An Interface Design for Mobile Devices Based on Color Semantics Theory

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***Abstract* — In this paper, the author researches on the interface design of mobile device based on the theory of color semantics. By analyzing the typically representative works, it also deeply explores the modern cultural environment and traditional cultural resources involved in development process of graphical user interface design, mining the theory of value in graphical user interface design, in order to better grasp the development trend after the integration of graphical user interface design and new technologies. This trend has a far-reaching significance to enrich our theoretical research of graphical user interface design, promote the creation of the design of graphical user interface, help our graphical user interface design accurately to position itself to the track of international development of graphical user interface design and benefit the development of our digital products and prosperity of traditional culture.**

Keywords - interface design; mobile device; app aplication; color semantics

I. INTRODUCTION

In recent years, with the gradual maturity of mobile Internet and mobile equipment technology, mobile Internet application based on smart phone is deeply influencing all aspects of people's basic necessities of life. Due to its features such as easy operation, portability, and sound interaction experience, smartphone mobile Internet application plays multiple roles of "assistant", "playmate", "teacher", etc. in people's daily life. However, with the rapid growth of the market of mobile Internet application, the homogenization phenomenon of smartphone mobile Internet application becomes increasingly serious. In the meantime, as a part of application R&D teams overlook the experience of application when they deliberately pursue the progress of application R&D, a great deal of low-level smartphone mobile Internet application starts appearing in the market, which forms into sharp contrast with the trend of consumers (users)'s gradually increasing demand for application experience and requirement degree. As the most important part of smartphone mobile Internet application, interface design directly determines users' experience effect of the application and it is the key factor to win the market, which enables the research of interface design to become one of the core problems concerned by the research field of smartphone mobile Internet application. However, most of the related research only focuses on the interaction and visual design of the interface design, and discipline limitation also exists in related research. Based on the problem mentioned above, Arjan's paper takes the interface design of smartphone mobile Internet application as the research object, adopts a collection of literature investigation, applies interdisciplinary research method, and combines practical case analysis to reconstruct interface design knowledge system, namely SUIG interface design knowledge system, with big-picture thinking of smartphone mobile Internet application from four aspects such as design strategy, user model and its task analysis, interaction of interface, and visual design[1]. Besides, on this basis of the study, by taking the interface design process of smartphone mobile Internet application as the research content, Ludlow's paper analyzes the principle and method of the interface design of smartphone mobile Internet application, emphasizes the user-centered ideas figuring out the whole process of interface design of application would require around the user and task model implementation and development [2]. Accordingly, constructing an interface design method model of mobile Internet based on smart phone, named UT-SUIG method model of interface design. Under interdisciplinary backgrounds including science of marketing, cognitive psychology and artistic design, Wang's paper develops a scientific study process of "theoretical exploration-SUIG knowledge system construction-UT-SUIG method model construction based on knowledge system--application and verification of method model construction" about the design of application interface according to the procedure of interface design of smartphone mobile Internet application[3]. The research contents at the stage of theoretical exploration mainly include: analyzing the design strategy of application from perspectives of market strategy, competitive mechanism, and user orientation; analyzing the user demand grade of the application and constructing user model from cognitive, behavioral, and emotional aspects; summarizing the interaction design principle of application interface through analyzing the method of interaction between users and interface; researching the basic theory of visual design of application interface from knowledge backgrounds such as aesthetics, semiotics and Gestalt psychology. The Li's research contents at the stage of SUIG knowledge system construction mainly include: obtaining design strategy which aspects need to be paid attention for the characteristics of smartphone mobile Internet application through comparatively analyzing the new-style application design strategy; exploring the creation method and key points of the character model and the task model of smartphone mobile Internet application interface based on the research on user model; analyzing and summarizing the interaction design method of application interface from aspects such as the component elements-information

