A SIGN-LOGO IMAGE SEARCH & COMBINATION SYSTEM
BY ANALYZING COLOR AND SHAPE FEATURES

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ABSTRACT
This paper presents a sign-logo search and combination system by analyzing the color and shape features of sign-logos. The objective of this system is to find a global way of communicating by combining sign-logo images, which are created by combining color and shape features, to express important messages with visualizations. This system would contribute to communication between foreign people who uses different languages, and to share the same interpretations during collaborating scenes. To realize this contribution, this system analyses the color and shape features of the image input by a user, also divides the shape into frames and objects, which consists of color layers. The frame stands for the context of the message, and the objects stand for the target of the message. The colors used in the sign-logos tend to implicitly express the importance of the message. The results of several experimentations for evaluating effectiveness of our system are shown in this paper.

KEY WORDS
Sign-Logo, Content-Based Image Retrieval, Visual Communication, Image Database, Image-Query Creation

1. Introduction

Throughout the world, there are many kinds of signs and logos used for maintaining our safety and security. These signs and logos are representing certain messages, which are created by the sender for the receivers to see. In this paper, we define the signs and logos expressing a certain meaning by the combination of color and shape as sign-logos. Generally, people can intuitively understand the messages corresponding to intentions of meaning based on color and shape features of sign-logo images. The messages that are expressed by combining color and shape features are shown in Figure 1, which is based on the United Nations Special Commission Survey [1]. For example, the combination of color (blue) and shape (circle) stands for the meaning (mandatory).

Content Based Image Retrieval (CBIR) systems are normally used to find our similar images to a given query image. These systems help us to find the image we are looking for. The image retrieval has been researched since the 1990s. QBIC [4, 5] released by IBM is a first commercial image retrieval engine. A lot of efficient retrieval engines have developed after that. Google Goggles [3] provided us with image retrieval services on WWW. This system retrieves objects that are included on an image that is taken by mobile phone with a digital camera. Most researches in CBIR have focused on developing concrete retrieval algorithms [7, 8, 9, 16, 19, 20, 23]. Image-query creation has been proposed as the one method of dealing with the retriever’s intention that should be more considered in CBIR. In this method, the user’s intentions that are focused on the image-features on retrieval steps are expressed by combining multiple images [12, 13, 14].

In this paper, we present a sign-logo image search and combination system focusing on the color and shape features of the sign-logos. The objective of this system is to find a global way of communicating by combining sign-logo images, which are created by combining color and shape features to express a certain message. This system would contribute to communication between people who uses different languages, and to share the same interpretations during collaborating scenes. For example, as a simple situation, when you need to tell the direction to a foreign person, you can show the sign-logo images to explain. As
another example, when people are collaborating to make a product, they can use the sign-logos to show the important points to the foreign employees.

This system analyses the color and shape information of the image input by the user, and divides the shape information into the frame information and object information, which consists of the color layers. The frame stands for the context of the message, and the objects stand for the target of the message. The colors used in the sign-logos express the importance of the message. The objects consist of several shapes having the same color, and the frame consists of the outline shape in the sign-logo image. By combining the colors, the frame and the objects that correspond to the message, the sign-logo message becomes visually clear to the receivers. The main feature of this system is to utilize the image retrieval in order to communicate with each other by combining three image features (colors, frames and objects) of sign-logo images based on the user’s imagination. In our system, we have implemented the decomposition and combination functions to search functions that legacy image retrieval systems already have. We have noticed that the image-context can be clearly express by combining multiple image-features. So, our approach connected these functions to create a new way to combine images for realizing a sign-logo image world.

2. Basic Method of Sign-Logo Image Search & Combination System

In our system, we focus on basic elements of image features the sign-logo has. The basic colors and shape combinations are based on the survey from United Nations Special Commission (Figure 1), and the safety colors from the JIS (Japanese Industrial Standards) and ISO (International Organization for Standardization) regulation (Figure 2). The colors used in this system are 10 colors (red, orange, yellow, green, cyan, blue, purple, magenta, white, black) based on the 8 colors from the JIS safety colors [2] with the additive primary colors (red, green, blue) and subtractive primary colors (magenta, yellow, cyan). Each color of sign-logo images is layered in 10 color layers in this system (Figure 3). The sample images are based on [2] and each image has a certain message (red: do not enter, orange: departure immigration, yellow: taxi, green: emergency exit, blue: information corner, purple: radio activity, white: information center, black: telephone, magenta: baby facility, cyan: directions).

