experiment

The reason the range was confined is because they can be considered as they have abilities in possessing automotive and are sensitive to automotive interior.

4.1.2. Questionnaire Environment

In the consumers sensibility desires investigation using human sensibility ergonomics, if object products and subjects are selected, the next stage is to collect adjectives being used in the questionnaire for surveying consumers sensibility desires. Generally, the adjectives which will be used in questionnaire are collected through FGI(Focused Group Interview) data, A/S data, consumers card, free-associate method about products, and previous studies on automotive interior using human sensibility ergonomics, and so on. Therefore, The final 56 adjectives were selected on the basis of upper data. These selected adjectives were focused on the consumers self-expressed adjectives on the automotive interior. <Table 1> shows the finally selected 56 adjectives for the questionnaire.

And in case of questionnaires method, the questionnaire for surveying consumers sensibility desires are usually classified with two cases, one is the questionnaire for sensibility desire survey using Semantic Differential method(SD method) by Osgood(1952), and the other is the preference questionnaire using Analytic Hierarchy Process(AHP) by Saaty(1985). In this paper, the questionnaire using SD method with five-point rating scales was prepared. And consumers were allowed to check their degrees of feeling about experimental objects on the list of questionnaire after observing them.

4.1.3. Experiment Procedure

Subjects were fully instructed how to experiment before implementing questionnaire. First, they implemented questionnaire through photographs of each three parts(total interior, IPC, display panel). And they had about five minutes recess with tea and cookies at resting place after having finished the first questionnaire. Then they moved to the second place, and implemented questionnaire through real product of the same parts as before. One assistant monitored the procedure to make the experimental process more exact and smooth at each place. It took about 70~90minutes per one subject to finish both questionnaires.

4.1.4. Analysis and Results

The paired comparison is usually used to compare and test the difference of two experiments, when the results of the two experiments are compared. The paired comparison is a method that compare the difference after observing the treatment effects between two pairs by applying

<Table 1> Final 56 Adjectives used for the Questionnaire

No.	Adjective	No.	Adjective	No.	Adjective	No.	Adjective
1	Cute	15	Convenient	29	Sharp	43	Active
2	Narrow	16	Comfortable	30	Stolid	44	Intense
3	High-class	17	Stylish	31	Grace	45	Simple
4	Clean	18	Balanced	32	Flexible	46	Snug
5	Strong	19	Soft	33	Brisk	47	New
6	Grand	20	Tidy	34	Pleasant	48	Hard
7	Beautiful	21	Fresh	35	Modern	49	Curved
8	Neat	22	Messy	36	Massive	50	Detailed
9	Pretty	23	Wide	37	Urbane	51	Familiar
10	Cozy	24	Roomy	38	Functional	52	Complex
11	Refined	25	Grave	39	Individual	53	Rough
12	Smooth	26	Rustic	40	Charming	54	Intellectual
13	Dull	27	Practical	41	Dignified	55	Fascinating
14	Attractive	28	Sporty	42	Splendid	56	Concise

treatment 1 to one experimental unit randomly and treatment 2 to another experimental unit in the homogeneous experimental unit pairs(or being considered as homogeneous pairs). And the fittest test method for this condition is t-test. The t-test is usually used when there is no information about population[1].

4.1.4.1. Analysis by Adjective

Firstly, The difference between real product and graphic image(photograph) was analyzed by adjectives according to statistical methods above. The results of significance level at 0.1 and 0.05 were illustrated at a. and b. in <Table 2>.

Also, the mark '*' in <Table 2> means that there is no difference among sensibility adjectives acquired from between real product and photograph. From the results of analysis by adjectives, the following conclusions can be draw:

● Total Interior : can be interpreted that there is significant difference between real product and photograph.

● IPC : can be also understood there is significant difference between graphic image and real product.

● Display Panel : Contrary to previous results, it can be considered as there is no significant difference between real product and photograph.