architecture and flow chart design, as well as navigation design of the contents and key points of application interface interaction design; concluding the principle and method of visual design of application interface based on a collection of literature investigation and theoretical research[4]. The Lee's research contents at the stage of UT-SUIG method model construction based on knowledge system mainly includes: based on the construction of the knowledge system of smartphone mobile Internet application interface design. Thinking from the view of the lifecycle development of application, applying the research method of logical reasoning to summarize and conclude the key points and mutual relations of all parts of the knowledge system of application interface design, to form into a complete method model suitable for the interface design of smartphone mobile Internet application [5]. The Wang's research contents at the stage of method model application and verification mainly include: based on linking theory with practice, applying all parts of the content of the method model of smartphone mobile Internet application interface design to practical cases and combining with SUIG knowledge system of interface design for analysis and verification, to primarily verify the correctness and reliability of UT-SUIG method model based on knowledge system[6]. Both theories and practical application have proved that the knowledge system and method model of smartphone mobile Internet application interface design can effectively instruct the application R&D teams for organizational planning and specific implementation of the interface design task, to enable the results of application R&D to correspond with the targeted goal of the interface application and help users to enjoy sound product experience and service when meeting target users' demand. Besides, the research result can as well provide important reference value for the development of teaching system of user experience design.

II. The Basic Theory of Color Semantics

Wong's paper focuses on a common semantic color sensors and color semantics in graphic design in the application mode. As one of the three elements in the print ad design, colors play an important role[7]. According to a study, attention to the human eye in the target object within the first 20 seconds, the first concern is the color, with time going, gradually transferred to the form factor of visual perception, triggering a series of emotional experience. For example, you can mix different colors to express different information symbols, including simple and elegant, quiet and elegant, gorgeous and rich, warming and excitement. These can result in strong psychological and emotional changes, which affect people's material life and spiritual life. Color semantics is prevalent in the print ads design. It is a perception phenomenon that people have in common. Different people's awareness and understanding of color may show a diverse, rich semantic state. Based on the color and summarized semantics, we may find the common rule of semantic color in print ads, which will sublimate our perception of graphic design and improve our color sensitivity. Studying and mastering color semantics can enhance the emotional grasp of graphic design. In the design process, more skillful use of color means to accurately convey information through visual color. His paper first discusses the concepts and semantics of color science, and then sums up the concept and role of color semantics, so as to provide a theoretical basis for the semantic color print ads in the application, pursuant to explore color and graphic design semantic links and summarize the semantics of specific colors used in the graphic design methods and application value. How to make use of semantic color in the print ad design to make the ads more expressive and attractive is the main purpose of this study.

Nilsson's study of color semantics and application of mobile phone interface design has become inevitable. His paper takes the undergraduate students as the main object, subdivide group and divide the group into four typical groups, based on the typical test result of Huicang Chen. His paper put forward survey by using quantitative analysis, qualitative analysis and other methods, according to the color semantic aptitude test of sanguine, choleric, melancholic and phlegmatic crowd. Obtain four color attributes of the four groups. On this basis, analysis the results, summarize the character and semantic expression of words by using the color semantic differential method and the Pearson Method. Combined with the semantic theory, carry on research of mobile phone interface color semantics design and construct color semantic scale map based on the four types of college students. Discussion the application of color semantic depth with the guide of color semantic scale map. Combine the color semantic inclination with personality characteristics and behavior characteristics, design the mobile phone interface sample of the four types of undergraduate students. Finally carry out experimental verification on of the sample by using ergonomics experimental verification of the sample by using ergonomics experiment equipment eye tracker, which is widely used in the world. On basis of recording eyes moving trajectory, fixation duration, fixation times, back times, pupil scale, extract useful data information, make scientific, objective evaluation of mobile phone interface color semantics design practice, to make the result of mobile phone interface color semantic visual study more credible. His paper provide the theoretical basis for the selection of mobile phone interface design in the color attribute, and provided color semantics guidance for the interface design of mobile phone, in order to make it convenient for designers to take actual operation.

