

Image Classification and Retrieval by Color Concentration Features

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Abstract – The method for distributed features of visual pattern extracted from intensity fragments and segments is considered. The features of intensity, pixel coordinates and mixed ones are calculated. Some main image features as well as results of similar patterns searching from known databases are presented.

Key words – pattern features, intensity volume, fragments, segments, searching of similar patterns.

I. Introduction

Content-based image retrieval Systems (CBIR) are based on two stages: indexing and searching. The central element of a vector image properties. The categories and properties of the image intensity, color histograms, a relative position of the colored object regions, their shape, the Fourier coefficients of wavelet functions and so on are the main features image retrieval. There are many works devoted to extracting image features. In particular, in [1 - 3] contain the regions, block color histogram and invariant factors. [4 - 6] present algorithms to form the main objects of attention and their quantitative characteristics. Various characteristics of texture and algorithms of calculation are proposed in [7-9]. The spatial locations of attention is also used for image classification. In particular, in [10, 11] the concept of "top", "bottom" and so on are introduced. The most known examples of CBIR are SIMPLicity [11] VisualSEEK [12]. In both systems, the image is segmented into regions, color and dimension are included in the vector properties.

II. The concentration of color

We propose to determine the concentration ratio of color image and its fragments to characterize a texture image as a whole. Let us to consider the three black and white images, in which the total areas of the black and white are the same. We suppose that the concentration of black and white colors in the leftmost image is the largest and on far right - the smallest

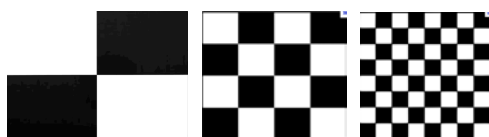


Fig. 1. Picture with different concentration of color

We denote the area square of white and black, respectively, S_w and S_b . We calculate the total length (which can be taken as the area square) of a single-pixel border between the white and black parts in the picture:

$$S_L(b, w) = \sum_{i \in I(b, w)} L_i(b, w) \quad (1)$$

where $S_L(b, w)$ - a boundary square, $I(b, w)$ - a set of boundary pixels between regions, $L_i(b, w)$ - a length of one boundary fragment.

We propose the concentration ratio of white and black as follows

$$K_k(w) = S_w / S_L(b, w), \quad (2)$$

$$K_k(b) = (S_b - S_L(b, w)) / S_L(b, w)$$

For the images presented in Fig. 1 the corresponding concentrations of white and black pixels without external borders are:

$$K_k(b) = 1, K_k(b) = 1/3, K_k(b) = 1/7 \quad (3)$$

Including the perimeter to the area squares the concentration of black changes not essentially:

$$K_k(b) = 1/2, K_k(b) = 1/4, K_k(b) = 1/8 \quad (4)$$

III. Procedure to determine area and perimeter squares

To determine the area of each color and perimeter length of a figure that forms a particular color, the procedure to scan an image by the 2x2 pixels area is being developed (Fig. 2). The scanning window moves by one pixel to the right and down. At the right and low boundaries we have rectangles by two pixels: 2x1 and 1x2. In Fig. 2a illustrates the scanning process, and Fig. 2b – types of scanning windows.

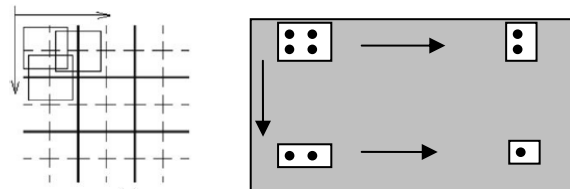


Fig. 2. Processing by scanning window

During the scanning process value of the horizontal and vertical components and borders between different colors are accumulated. Operations based on the first pixel are carried out to create the necessary vectors and matrices. Fig. 3 presents three examples of binary images and calculated concentrations of black and white colors.



Fig. 3. Binary images. And their concentrations of black and white:
a) 3, 11, b) 8, 20, c) 20, 20

IV. Concentration extraction for image fragments

We propose the new image features as a set of color concentrations which the image fragments could be characterized. We call the distributed features.