Therefore, total interior and IPC which require detailed cubic image have difference in the result of questionnaire both of photograph and real product. And display panel whose real product itself looks like a 2-dimension(plane) can be inferred to have no significant difference statistically.

From the total results of analysis by adjectives, in case of display panel, it showed the possibility that we can extract similar results from graphic image without using real product when we make up questionnaire for the purpose of collecting consumers sensibility.

4.1.4.2. Analysis by Gender

In case of analysis by gender, <Table 3> shows the specific results. The A , B, and C in <Table 3> means total interior, IPC, and display panel, respectively. And it means that the difference between real product and photograph decreases as the value of Prob>|T| increases.

Therefore, it was analyzed that male has more significant difference than female. This result can be interpreted as follows : female who are more delicate and have a vigorous imagination feel

<Table 2> Results of Analysis by Adjective

a. Significance level at 0.1 (α=0.1)

No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	No. of same adjectives
A																																																									6
B																																																									10
C																																																									26

※A: Total Interior, B: IPC, C: Display Panel

b. Significance level at 0.05 (α=0.05)

No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	No. of same adjectives
A																																																									6
B																																																									11
C																																																									29

※A: Total Interior, B: IPC, C: Display Panel

almost similarly to the image of real product by interpreting analogically the image of the photograph, but in case of male, it can be analyzed that they feel a lot differences between real product and photograph because of accepting the visual stimuli without extra analogical interpretation. Also, female consumed more time in finishing questionnaire than male, this can be analyzed that female concentrate more their attention on interpreting images than male.

4.1.4.3. Analysis by Occupation

Comparing the results of questionnaire about between real product and photograph by occupations, the specific results are shown at <Table 4>. The A ,B, and C in <Table 4> means total interior, IPC, and display panel, respectively. From the <Table 4>, the difference between photograph and real product was appeared least in case of the housewives who have the highest average value of Prob>|T|, next follows by company employees, and self-sustainers. This shows similar tendency with the results by gender.

4.2. Experiment II: Comparison between Real Product and Image on CRT Monitor

4.2.1. Experiment Overview

Based on the first experiment, another experiment using graphic image on CRT monitor was implemented. It is also basic and fundamental experiment for developing a remote human sensibility survey system through Internet. Therefore, if there is no difference between graphic image on CRT monitor and real product, various and sufficient data can be collected and analyzed effectively from anywhere and anytime through Internet. The object for this experiment was limited to automotive interior, and it was divided into two parts such as IPC and display panel. In this case total interior was excluded because it was considered to have almost similar effects with IPC from the first experiment. L-automotive made by D-motors company in S. Korea was selected as an object product.

Total of 20 subjects(male graduate students) were selected and age was ranged from 25 to 31, and they were divided into two groups(10 subjects each group) to evaluate the influence caused by learning effects. One group made a experiment on the graphic image on CRT monitor first and then did on real product, and the other group conducted it contrariwise at the same time. The monitor

<Table 3> Results of Analysis by Gender

Division	Male				Female			
Variable	Mean	Std Dev	T	Prob>|T|	Mean	Std Dev	T	Prob>|T|
A	-35.04	25.85	0.0001	-13.44	-13.44	32.8	-1.23	0.2538
B	-20.44	32.38	-4.24	0.0001	-20.67	20.82	-2.98	0.0177
C	-14.42	29.96	-3.23	0.0023	-0.22	23.09	-0.03	0.9777

※A: Total Interior, B: IPC, C: Display Panel

<Table 4> Results of Analysis by Occupation

Division	Variable	Mean	Std Dev	T	Prob>|T|
Company employees	A	-35.43	28.46	-5.71	0.0001
	B	-17.29	28.79	-2.75	0.0123
	C	-15.81	33.79	-2.14	0.0445
Self-sustainers	A	-34.71	23.96	-7.1	0.0001
	B	-23.21	35.96	-3.2	0.0040
	C	-13.21	26.84	-2.4	0.0243
Housewives	A	-13.44	32.8	-1.23	0.2538
	B	-20.67	20.82	-2.98	0.0177
	C	-0.22	23.09	-0.03	0.9777

※A: Total Interior, B: IPC, C: Display Panel

used for the experiment was a Samsung SyncMaster 17GLi model set with 1152×864 resolution and 16 bits colors.