III. The Algorithm

The algorithm can be expressed as following equation (1-8):

$$f^{(\alpha)}(x0) = \left.\frac{df(x)}{dx^{\alpha}}\right|_{x=x_0} = \lim_{\delta x \to 0} \frac{\Delta^{\alpha}(f(x) - f(x_0))}{(x - x_0)^{\alpha}} \qquad (1)$$

for $0 < a \leq 1$ where

$$\Delta^{\alpha}(f(x) - f(x_0)) \cong \Gamma(1+\alpha) \lim_{x \to \infty} \Delta(f(x) - f(x_0)) \qquad (2)$$

And local integral of $f(x)$ defined by equation 3.

$$
\begin{aligned}
{}_aI_b^{(\alpha)} f(t) &= \frac{1}{\Gamma(1+\alpha)} \int_a^b f(t)(dt)^\alpha \\
&= \frac{1}{\Gamma(1+\alpha)} \lim_{\Delta t \to 0} \sum_{j=0}^{j=N-1} f(t_j)(\Delta t_j)^\alpha
\end{aligned} \tag{3}
$$

The we get:

$$
H_\alpha \{ f(t) \} = \hat{f}_H^\alpha(x) = \frac{1}{\Gamma(1+\alpha)} \int_R \frac{f(t)}{(t-x)^\alpha} (dt)^\alpha \tag{4}
$$

Where x real and the integral is treated as a catchy principal value, that is,

$$
\begin{aligned}
&\frac{1}{\Gamma(1+\alpha)} \int_R \frac{f(t)}{(t-x)^\alpha} (dt)^\alpha \\
&= \lim_{\varepsilon \to 0} [\frac{1}{\Gamma(1+\alpha)} \int_{-\infty}^{x-\varepsilon} \frac{f(t)}{(t-x)^\alpha} (dt)^\alpha + \\
&\frac{1}{\Gamma(1+\alpha)} \int_{x+\varepsilon}^{\infty} \frac{f(t)}{(t-x)^\alpha} (dt)^\alpha]
\end{aligned} \tag{5}
$$

Rewrite again Eq. (4) as

$$
\begin{aligned}
\hat{f}_H^\alpha(x) &= \frac{1}{\Gamma(1+\alpha)} \int_{-\infty}^{\infty} \frac{f(t)}{(t-x)^\alpha} (dt)^\alpha \\
&= \frac{1}{\Gamma(1+\alpha)} \int_{-\infty}^{\infty} f(t) g(x-t) (dt)^\alpha = f(x) * g(x),
\end{aligned} \tag{6}
$$

$$
\partial_j (C_{ijkl} \partial_k u_l + e_{kij} \partial_k \varphi) - \rho \ddot{u}_i = 0 \tag{7}
$$

$$
\partial_j (e_{ijkl} \partial_k u_l - \eta_{kij} \partial_k \varphi) = 0 \tag{8}
$$

The linear equation can be expressed into the following simplified forms:

$$
L(\nabla, \omega) f(x, \omega) = 0
$$

$$
L(\nabla, \omega) = T(\nabla) + \omega^2 \rho \mathrm{J} \tag{9}
$$

In which,

$$
T(\nabla) = \begin{Vmatrix} T_{ik}(\nabla) & t_i(\nabla) \\ t_k^T(\nabla) & -\tau(\nabla) \end{Vmatrix}, \quad f(x, \omega) = \begin{Vmatrix} u_k(x, \omega) \\ \varphi(x, \omega) \end{Vmatrix} \tag{10}
$$

Consider delay, the L can be expressed as:

$$
\mathrm{L}^0 = \begin{Vmatrix} C_{ijkl}^0 & e_{kij}^0 \\ e_{ikl}^{0T} & -\eta_{ik}^0 \end{Vmatrix} \tag{11}
$$

These functions can be expressed:

$$
\begin{aligned}
&C(\mathrm{x}) = C^0 + C^1(\mathrm{x}), \; e(\mathrm{x}) = e^0 + e^1(\mathrm{x}), \\
&\eta(\mathrm{x}) = \eta^0 + \eta^1(\mathrm{x}), \; \rho(\mathrm{x}) = \rho_0 + \rho_1(\mathrm{x})
\end{aligned} \tag{12}
$$