If we divide the image into N parallel fragments ($s = 1, \dots, N$), we can calculate concentration ratios of black and white for every of them:

$$K_k(s, w) = S_w(s) / S_L(s, b, w),$$

$$K_k(s, b) = (S_b(s) - S_L(s, b, w)) / S_L(s, b, w), \quad (5)$$

where $S_L(s, b, w)$ - an area of the border region for color within the s -th fragment; $S_w(s)$ - an area of the color region of within the s -th fragment.

Thus, we obtain the feature vector whose $K_k = \{K_k(s, w), \dots, K_k(s, b)\}, s = 1, N$ components are being made as keys for classification or image retrieval by content.

Fig.4 shows an example of the image and concentration of black for 25 horizontal fragments

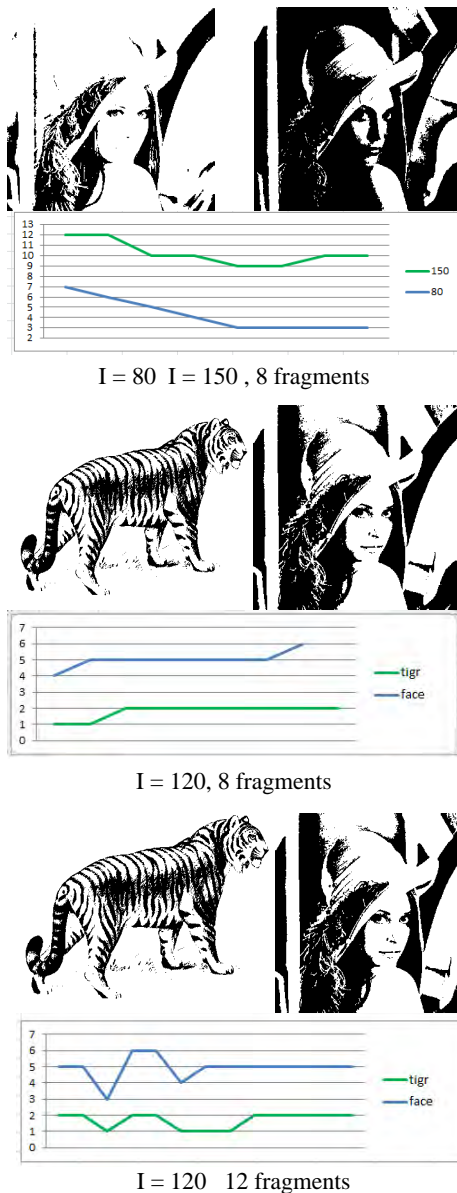


Fig. 4. Binary images and the concentration of black in fragments

To compare the image color concentrations with different dimensions it is proposed the increasing (decreasing) coefficient to equalize color concentrations:

$$r_{hw} = \sqrt{r_h * r_w},$$

where r_h, r_w - increasing (decreasing) coefficients for image width and height according to the query one/ This coefficient is used to multiply the color concentration of the images with other dimension.

V. Experiments

The proposed features were used for image classification and retrieval by content. For a number of binary image textures the concentration ratios of black and white were calculated. Classification results are presented on Fig. 5 where sum of feature squares were sorted.

