Rotation and Scale Invariant Hybrid Image Descriptor and Retrieval

Computers & Electrical Engineering, Elsevier, 2015

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Introduction

- A rotation and scale invariant hybrid descriptor (RSHD) is proposed from color and textural data for image retrieval.
- Color is encoded by quantizing RGB color into 64 shades.
- Texture is extracted using 5 rotation invariant structuring element over each quantized color shade.
- Color and texture information are fused together by encoding the texture over color shades.
- RSHD outperforms state-of-the-art descriptors like SEH [1] and CDH [2].

Color Quantization

The color quantization technique is illustrated in Fig.1. The Red, Green and Blue channels of the image are having the values in the range 0 to 255. After quantization, it becomes one channel with the values in the range of 1 to 64.

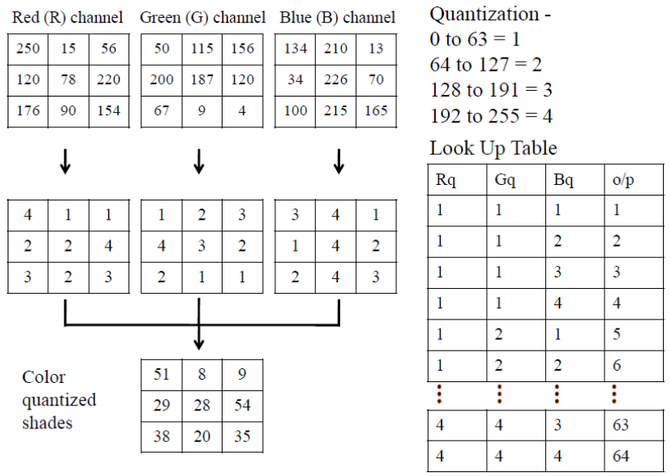

Fig.1. Color quantization technique.

Descriptor Construction

The five structure elements used are shown in the Fig. 2. It is represented by the number and orientation of the active elements (i.e. highlighted pixels). We refer these structures of Fig. 2 (a-e) as type 1, type 2, type 3, type 4, and type 5 structures respectively. We define six patterns, $Pattern_i$ for i=0 to 5 from five structuring elements of 5 bins as shown in Fig. 3. $Pattern_0$ corresponds to no structure for a particular quantized shade and the values of all five bins are set to zero. $Pattern_i$ for i=1 to 5 correspond to type i structure element and only the i^{th} bin is set to 1 in the corresponding pattern (all other bins are set to zero). To illustrate the concept of structuring pattern, suppose we have only four quantized shades form 1 to 4. Fig. 4 illustrates the computation of the structuring pattern for each quantized shade (i.e., $SP^c|_{c\in[1,Q]}$, where Q is the number of quantized color shade) for three examples.

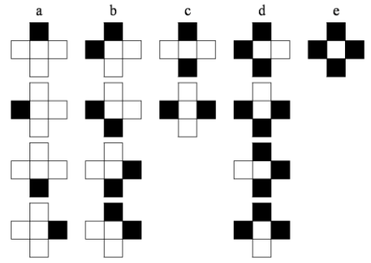

Fig.2. Five structure element containing (a) only one, (b) two consecutive, (c) two non-consecutive, (d) three consecutive, and (e) four consecutive active elements.

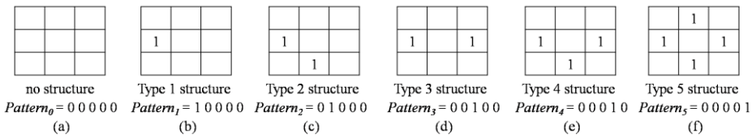

Fig.3. Six patterns derived from the five structure elements, representing (a) no structure, (b) type 1 structure, (c) type 2 structure, (d) type 3 structure, (e) type 4 structure, and (e) type 5 structure.