The value with superscript of 1 represents the difference below:

$$
\begin{aligned}
&C^1 = C - C^0, e^1 = e - e^0, \\
&\eta^1 = \eta - \eta^0, \rho_1 = \rho - \rho_0
\end{aligned} \tag{13}
$$

$$
\begin{aligned}
f(x, \omega) = f^0(x, \omega) + \int_V \mathrm{S}(x - x')(\mathrm{L}^1 F(\mathrm{y}') \\
+ \rho_1 \omega^2 \mathbf{g}(R) \mathrm{T}_1 f(\mathrm{y}')] S(\mathrm{y}') \mathrm{d}\mathrm{y}'
\end{aligned} \tag{14}
$$

In addition, we can introduce the abbreviated formula:

$$
\mathrm{g}(x, \omega) = \begin{Vmatrix} G_{ik}(x, \omega) & \gamma_i(x, \omega) \\ \gamma_k(x, \omega) & g(x, \omega) \end{Vmatrix},
$$

$$
\mathrm{s}(x, \omega) = \begin{Vmatrix} G_{ik,l}(x, \omega) & \gamma_{i,k}(x, \omega) \\ \gamma_{k,l}(x, \omega) & g_{,k}(x, \omega) \end{Vmatrix},
$$

$$
L^1(x, \omega) = \begin{Vmatrix} C_{ijkl}^1 & e_{kij}^1 \\ e_{kij}^{1T} & -\eta_{ik}^1 \end{Vmatrix}, \quad F(x, \omega) = \begin{Vmatrix} u_{(i,j)}(x, \omega) \\ \varphi_{,i}(x, \omega) \end{Vmatrix} \tag{15}
$$

In these expression, $G_{ik}(x, \omega)$, $\gamma_i(x, \omega)$, $g(x, \omega)$ can be represented as:

$$
\mathrm{g}(x, \omega) = \frac{1}{(2\pi)^3} \int \mathrm{g}(k, \omega) \exp(-i\mathrm{k}\square\mathrm{x}) d\mathrm{k},
$$

$$
\mathrm{g}(k, \omega) = \begin{Vmatrix} G_{ik}(k, \omega) & \gamma_i(k, \omega) \\ \gamma_k^T(k, \omega) & g(k, \omega) \end{Vmatrix},
$$

$$
G_{ik} = (\Lambda_{ik} + \frac{1}{\lambda} h_i h_k^T)^{-1}, \; g = -(\lambda + h_i^T \Lambda_{ij}^{-1} h_j)^{-1},
$$

$$
\gamma_i = \frac{1}{\lambda} h_k^T G_{ki},
$$

$$
\Lambda_{ik}(k, \omega) = k_j C_{ijkl}^0 k_k - \rho_0 \omega^2 \delta_{il}, \; h_i(k) = e_{kil}^0 k_k k_l,
$$

$$
h_l^T = e_{ikl}^{0T} k_i k_k, \quad \lambda(k) = \eta_{ik}^0 k_i k_k
$$

$$
\frac{1}{2\pi} \int_{-\infty}^{\infty} e^{-ik_3 x_3'} dx_3' = \delta(k_3) \tag{16}
$$

Equation (8) can be converted into the following form:

$$
\begin{aligned}
f(y, \omega) &= f^0(y, \omega) + \int_s S(y - y', \omega) \mathrm{L}^1 F(\mathrm{y}', \omega) \mathrm{d}\mathrm{y}' \\
&+ \rho_1 \omega^2 \int_s \mathbf{g}(y - y', \omega) \mathrm{J} f(\mathrm{y}', \omega) \mathrm{d}\mathrm{y}'
\end{aligned} \tag{17}
$$

In which, S is cylinder cross section, $y = (x_1, x_2)$, and

$$
\begin{aligned}
&\mathbf{g}(y - y', \omega) = \frac{1}{(2\pi)^2} \int_0^\infty \bar{k} d\bar{k} \\
&\int_0^{2\pi} \mathbf{g}(\bar{k}, \omega) \exp(-i\mathrm{k}\square(\mathrm{y} - \mathrm{y}')) d\phi
\end{aligned}, \quad \bar{k} = (k_1, k_2) \tag{18}
$$