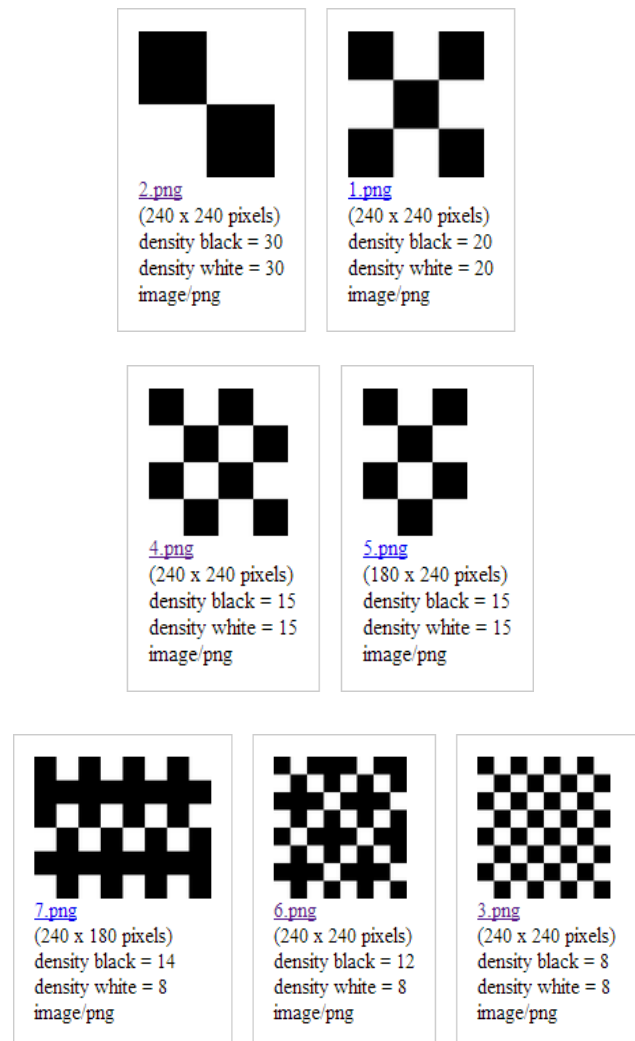


Fig. 5. Textures for classification

The key features of both colors allow to search images by content in the database. The group of 15 different types of images were taken to make searching experiments. Results for the image-query testing are given on Fig.6 -9 for different types of images as well as the criterion function values.

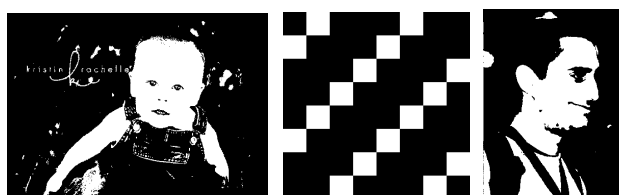


Fig. 6. Searching results for the plant-query

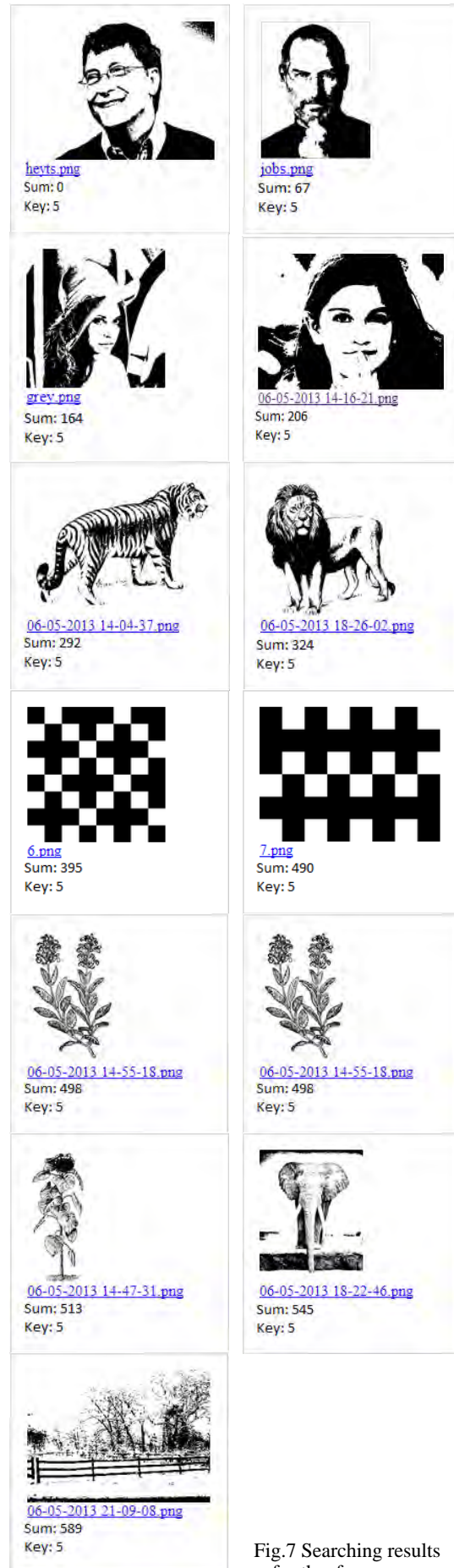


Fig.7 Searching results for the face-query



Fig. 8. Searching results for the nature-query



Fig. 9. Searching results for the children-query

Conclusions

The method to calculate the concentration of color and the image features is proposed. The calculated features are used to search and classify images by content.

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