# EFFECTS OF COLOR DECORATION ON USERS' FEELING AND OPERATIONAL PERFORMANCE ON TOUCH PANEL DEVICE

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## ABSTRACT

A novel representation model of relationship between interface color design and operation is proposed. User performance and screen impression data are used for creating the model. To evaluated users' performance, experiments have been conducted with a simple application of arithmetical calculation in which a touch panel is used. Furthermore, questionnaire approach has been used to assess the screen impressions. Finally, the proposed model has been created via analysis of Structural Equation Modeling (SEM). By using the proposed model, we can verify the effects of touch panel coloration on operator's feeling, and clarify how the feelings affect the operations.

## INTRODUCTION

Touch screen technology is widely used for ATMs (Automated Teller Machines), ticket vending machines, interactive kiosks and so forth. Many personal devices such as smart phones, tablets PC, also use this technology. These devices are used in several fields e.g., health care [1]. Touch panel interfaces have some advantages, i.e., easy use, flexible design, and better performance. Therefore touch screens have become prevalent, and user-friendly touch panel interfaces are required.

Color information is one of the most influential factors which affect users' perception, physiological reaction and emotion reactions [2]. There are many studies which inquired into relationship between interface design and operation. However, user's perception for the interface is difference depend on the individual. It can be assumed that the difference might be caused from the user's feeling. Thus, this research aims to clarify the causality between effects of coloration and users' performance by considering through users' feeling perspective. Correlation between colorations and users' emotion is investigated as well as the relationship between users' emotion and operational performance is also verified and a representative model is proposed.

## LITERATURE REVIEWS AND RESEARCH MODEL

Relationship between interface design and effects on users' behavior has been being discussing. Cyr et al. [3] found that website color appeal is a determining factor for website trust and satisfaction. Bonnardel et al. [4] sought the effect of website colors on users' cognitive processes and the impact of the color on the users' revisit rate was found. The results show that the user spent for longer time on web sites which have warm colors than which have cool colors. Similarly, Sakamoto et al. [5] studied relationship between impressions by looking the color designing of touch panel interfaces design and the operations, and concluded that the colors which are cool-casual scheme (i.e. mild green and mild yellow) have positive effects on users' performance. Besides, they argued that the emotional of the operator are strongly related to accuracy of the operation.

In all of above mentioned interface studies, relationships between design and user's behaviors were investigated. This scheme can be represented as Figure 1 (A). However, cognition of design varies

from person to person and the relationships also may change depend on an individual. Thus, the authors have assumed another scheme represented in Fig. 1 (B): At first, an interface design is recognized by an operator, and he/she has some feelings about the design. Then, his/her operations are influenced by the feelings. In order to verify the validity of the scheme, a Structural Equation Model has been created and has been analyzed.
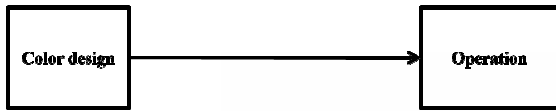


**Figure 1(A). Traditional model**
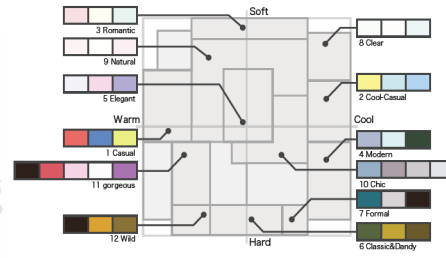


**Figure 1(B). Proposed model**



**Figure 2. The twelve color schemes which were used in this experiment**

## CREATING PROPOSED MODEL

In this section, the methodology of creating proposed model is described. In the data gathering process, two methods are adopted: experiments and questionnaires. The relationship between user's feeling and operation are investigated through experiment. The participants are asked to work arithmetical tests (single digit ones) and questionnaires in order to examine users' feelings on each screen. Afterward, experiments data and questionnaires data were prepared in order to create proposed model. The participants were males and females student in their twenties to thirties.