<table>
<thead>
<tr>
<th>Color</th>
<th>Square</th>
<th>Rectangle</th>
<th>Circle</th>
<th>Triangle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td></td>
<td></td>
<td><img src="image" alt="Prohibition" /></td>
<td><img src="image" alt="Regulation" /></td>
</tr>
<tr>
<td>Yellow</td>
<td></td>
<td></td>
<td><img src="image" alt="Warning" /></td>
<td></td>
</tr>
<tr>
<td>Green</td>
<td><img src="image" alt="Aid" /></td>
<td><img src="image" alt="Emergency" /></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blue</td>
<td><img src="image" alt="Mandatory" /></td>
<td><img src="image" alt="Mandatory" /></td>
<td><img src="image" alt="Mandatory" /></td>
<td></td>
</tr>
</tbody>
</table>

Figure 1. The Messages that AreExpressed byCombining of Color and Shape Features

<table>
<thead>
<tr>
<th>JIS Color</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>File Extinction, Prohibition, Stop, High risk of danger</td>
</tr>
<tr>
<td>Green</td>
<td>Safety, Evacuation, Health, Aid, Progress</td>
</tr>
<tr>
<td>Blue</td>
<td>Mandatory, Precaution</td>
</tr>
<tr>
<td>Yellow</td>
<td>Warning</td>
</tr>
<tr>
<td>Orange</td>
<td>Danger, Security facilities for air and sail</td>
</tr>
<tr>
<td>Purple</td>
<td>Radiation</td>
</tr>
<tr>
<td>White</td>
<td>Passage, Oder</td>
</tr>
<tr>
<td>Black</td>
<td>Word, Mark</td>
</tr>
</tbody>
</table>

Figure 2. The 8 Safety Colors and The Meaning

The shapes used in this system are separated to the frame-shape and object-shapes. Primitive shapes (circle, triangles, squares, rectangles, diamond, pentagon, hexagon) are used for the frame as shown in Figure 4. Variations of objects such as the ones shown in Figure 5 are representing the target of sign-logo as the object-shapes used for expressing the message. In this point of view, we point out that all the signs and logos, pictograms, symbol marks, road signs etc. can be considered as the same, and define them as sign-logos. We do not consider letters in logotypes as sign-logos currently, since they directly show letters for reading.
The system structure is shown in Figure 6. Firstly, the user posts the sign-logo image that actually exists to the system. Then, the script program receives and connects to the image processing methods. The analyzed data from the image processing methods would be responded back to the script program, and then the result information would be shown to the user on the browser interface. In order to create a sign-logo message, this system mainly has three processes: (1) Decomposition, (2) Search and (3) Combination. The processes are shown in Figure 7.

(1) Decomposition Process: In the decomposition process, this system decomposes the color, the frame and the objects from the sign-logo image. In order to decompose, an image feature extraction method on this system is executed. Firstly, the input sign-logo image is resized by constant width and length size. Secondly, the background of the image is subtracted and saved as the base image used in this system. Thirdly, another image would be saved, which is filled with the main color of the image. This image becomes the frame image. The colors used in the base image are clustered by the most similar color of 10 colors; which means reducing the variations of colors. The color histogram as a color feature vector \([15, 18]\), which contains the color ratio information, is extracted from every pixel of the modified base image. Except for the case of white and black, the colors with smaller ratios compared to the threshold is shifted, and added to the similar color. Based on this shifted color histogram, the system generates the color layer images, are shown in figure 8, which becomes the important images used for decomposing the analyzed data: area (pixels), object count, and centroid (x and y point) for the whole image. These layers also have the role to separate the image into objects. The area data means pixel count of each color layer and it is used for judging concentration degree of objects on the same color layer. This area data is expressed as integer. In this process, the area data holds the position information on each
In the case of each element of color histogram, they don't hold the information. Additionally, if the information on all the area data is integrated, it will become equivalent to the color histogram. The object count means number of objects that exist on each color layer. The object count data is expressed as integer. The centroid means summation of all centroids of each object that exists on each color layer. The centroid data is expressed as double. These values are used for the key for searching objects with a different color and the similar shape. After the base image, frame images, and object images are generated; these images are analyzed and used for the search process. Finally, these image-features are expressed as vector data model, and are stored to each table of the sign-logo image database corresponding to schema of the image-features.

(2) Search Process: This system executes frame-level and object-level search in order to retrieve similar sign-logo images in the search process by analyzing the color, area, object count, centroid and shape information. The system uses the analyzed data from the decomposition process. To efficiently calculate similarity degree between every feature vectors, the vector intersection method, which calculates the overlap degree between two feature vectors, is adopted to the search process in the system. The data structure of the sign-logo database is shown in Figure 9-12. The upper 10 image results calculated from the similarity degree provided from this method are shown to the user ranked in the similarity order.