$$
G_{ik}(\bar{k}, \omega) = \frac{1}{\rho_0 \omega^2} \begin{bmatrix} \frac{\beta^2}{\bar{k}^2 - \beta^2} \theta_{ik} + \bar{k}_i \bar{k}_k \left(\frac{1}{\bar{k}^2 - \alpha^2} - \frac{1}{\bar{k}^2 - \beta^2} \right) \\ + m_i m_k \frac{\beta_\perp^2}{\bar{k}^2 - \beta_\perp^2} \end{bmatrix}
$$

$$
\mathrm{g}_{ik}(\bar{k}, \omega) = -\frac{1}{\eta_{11}^0} \frac{1}{\bar{k}^2} + \frac{1}{\rho_0 \omega^2} \left(\frac{e_{15}^0}{\eta_{11}^0} \right)^2 \frac{\beta_\perp^2}{\bar{k}^2 - \beta_\perp^2},
$$

$$
\gamma_i(\bar{k}_i, \omega) = \frac{1}{\rho_0 \omega^2} \left(\frac{e_{15}^0}{\eta_{11}^0} \right)^2 \frac{\beta_\perp^2}{\bar{k}^2 - \beta_\perp^2} m_i \tag{19}
$$

In which,

$$
\alpha^2 = \frac{\rho_0 \omega^2}{C_{11}^0}, \quad \alpha^2 = \frac{\rho_0 \omega^2}{C_{66}^0}, \quad \beta_\perp^2 = \frac{\rho_0 \omega^2}{C_{44}'},
$$

$$
C_{44}' = C_{44}^0 + \frac{(e_{15}^0)^2}{\eta_{11}^0} \tag{20}
$$

IV. THE EXPERIMENT RESULT AND DATA ANALYSIS

With the emergence and development of the computer technology and new media network, interface design has become a new and important member in the field of art design. The design can be broadly divided into three parts:

structural design, interaction design and visual design. The graphical user interface studied in this article belongs to the visual design of the interface design, which is the most intuitive part that digital products present to the user and also the interface between users and digital products to operate each other. When the art design develops into a deep level, it not only has a further contact with science and technology, but also surely happens to cross with some branches of culture, such as history, folklore, study of human culture, social psychology, and social ethics. Implementation through the design is not just commercial purposes, but also the reflection of politics, economy, culture, philosophy, aesthetics and social psychology in a certain period. As a product of modernly-advanced science and technology and rapidly-developed cultural media industry, graphical user interface which is a new and special media, carries abundant but complex cultural information. One important aim of interface design is to convey information, which itself is just a phenomenon of information dissemination. Graphical user interface design is not only an act of information dissemination, but also an act of cultural symbol; its process can be seen as a cultural process of information dissemination. Therefore, graphical user interface and cultural transmission are two concepts of two completely different areas, but this article will still link the two closely. Figure 1 shows the ways of collecting data.

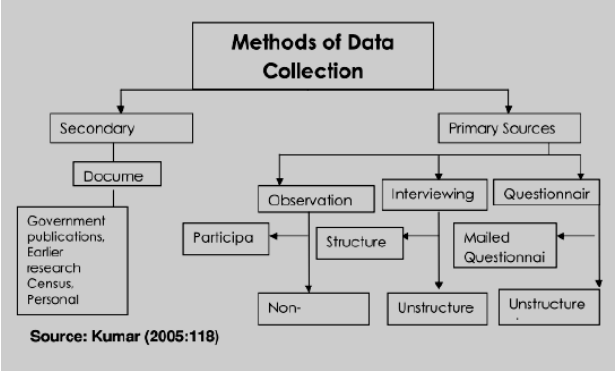

Figure 1. Ways of collecting data

Color semantics theory, includes the influence factors of effect, the specific effects of culture which is also known as the culture of communication and integration and cross-cultural conflict and cultural transmission, Chapter Six—Trend theory, at the above address, imagines the future of graphical user interface, and comes up the trend of graphical user interface design based on cultural transmission, that is, the development from the previous design technology and the concept of "Western supremacy" to the present " East-West fusion ? pluralistic coexistence "situation, will eventually move toward the design of the concept of" return self ". Figure 2 shows the relationship between color semantics and its promoting effect and figure 3 shows the relationship between the number of reporting times of the same color semantics and its' efficiency.

