User Emotion Sensing in Search Process based on Chromatic Sensation

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ABSTRACT
The sensing of user emotion in the Web space is typically performed using user logs, e.g., pages visiting by users and/or the texts input by users. These techniques are essentially based on text to identify the target in which the users showed interest. However, it is difficult to estimate the emotion only by text. On the other hand, it is known that the color sensation has direct connection to human's affective sensation and thus is suitable for emotion sensing. Based on this, we propose a model for sensing user emotion on the basis of the psychological principle, namely, color sensation. The model extracts the present feeling of the user by using the colors browsed or selected by the user. The model has five elements: an algorithm for extracting feature colors that potentially represent user emotion, an emotion database for describing the relationships between emotions and colors, an algorithm for extracting the user emotion from the extracted feature color, images symbolizing information for making it easier for users to find relevant information that match their present feeling, and an interface for browsing information from sense-related viewpoints. As a first step in implementing this model, it was tested using 50 people searching for an application using an intuitive interface. The results revealed that the colors they selected were potentially related to their feelings especially for users with ambiguous information needs.

Categories and Subject Descriptors
H.3.3 [**Information Storage and Retrieval**]: Information search and retrieval – *Information filtering, Search process*, H.5.2 [**Information Interface and Presentation**]: User interfaces – *Graphical user interfaces (GUI), Interaction styles, User-centered design*

General Terms
Design, Experimentation, Verification.

Keywords
Emotion, Color psychology, Multi-faceted metadata, Graphical search interface, Application search

1. INTRODUCTION
The sensing of user interest in the Web space is typically performed using the information browsed by users or the texts input by users. The first approach is problematic because it is based on the assumption that the information browsed is the information of interest to the user. However, the actual information of interest at the moment cannot be ascertained since browsed information in which the user is not actually interested or information incidentally browsed is also judged to be the information of interest. The second approach is also problematic because it can be used only when users input texts at their own initiative.

Both approaches are used in online shopping for placing advertisements and providing recommendations. For these approaches to be effective, the advertisements and recommended information should match the target person's information needs [1]. In the user model generally used for information retrieval, the user's information needs when a search commences are ambiguous but become clearer as the search continues [2]. A user with ambiguous information needs generally has difficulty specifying keywords expressing those needs. One way to help users with ambiguous information needs is to enable them to convey their emotion to the search system. If the search system could sense the user's emotion through an intuitive interface, it could better understand the user's feelings.

In this paper, we present a model for sensing user emotion that is based on the psychological principle that, of the visual elements, color has the greatest effect on human feelings [3]. Color is commonly used in psychological therapy because it can be used to identify human emotion [3]. We speculated that color could also be used for sensing user emotion in the Web space. In our proposed model, the present user emotion is estimated using the colors browsed or selected by the user. The model has five elements: an algorithm for extracting feature colors that potentially represent user emotion, an emotion database for describing the relationships between emotions and colors, an algorithm for extracting the user emotion from the extracted feature color, images symbolizing information for making it easier for users to find relevant information that match their present feeling, and an interface for browsing information from sense-related viewpoints. As a first step in implementing this model, we tested it using 50 people who searched for an application using an intuitive interface with sense-related search facets such as color and atmosphere.

2. PROPOSED MODEL
2.1 Problems in Related Work
Many techniques for sensing user needs have been proposed and implemented by various companies and researchers. Sensing techniques are used by online shopping sites, for example, to place advertisements and to recommend products. A shopper's

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interests are estimated from the shopper's input texts such as search keywords and comments, the shopper's browsing history on the shop's website for getting information and/or purchasing products, and the shopper's purchase history. This approach is based on the assumption that the information browsed is the information of interest to the shopper. Because it involves analysis of the texts input by shoppers and the texts browsed by shoppers, unexpected changes in a shopper's interests are not captured. Moreover, it is difficult to estimate the interests of shoppers who rarely input texts. It is also difficult to estimate the interests of shoppers who do not perform any actions, e.g., shoppers who only browse and never buy anything and shoppers who only browse and never input comments.