4.2.2. Experiment Procedure

The questionnaire environment used for this experiment is the same as the first experiment conditions. Subjects were instructed how to experiment enough, before implementing questionnaire. And they had more than one hours' recess with tea and cookies at resting place after having finished the first questionnaire. Then they moved to the other place, and each group conducted a questionnaire through real product or graphic image on CRT monitor about each two parts(IPC and display panel) of automotive interior at pertinent places. One assistant monitored the procedure to make the experimental process more exact and smooth at each place. It took about 80-100minutes(including one hour' recess) per one subject to finish both questionnaires.

4.2.3. Analysis and Results

First, the frequency analysis was conducted on the answers with errors. In this case the error within |1| is ignored because sensibility is affected by various environments and variables and the five-point rating scale has a little bit uncertainty. At the result of the frequency analysis, display panel got 102 answers and IPC did 132 answers in total 1120 answers, and this means display panel has better similarity between real product and graphic image on CRT monitor compared with IPC. <table 5> shows display panel has error within 10%.

Secondly, wilcoxon sign test was conducted. This is usually applied when two subordinate samples are used to inquire whether there is difference or not between effects of two experimental conditions. At <table 6>, it shows display panel has similarity with almost 90% reliability.

And finally t-test was fulfilled to analyze the similarity between two objects, <table 7> is showing display panel has similarity with 84% between real product and graphic image on CRT monitor. From the results of upper analyses, following conclusions can be draw:

● IPC : can be considered there is significant difference between graphic image on CRT monitor and real product.

● Display Panel : can be considered there is no significant difference between graphic image on CRT monitor and real product.

<Table 5> Result of Frequency Analysis(greater than |1|)

Division	>+1	<-1	Total
IPC	63	69	132
Display Panel	56	46	102

<Table 6> Results of Wilcoxon sign test

Division	+	−	SUM	z-value
IPC	320	288	608	1.34
Display Panel	330	291	621	1.61

<Table 7> Results of Similarity Analysis

Division	IPC			Display Panel		
	Mean	Std Dev	P>|T|	Mean	Std Dev	P>|T|
Real	2.866	0.970	0.806	3.070	1.006	0.160
Image	2.841	0.976		3.029	1.044	

Results of experiment II also showed that IPC which requires detailed cubic image has difference between graphic image on CRT monitor and real product. But display panel whose real product itself looks like a 2-dimension(plane) can be considered to have no significant difference statistically.

From the overall results of the study, in case of display panel, it showed the possibility that similar results from the graphic image on CRT monitor can be extracted instead of real product when human sensibility is collected and analyzed using a remote human sensibility survey system through Internet.

5. Conclusion and Further Works

To synthesize all the results of analyses, it can be inferred that consumers sensibility desires can be surveyed and collected effectively with using graphic image instead of real product, if the 2-dimensional image(graphic image) and 3-dimensional image(real product) are presented similarly to subjects(consumers). Also, in case of display panel whose the real product itself looks like almost 2-dimension, the similar results from graphic image can be extracted because there is no significant difference between graphic image and real product.

But, in case of IPC which has a lot of design factors, it is desirable to survey consumers sensibility desires using real product because there are a lot of differences between two objects if graphic image has not loud colors and intense design patterns. And when the subjects are female and housewives, there was no significant difference between graphic image and real product compared with male. Therefore, it can be said that it becomes possible to use graphic image for female.