By analyzing the typically representative works, it also deeply explores the modern cultural environment and traditional cultural resources involved in development process of graphical user interface design, mining the theory of value in graphical user interface design, in order to better grasp the development trend after the integration of graphical user interface design and new technologies. This trend has a far-reaching significance to enrich our theoretical research of graphical user interface design, promote the creation of the design of graphical user interface, help our graphical user interface design accurately to position itself to the track of international development of graphical user interface design and benefit the development of our digital products and prosperity of traditional culture. Figure 4 shows the relationship between the relative frequency and validity of the same color semantics.

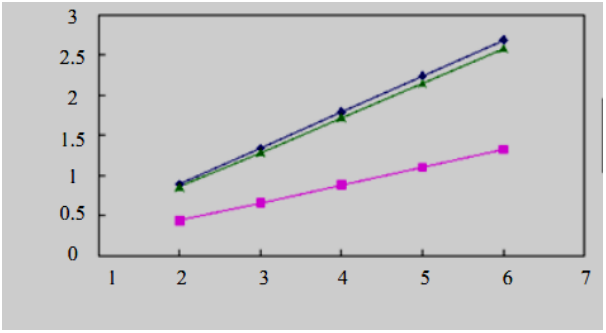

Figure 2. The relationship between color semantics and its promoting effect.

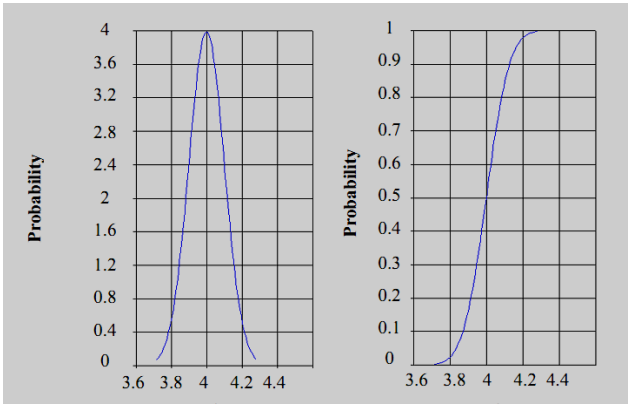

Figure 3. The relationship between the number of reporting times of the same color semantics and its' efficiency.

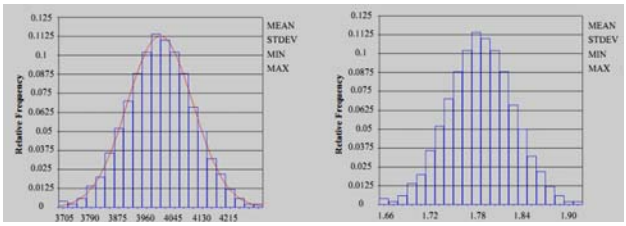

Figure 4. The relationship between the relative frequency and validity of the same color semantics.

V. CONCLUSION

In this paper, the author researches on the interface design of mobile device based on the theory of color semantics. Thinking from the view of the lifecycle development of application, applying the research method of logical reasoning to summarize and conclude the key points and mutual relations of all parts of the knowledge system of application interface design, to form into a complete method model suitable for the interface design of smartphone mobile Internet application. he graphical user interface studied in this article belongs to the visual design of the interface design, which is the most intuitive part that digital products present to the user and also the interface between users and digital products to operate each other. When the art design develops into a deep level, it not only has a further contact with science and technology, but also surely happens to cross with some branches of culture, such as history, folklore, study of human culture, social psychology, and social ethics.

This paper is a one-hour lecture on the topic of fault current limiter presented to engineering students. The lecture has started with the causes and effects of fault on power systems. The traditional ways of fixing fault current have been described. The detailed analysis of two types of fault current limiters: based on magnetic materials and high temperature superconductor materials have been presented. With some modification (elimination of mathematical part) the lecture can be presented to general public.

ACKNOWLEDGMENT

This work is supported by the Key Project of Guangxi Social Sciences, China (No.gxsk201424), the Education Science fund of the Education Department of Guangxi, China (No.2014JGA268), and Guangxi Office for Education Sciences Planning, China (No.2013C108).

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