Several studies have investigated making recommendations on the basis of text messages [4, 5]. These techniques use not only the user's history but also those of other users such as users who bought similar products or users who browse the same information under the assumption that they have the same interests. The techniques proposed are based on the changes in user interest. However, they focus on user interests, not user emotions. In general, when users start searching, their information needs are ambiguous and they only have a picture in their mind of something, so it is difficult to express their needs in words. While this approach can be effective for users because information is automatically displayed without inputting texts, it does not necessarily satisfy a user's present information needs.

Several studies have investigated extracting user emotion by sentiment analysis using texts and/or visual contents. Techniques using text analysis alone [6] also have the problems described above such as the difficulty of sensing the user's present information needs because emotions are always changing. The techniques that use both texts and visual contents [7] construct a visual sentiment ontology on the basis of the relationships between adjectives and colors and between adjectives and noun pairs. For the images with texts, they displayed face illustrations expressing the emotion of users who uploaded them by using a proposed novel visual concept detector library. This technique worked better than techniques using only texts and could sense the user's emotion when the user uploaded images with texts. However, it is not effective at sensing the user's present emotion when browsing an image. It is also difficult for users to compare their information needs to images if the images are too complex to understand their meaning.

2.2 Requirements

We defined four system requirements for a model used to sense the user's present emotion.

(1) The system must use visual features extracted from the information browsed by users.
(2) The system must translate the visual features into an emotion.
(3) The system must display images to enable users to understand the meaning of the information.
(4) The system must prepare an intuitive search interface to enable users to select information matching the user's feeling.

To meet requirement (1), the system must extract the feature colors of images browsed by users. Research in the field of color psychology has defined the relationships between colors and adjectives [8]. These adjectives are often used to express human emotions. To meet requirement (2), the system must have a database expressing the relationships between colors and adjectives expressing emotion.

When both texts and images are displayed on the same screen, the viewer can typically catch the meaning of the information conveyed by the images more quickly than the information conveyed by the texts because people generally understand images more quickly than texts [9]. To meet requirement (3), the system must create images symbolizing information to enable users to easily compare their ambiguous information needs to displayed images. Moreover, the interaction between the user and the system is important. To meet requirement (4), the system must prepare sense-related search facets that are easy to operate because users have difficulty inputting texts such as search keywords for ambiguous information needs.

2.3 Emotional Sensing Model

The proposed model is illustrated in Figure 1. This model has five elements: an algorithm for extracting feature colors that potentially represent user emotion, an emotion database for describing the relationships between emotions and colors, an algorithm for extracting user emotion from the extracted feature color, images symbolizing information for making it easier for users to find relevant information that match their present feeling, and an interface for browsing information from sense-related viewpoints.

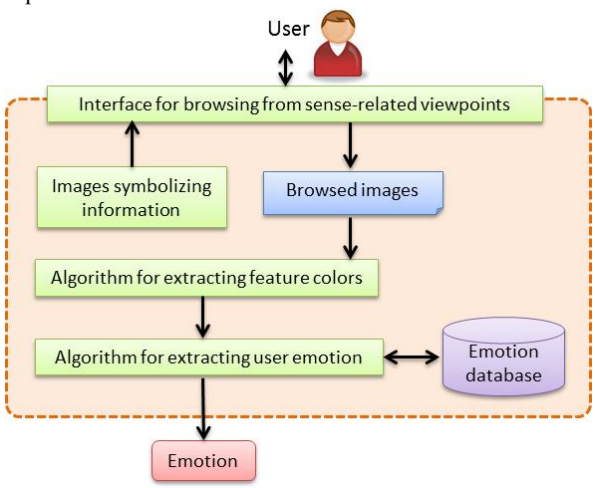

Figure 1. Overview of proposed model.

A user interacts with the search system through an interface with sense-related search facets and filters the images symbolizing the information. The images symbolizing the information enable users to quickly show the feeling when browsing the information and to easily convey their emotion to the search systems. The images browsed by the user and information related to the user's browsing behavior such as time for browsing are stored and input to the algorithm for extracting the feature colors of browsed images. The feature colors are translated in the algorithm for extracting user emotion into emotions by using the emotion database expressing the relationships between colors and adjectives [8] with the expansion of thesaurus.

(a) initial screen (b) add color dial (c) use multiple dials

Figure 2. Screenshots of ring-structured graphical search interface being used.