*Experimental equipment*

To get performance data, a simple computer application which quizzes addition questions was used. The bottom of screen of the application is decorated by a color schemes. This color scheme can be chosen from the color sets on the mix color image scale [6], which is an image map which transforms color schemata into impressions. This scale has two axes, "soft-hard" and "cool-warm." Twelve major descriptive phrases were selected as representative color schemes as shown in Figure 2. The background of the windows are colored by pale gray (N8), and the push panels' color are white (N9.5). The color of characters are dark gray (N3). The colors of these components were chosen by considering visibility of characters in the screen. The three alternatives of question are placed for each problem. An example of screen which used in this experiment is shown in Figure 3. In the experiments, the decoration color scheme was chosen from representative color schemata which mentioned before. Each screen was displayed with a different color scheme without changing other components.

*Tasks*

In the experiments, the participants tried single-digit mental arithmetic tests. The participants were requested to select one correct answer from three alternatives by touching one of three push buttons. If a participant does not touch any buttons within 1.5 seconds, the system moved on the next problem automatically. Thirty different problems were contained in each condition. The spending time and the accuracy rate were chosen as indicators to measure operational performances, and recorded.

*Evaluation of users' feeling*

Questionnaires have been conducted to obtain participants' feeling data for each screen. The questionnaire comprised fifth-teen sensations query: preference, understandability, visibility, enables concentration, volition, hesitation, number of tasks, familiarity, eye strain, readability, beauty, trouble, comfortableness, impressive, and safety. Rating linear measurement method was utilized for the scoring. A part of questionnaire is shown in Figure 4.
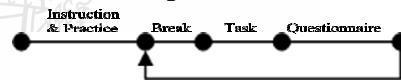
*Procedure*

The experiment ran on twelve different conditions as described above. In each condition, each participant requested to do calculation tasks and answer questionnaires. Figure 5 shows the timeline of the experiments. In the beginning, each participant got the instructions and trialed a training task. The training task was conducted on a screen that had no color decoration. Then, a participant has done tasks on the twelve screens. Afterward, the participants had to answer the questionnaire to evaluate their feeling with each decorated color scheme. A two minuets break was given between each condition. Then, the proposed model has been created by using Structural Equation Modeling (SEM). SEM is technique to express a complicated statistical model by a path diagram which expressed the causation between variables in an arrowed line clearly. As SEM model, each square represents variable as well as each arrow means causation between variables. A numerical value expresses a degree of effect [7]. SEM helped us to explore the causal relation between color schemes and user's emotions along with relationship between emotions and performances. A sample model was generated from analyzing data which gained from the experiments and the questionnaires. Figure 6 shows the generated model.
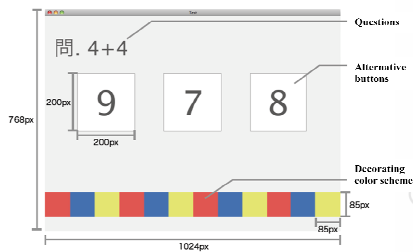
**Figure 3. An example of screen which used in this experiment**
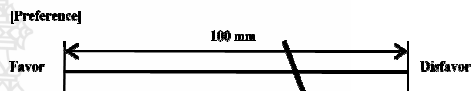


**Figure 4. An example of rating linear measurement method which used in the experiment**



**Figure 5. The procedures of the experiment**

## RESULTS AND DISCUSSION

In this section, the validity of proposed model was discussed. As shown in Fig. 6, there are fifth emotions which linked up the operations. Correlations between the results of the performances and the feeling on the screens are shown in Table 1. There are positive correlations between the both operations and the safety. There is also a positive correlation between the spending time and the hesitation. In addition, there is a positive correlation between the accuracy rate and the understandability. On the other hand, there are negative correlations between the performances and beauty. There is also a negative correlation between the spending time and the activeness. Hence, it can be said that the operational performances and the user's feeling have a causal association. Following, the results of evaluated feeling on each screen which used in experiments are shown in Table 2. We can notice that different colors decorating can reflect individual emotion.

## CONCLUSION

A new scheme which represents relation between design and operation has been proposed. With this model, we can understand the scheme in which how an operator feels about an interface design, and how the operation gets effects from the feelings. Experiments and questionnaires have been conducted to generate an example model. Then the model has been analyzed. The results of the analysis demonstrate that each color can reflect emotion differently. Besides, the safety has been found to have positive effect on operational performances. On the contrary, the beauty has negative effect on operational performances. This avenue of research further has potential to provide interface designers with enhance knowledge for how to design capital interface through the effective use of colors.