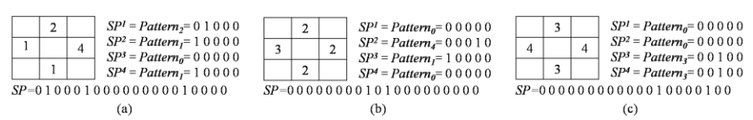

Fig.4. Three examples to illustrate the computation of Q patterns over each quantized shade for a particular pixel; in this example, the value of Q is set to four.

The structuring pattern SP for any pixel (x, y) of image is defined as the concatenation of the structuring pattern over each shade for pixel (x, y)) and given as follows,

$$SP(x,y) = \left(SP^1(x,y), SP^2(x,y), \ldots, SP^c(x,y), \ldots, SP^Q(x,y)\right) \quad (1)$$

where $SP^c(x,y)$ is the structuring pattern over c^{th} color shade.
The final RSHD descriptor for image M is mathematically defined as follows,

$$des = \sum_{\forall\,(x,y)\in M} SP(x,y) \quad (2)$$

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Databases

1. Corel-cbir database [3] - 80 categories, 10800 images.
2. Corel-10k database [4] - 10 categories, 1000 images.
3. Corel-rotated database - angles 0, 90, 180, and 270 degrees, 10 categories, 4000 images.
4. Corel-scale database - scales of 0.5, 0.75, 1, 1.25, and 1.5, 10 categories, 5000 images.

Experimental Results

The RHSD descriptor is compared with SEH and CDH in Fig.5 in terms of the similarity score using the distance used in [4]. The image retrieval results in terms of precision vs recall are shown in Fig. 6. The retrieved images for a query are displayed in Fig. 7.

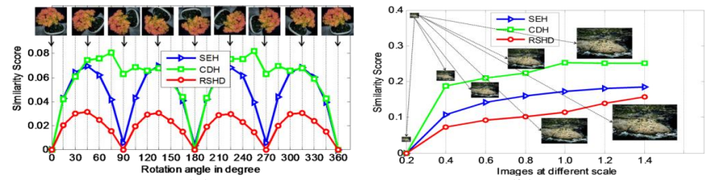

Fig.5. Comparison of RSHD descriptor with SEH and CDH descriptors (a) under rotation, and (b) under scale change conditions.

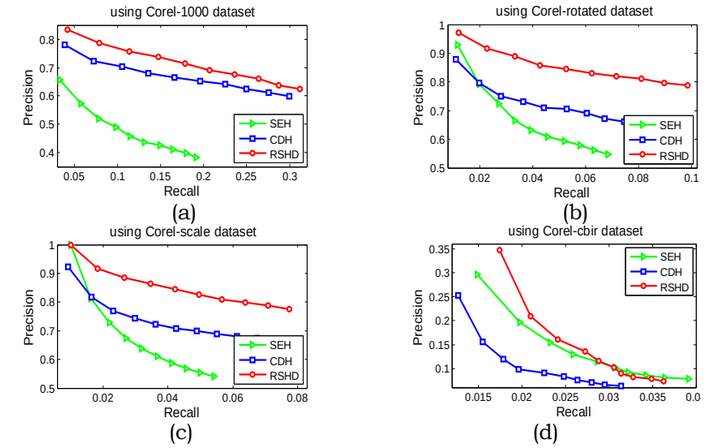

Fig.6. Performance comparison of RSHD descriptor with other prominent feature descriptors such as SEH and CDH over (a) *Corel-1000*, (b) *Corel-rotated*, (c) *Corel-scale*, and (d) *Corel-cbir* databases.

(a) using SEH (b) using CDH (c) using RSHD

Fig.7. Retrieved images using different descriptors for a query image (i.e. first image in each result) from *Corel-cbir* database.

References

[1]. Wang, X., Wang, Z.: 'A novel method for image retrieval based on structure elements' descriptor', *Journal of Visual Communication and Image Representation*, 2013, 24, (1), pp. 63-74.

[2]. Liu, G.H., Yang, J.Y.: 'Content-based image retrieval using color difference histogram', *Pattern Recognition*, 2013, 46, (1), pp. 188-198.

[3]. https://sites.google.com/site/dctresearch/Home/content-based-image-retrieval.

[4]. http://wang.ist.psu.edu/docs/related/.