3. TESTING

3.1 Objective

As a first step towards implementing this model, we tested its effectiveness in displaying images symbolizing information and preparing an interface for browsing from sense-related viewpoints. For one way to meet requirement (3) in section 2.2, application search was used as the test situation because the icon image of an application typically symbolizes its function[1]. It is also considered that the icon image was designed with expressing the feeling before/after using the application. It was reported that the icon color of the applications related to foods such as restaurant search and recipe search was red because red color gives an appetite [10]. In the pre-testing, we determined that 75% of users had installed applications based on their icon designs when they found free applications with the same functions. Requirement (4) was met by using a ring-structured graphical search interface [10] that enables users to continue searching without inputting keywords. It supports continuous attribute values such as for color and atmosphere. Users select a search facet and adjust the attribute values used as search keys by easily operating the ring.

3.2 Interface

Figure 2 shows screenshots of the ring-structured graphical search interface being used to search for iPhone applications. The application database contained 1150 free applications, each in the top 50 of one of the 23 categories in the iTunes App store. Search facets were prepared for five application attributes: icon color, icon tone, application category, user evaluation, and release date. The icon color attribute expresses the color level, and it was defined as the frequently appearing colors in the icon images. For providing intuitive search, we selected two colors: the most frequent color and the color which has different color name in hue circles with 24 colors from the first selected color. The icon tone attribute ranged from pastel tones to primary colors to dark tones. It was calculated using the brightness and saturation of the most frequent color in the icon images. These two attributes are automatically extracted from the icon images. The other attributes were defined by information obtained from the App store.

Figure 2(a) shows the initial screen. The five facets are shown at the bottom of the screen as *category dials*. When a *category dial* is tapped or dragged into the upper circle of big dials, a corresponding *key dial* appears at the center of the screen. This *key dial* carries attribute values that can be used as search keys for the selected facet. The top part of the *key dial* indicates the facet's search key. In the example shown in Figure 2(b), the search key is 'icon color is pink.' Users can adjust the search keys and browse the retrieved results by rotating the *key dials*. They can combine search keys by using multiple *key dials*. In the example shown in Figure 2(c), the search keys are 'icon color is green,' and 'category is transfer.'

The retrieved results are displayed inside the dials alternately from top left to bottom right in accordance with the search key values and their priorities. Users can browse the next set of candidates by scrolling the area of retrieved results. A search facet can be deleted by tapping the corresponding *category dial*. The maximum number of search facets that can be used concurrently is three due to the need for a sufficiently large area at the center for displaying the retrieved results.

3.3 Procedure

There were 50 participants aged between 25 and 49 (25 male and 25 female). Their school majors or jobs were not related to color or psychology. The participants first spent ten minutes learning how to use the interface. They did this on their own by making use of the help pages and freely using the interface. We then asked them to use the interface to find applications that matched their present feeling.

[1] http://gizmodo.com/how-to-design-beautiful-ios-app-icons-according-to-app-789613992

First, we asked them to select one of eight emotions that best matched their present feeling [8]: joy, trust, fear, surprise, sadness, disgust, anger, and anticipation. They then freely searched for an application that matched that emotion. After they had found an application, we asked them to select the most frequent color of the icon image of the application from eight colors: yellow, yellowish green, green, sky blue, blue, purple, pink and red. Each emotion in the first question corresponds to each color in the second question. One of the choices for both emotion and color was 'other,' so they had nine choices for each. Finally, they described the reason they selected the application.

3.4 Results

In this test, we prepared an emotion database containing the eight basic feelings and colors described in the questionnaire sheet. For the first step, we treated the color answered by users in the second question as the color calculated by the algorithm for extracting feature colors. Figures 3 and 4 show the percentage of the participants for each emotion and icon color. Each corresponding emotion and color is represented by the same color. Table 1 shows the percentage of coincidence between each emotion and each color except for the participants who selected 'other' for emotion or icon color. The average of its coincidence was 55.6% for men, 71.4% for women, and 67.6% for all participants.