## ACKNOWLEADGEMENT
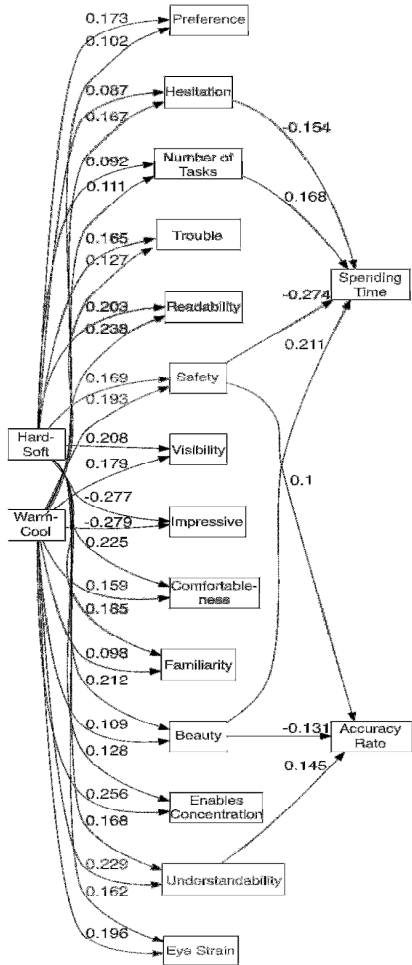
**Figure 6. The results diagram from Structural Equation Modeling**

| Sensation | Performance | |
|---|---|---|
| | **Spending time** | **Accuracy rate** |
| Preference | | |
| Beauty | 0.211 | -0.131 |
| Comfortableness | | |
| Familiarity | | |
| Visibility | | |
| Readability | | |
| Trouble | | |
| Hesitation | -0.154 | |
| Concentration | | |
| Understandability | | 0.145 |
| Number of tasks | 0.168 | |
| Impressive | | |
| Safety | -0.274 | 0.100 |
| Eye strain | | |

**Table 1. The causal relations between user's feeling and operation**

| | Preference | Beauty | Comfort ableness | Familiarity |
|---|---|---|---|---|
| **Warm-Cool** | 0.102 | 0.109 | 0.159 | 0.098 |
| **Soft-Hard** | 0.173 | 0.212 | 0.225 | 0.185 |
| | **Visibility** | **Readability** | **Trouble** | **Hesitation** |
| **Warm-Cool** | 0.179 | 0.238 | 0.127 | 0.167 |
| **Soft-Hard** | 0.208 | 0.203 | 0.165 | 0.087 |
| | **Concentration** | **Understandability** | | **Number of tasks** |
| **Warm-Cool** | 0.256 | 0.229 | | 0.111 |
| **Soft-Hard** | 0.128 | 0.168 | | 0.092 |
| | **Impressive** | **Safety** | | **Eye strain** |
| **Warm-Cool** | -0.279 | 0.193 | | 0.196 |
| **Soft-Hard** | -0.277 | 0.169 | | 0.162 |

**Table 2. The correlations between colorations and users' feeling**

## REFERENCES

1. Shervin, N., Dorrwachter, J., Bragdon, C.R., Shervin, D., Zurakowski, D., & Malchau, H. (2011). Comparison of paper and computer-based questionnaire modes for measuring health outcomes in patients undergoing total hip arthroplasty. *The journal of Bone & Joint Surgery, 93(3)*, 285-293. doi:10.2106/jbjs.i.01104

2. Valdez, P., & Mehrabian, A. (1994). Effects of color on emotions. *Journal of experimental Psychology 123 (4)*,394-409.

3. Cyr D., Head, M., &Larios, H. (2010). Colour appeal in website design within and across cultures: A multi-method evaluation. *International Journal of Human-Computer Studies 68*, 1-21.

4. Bonnardel, N., Piolat, A., & Bigot, L. L. (2011). The impact of colour on Website appeal and user's cognitive processes. *Display 32*, 69-80.

5. Sakamoto, M., Suto, H., &Sawai, M. (2010). Relation between impressions of a touch panels' coloration and operation. *Artifcial Life and Robotics15(3)*, 335-340.

6. Kobayashi, S. (1987). *A book of colors: matching colors, combining colors, color designing, color decoration.* Kodansha America

7. Takaya, K. (2003). *Covariance structure analysis and graphical modeling by excel.* Ohmsha