(3) Combination Process: In the combination process, the system combines the colors, the frame and the objects for creating a new sign-logo image. The user selects the frame shape and frame color. Next, the user selects the object shape and object color that should be included in the frame. The system prepares the frame image and object images based on the user’s selections, and layers these images. After that, a new sign-logo image is created from combining these layers together.

In order to refine the meaning of the created sign-logo image, the user would be able to use the cycle process from (1) to (3).
3. Implementation

We have implemented an experimental system by applying the MATLAB system [17]. The user interface of the input form and the browsing interface that are shown in Figure 4 were developed by PHP and HTML. All image features of 100 sign-logo images that were extracted by a series of image processing in advance are stored to array as the sign-logo database. Some sign-logo images as examples that are stored to the sign-logo database are shown in Figure 13. These images and text data explaining the meaning of each sign-logo image were collected from the World Wide Visual Symbols [2]. Each image stands for a certain message:

1: cars do not enter, 2: aid, 3: caution, 4: workers on road, 5: do not run, 6: lost and found, 7: pedestrians crossing, 8: no cars except two wheels, 9: taxi, 10: wheelchair slope based on [2]).

Each RGB value of the 10 representative colors that are defined to the system is as follows: red = [197 14 10], orange = [249 103 0], yellow = [255 183 0], green = [0 118 101], blue = [10 87 157], purple = [156 60 143], white = [248 241 252], black = [28 26 30], magenta = [201 73 162], cyan = [0 174 239]. The RGB values of all colors that are defined by JIS and ISO standards are used. Comparing color difference on RGB color space between each color of two pixels is calculated by Euclidean distance.

4. Experiments

In this time, we have evaluated performance of minimum functions required for whole of the sign-logo search & combination system through several experiments.

4.1 Experiment-1

In Experiment-1, we used 100 sign-logo sample images to check how well the background of the image is erased. The contents of the sign-logo should remain, while the background colors are being removed. The numbers of correctly processed images were 92, which means 92% of the images processed in this system returns the correct results.

4.2 Experiment-2

In Experiment-2, we checked the color layers for the sample images to see how well the colors are decomposed. Out of the 100 images, 98.7% of the images were correctly processed and analyzed with correct objects on each layer. The red layers were 99.7%, orange layers were 100%, yellow layers were 100%, green layers were 100%, cyan layers were 99.8%, blue layers were 99.5%, purple layers were 99.9%, magenta layers were 99.8%, and white and black layers were 100% correct.

4.3 Experiment-3

In Experiment-3, we set an image-query (stop sign) and compared with 5 sample images. Firstly, the image-query becomes decomposed as shown in Figure 14.
The 5 sample images are chosen in the similarity level, compared to the image-query. The sample images and the similarity level are shown in Figure 15.

Next, we calculated the integration between the image-query and each sample image. The results are ranked as in Figure 16.

4.4 Experiment-4

For Experiment-4, we set an image-query (toilet) that is more complicated in comparing to Experiment-2, and it is compared to sample images that are also more complicated. The image-query becomes decomposed as shown in Figure 17.

The sample images and the similarity level are shown in Figure 18.

In the same way as Experiment-3, we succeeded in calculating the integration between the image-query and each sample image. The results are ranked as in Figure 19.
5. Conclusion

In this paper, we have presented a sign-logo search & combining system focusing on the color and shape features of sign-logos. This system analyses the color and shape information of the image input by the user, and divides the shape information into the frame information and object information, which consists of the color layers. In order to realize the sign-logo communication, we have experimented to confirm effectiveness of our system. In Experiment-1, we found out that the preprocessing step of the system is 92% correctly working. The 8% of the images turned out to be blank because the system misread the color information and erased the necessary colors in the image with the background colors. From Experiment-2, we found out that 98.7% of the color layers were correctly processed. Almost all the color layers were correctly generated, but the wrong layers tend to turn out as sets for the close colors such as blue and cyan, purple and magenta. From Experiments-3 and 4, by setting the same, similar, and different images in the retrieval step we found out that the same image becomes 1st rank and the similar image becomes 2nd. From this experiment, we noticed that the decomposition and search process is working. The combining section should be added and connected so that the user can dynamically create the sign-logo image in their mind.

This system has a possibility of contributing to communication between people who uses different languages, and to share the same interpretations during collaborating scenes mentioned in the examples.

As our future work, we have several points we need to cover and extend in order to create a better system and a sophisticated user interface. Firstly, as mentioned in Experiment 2, we need to figure out how to process the close colors correctly. Secondly, in our current system, the objects in the same color layer are counted as one object. In the future, the system needs to be improved so that the related objects within the same color layer are counted as one object. Lastly, we need to extend the system so that the combining process can automatically run.

References