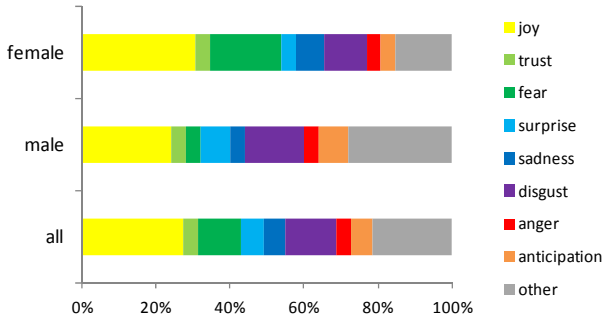

Figure 3. Results for emotion.

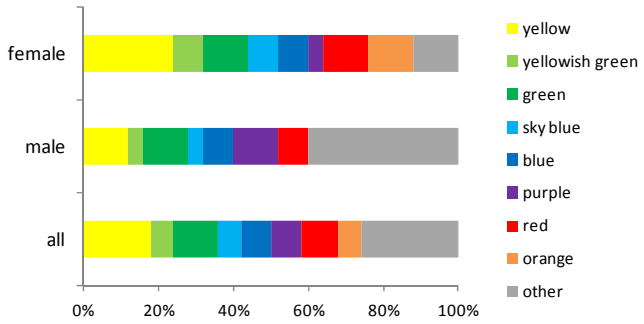

Figure 4. Results for selected icon color.

Table 1. Results for coincidence between emotion and color.

Emotion	Color	Coincident (%)		
		men	women	all
joy	yellow	33.33	75	57.14
trust	yellowish green	100	0	50
fear	green	100	60	66.67
surprise	sky blue	50	100	66.67
sadness	blue	100	100	100
disgust	purple	100	33.33	42.86
anger	red	50	100	100
anticipation	orange	66.67	100	66.67
Average except for 'other'		55.6	71.4	67.6

Many of the male participants whose emotion did not match the icon color said that they selected the application on the basis of their situation; e.g., one said he was hungry and selected an application related to food, and another said he liked reading and selected an application related to books. On the other hand, many of the female participants whose emotion did not match the icon color said that they selected the application on the basis of icon appearance; e.g., one said the coloration of the icon was pretty so she wanted to download it, and another said the icon design was fresh and she felt curious. Although application selection was sometimes related to factors other than icon color and the user's emotion, this interface still has the potential to be used for sensing the emotions of users.

4. POTENTIAL APPLICATIONS OF MODEL

Potential applications of our model include real-time recommendation on e-commerce sites, e.g., online bookstores. The image on a book cover gives potential buyers not only an impression of the book's contents but also a clue for search and browsing before or after buying the book. In general, the higher the person's expectations before reading, the lower the level of satisfaction after reading, and the lower the expectations before reading, the greater the chance of opportunity loss [11]. It is thus important to reduce the gap between the impression obtained from a book's cover image and the impression gained by reading the book. Reader impressions can be found in the reader reviews commonly found on the sites of online bookstores. Potential buyers can read the reviews and use them to make a purchase decision. However, a reader's emotions and latent feelings about a book are most likely to be represented in images, not text [12]. In addition, the meaning of something can generally be understood more quickly from an image than from text [9].

Creating book cover images on the basis of the impressions of people of who had read the books [13] would make it easier for potential buyers to find books that match their present feeling. It is difficult to assess users' present feelings and preferences because they are continuously shifting over time. Displaying a cover image designed on the basis of our method during a book search would enable users to assess the impressions of those who have read the book and determine whether they matched the users' present feelings. Analysis of a user's browsing history in real time would enable recommendations to be given that reflect the user's present feelings.

The models for the automatic data indexing using the relationships between human events and multimedia contents have been proposed [14,15]. These models provided a referencing mechanism to link real-life event elements with content segments. Our proposed model has tried to make relationships between present user emotions and multimedia contents. If we could apply our proposed model to event analysis, the system would be able to understand not only what includes in the contents but also how a user feels when using or browsing the contents.

5. CONCLUSION

Our proposed model for sensing user emotion is based on the psychological principle that, of the visual elements, color has the greatest effect on human feelings. A system based on this model extracts the user's present feeling on the basis of the colors browsed or selected by users. Testing using application search and an intuitive interface revealed that the colors browsed or selected by users were potentially related to their feelings. Future work includes verify the satisfaction of the application selected based on application icons, implementing other elements and evaluating the effectiveness of sensing emotion on the basis of colors browsed by users.

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