Hereafter, at the basis of these experiments, more exact and objective relationship must be extracted after analyzing the difference between graphic image and real product through a lot of various experimental objects and conditions. Furthermore, it is requested to develop compensatory coefficient that can make the same effects as real product by applying some weighted values to graphic image.

References

[1] C. L. Kim, Statistical Box called as SAS, DataResearch, p.221, 1996.

[2] C. Tanoue, K. Ishizaka, M. Nagamachi, Kansei Engineering: A Study on perception of vehicle interior Image, International Journal of Industrial Ergonomics, Vol. 19, p115-128, 1997.

[3] C. Wickens, Ergonomic-driven displays: A set of principles of the perceptual-cognitive interface, Proceedings of the Fourth Mid-Central Ergonomics/Human Factors Conference. Champaign, IL: University of Illinois, 1987.

[4] D. G. Boles, C. D. Wickens, Display formatting in information integration and non integration tasks, Human Factors, Vol. 29, No. 4, p.395-406, 1987.

[5] D. H. Kee, H. S. Kim, S. J. Lee, S. W. Jang, S. H. Shin, and E. S. Jung, Design Method of Automotive Display panel for improving Readability, Proceeding of the 97 Autumnal Conference of Ergonomics Society of Korea , p109-113, 1997.

[6] D. H. Kee, Color Design of Combination Meter in Passenger Car for Improving Readability, IE Interfaces Industrial Engineering, Vol. 11, No. 2, p.139-147, 1998.

[7] E. S. Jung, Y. H. Jun, D. H Kee, M. H. Yoon, J. H. Choi, J. D. Park, S. J. Park, and D. S. Kang, A Study on Human Sensibility Ergonomics Approach Method for Automotive Interior Design, Proceeding of the 97 Spring Conference of Industrial Engineering Society of Korea, p124-127, 1997.

[8] J. J. McGrath, SAE Study of Vehicle Controls Location, Santa Barbara, CA, Anacapa Sciences,

Inc., p182-191, 1974.

[9] J. J. McGrath, Driver Expectancy and Performance in Locating Automotive Controls, SAE SP-407, Warrendale, PA, SAE, 1976.

[10] K. H. Lee, Sensibility Ergonomics in Social and Industrial Environment, Korean Journal of The Science of Emotion & Sensibility, Vol. 1, No. 1, p13-17, 1998.

[11] K. Nakada, Kansei Engineering Research on the Design of Construction Machinery, International Journal of Industrial Ergonomics, Vol. 19, p129-146, 1997.

[12] K. P. Kim, The Ergonomic Design Method of Vehicle Instrument Panel Considering Drivers Frequency-Importance and Performance, Master's thesis in Ajou Univ., 1997.

[13] M. C. Park, S. G. Shin, K. H. Han, and S. M. Whang, Measuring meaning of Korean adjectives and colors, Korean Journal of The Science of Emotion & Sensibility, Vol. 1,No.2, p1-11, 1998.

[14] P. Green, Ergonomics of Automotive Displays, SPIE/ESD International Symposium on Optical Engineering and Industrial Sensing for Advanced Manufacturing Technologies, Dearborn, MI, 1988.

[15] S. M. Kang, S. Y. Paik, and P. Park, A Study of Automotive IP Design based on the Drivers Cognitive Characteristics, Korean Journal of The Science of Emotion & Sensibility, Vol. 1,No.2, p81-91, 1998.

[16] S. Y. Paik, P. Park, A Study of the Effective Method for Collecting and Analyzing Human Sensibility Applied Fuzzy Set Theory, Journal of Ergonomics Society of Korea, Vol.17, No. 1, p.47-54, 1998.

[17] T. Jindo, K. Hirasago, Application studies to car interior of Kansei engineering, International Journal of Industrial Ergonomics, Vol. 19, p105-114, 1997.

[18] W. W. Wierwille, Visual and manual demands of in-car controls and displays, Automotive Ergonomics, Taylor & Francis, London, p301-302, 1993.