



Boosting Local Binary Pattern with Bag-of-Filters for Content Based Image Retrieval

IEEE UPCON, 2015 (Best Paper Award)

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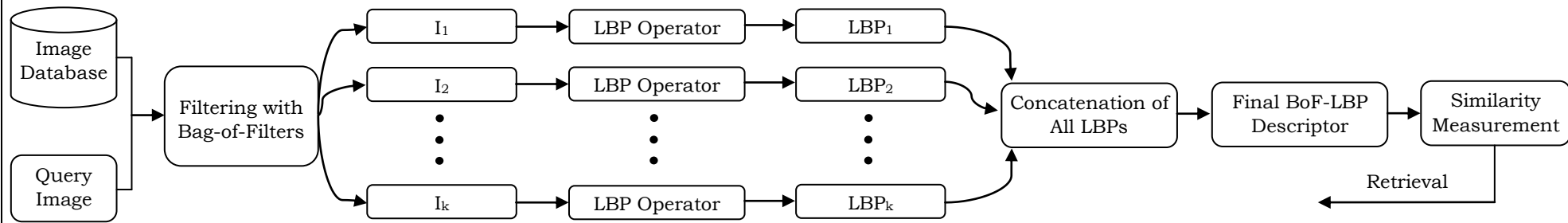


Fig.1. The proposed image retrieval framework using Bag-of-Filters (BoF) and Local Binary Pattern (LBP).

Introduction

- Most of the descriptors are computed over the raw intensity image which lacks the local relationships.
- It is proposed here to compute the descriptors over the filtered images using several kinds of filters.
- BoF-LBP computes the LBP descriptor [1] over five filtered images and finally combines all into one descriptor.
- The improved performance is observed over natural and texture databases using image retrieval experiments.

Proposed CBIR System

- The schematic diagram of the proposed CBIR system is presented in the Fig. 1.
- First of all, each image is processed by Bag-of-Filters (BoF) to obtain the multiple filtered images having different kinds of crucial information such as edges, corners, etc.
- In order to encode such information locally in the descriptor form, Local Binary Pattern (LBP) operator is applied over each filtered image.
- Finally, all descriptors are concatenated to construct the final BoF-LBP feature descriptor.
- The query image is matched with the database images by finding the distance between the BoF-LBP descriptor of query image and database images.
- The most relevant images are retrieved from the database on the basis of the shortest distances between the descriptors.
- The five different types of filter masks are Average, Horizontal-vertical difference, Diagonal difference, Sobel edge in vertical direction and Sobel edge in horizontal direction in the Bag-of-Filters. Fig. 2 presents the 3×3 mask for these filters.

$$\frac{1}{9} \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix} \quad \begin{bmatrix} 0 & -1 & 0 \\ -1 & 4 & -1 \\ 0 & -1 & 0 \end{bmatrix} \quad \begin{bmatrix} -1 & 0 & -1 \\ 0 & 4 & 0 \\ -1 & 0 & -1 \end{bmatrix} \quad \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix} \quad \begin{bmatrix} 1 & 0 & -1 \\ 2 & 0 & -2 \\ 1 & 0 & -1 \end{bmatrix}$$

Fig.2. The five types filters used in the Bag-of-Filters, (a) Average filter, i.e. F_1 , (b) Horizontal-vertical difference filter, i.e. F_2 , (c) Diagonal filters, i.e. F_3 , (d) Sobel edge in vertical direction, i.e. F_4 , and (e) Sobel edge in horizontal direction, i.e. F_5 .

The images obtained by applying the five filter masks over an example image are depicted in Fig. 3. It can be observed that the Average filter (i.e. F_1) gives the low frequency information (i.e. smooth variations), whereas, the remaining filters (i.e. $F_i |_{i=2,3,4,5}$) provide the high frequency oriented information (i.e. edges in particular directions). The combination of both types of filters increases the discriminating ability of *BoF-LBP* descriptor.

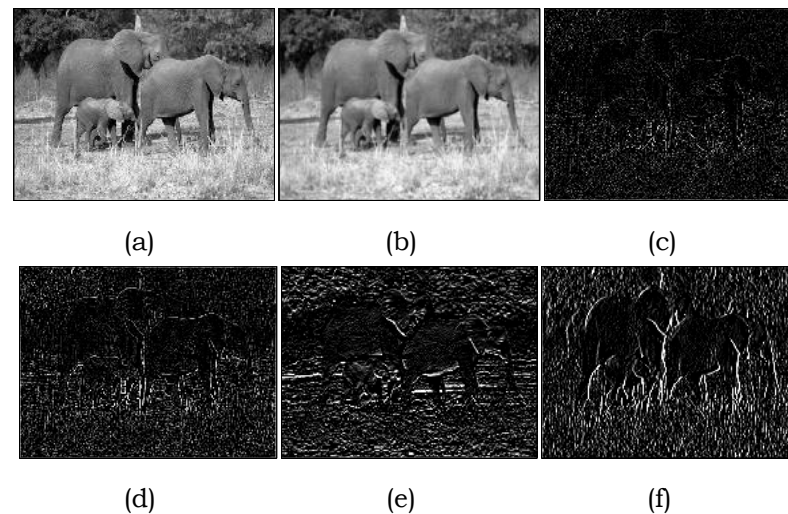


Fig.3. (a) An example image, (b-f) the image obtained after applying the 5 filters with mask $F_i |_{i=1,2,3,4,5}$ respectively over the example image of (a).

Experiments and results

Databases Used -

Corel-1k [2]: 1000 images from 10 categories,
Corel-10k [3]: 10800 images from 80 categories,
MITVis-Tex [4]: 640 images from 40 categories, and
STex-512S [5]: 7616 images from 26 categories.

Corel-1k and Corel-10k are the natural databases, whereas, MITVis-Tex and STex-512S are the texture databases.

Descriptors Compared -

Local Binary Pattern (LBP) [1], Semi-structure Local Binary Pattern (SLBP) [6], Sobel Local Binary Pattern (SOBEL-LBP) [7], Local Ternary Pattern (LTP) [8], Local Derivative Pattern (LDP)

[9], Local Tetra Pattern (LTrP) [10], and Spherical Symmetric 3-Dimensional Local Ternary Pattern (SS-3D-LTP) [11]. Fig.4 shows the experimental results using average retrieval precision (ARP). Fig.5 displays the retrieved images for a query image.

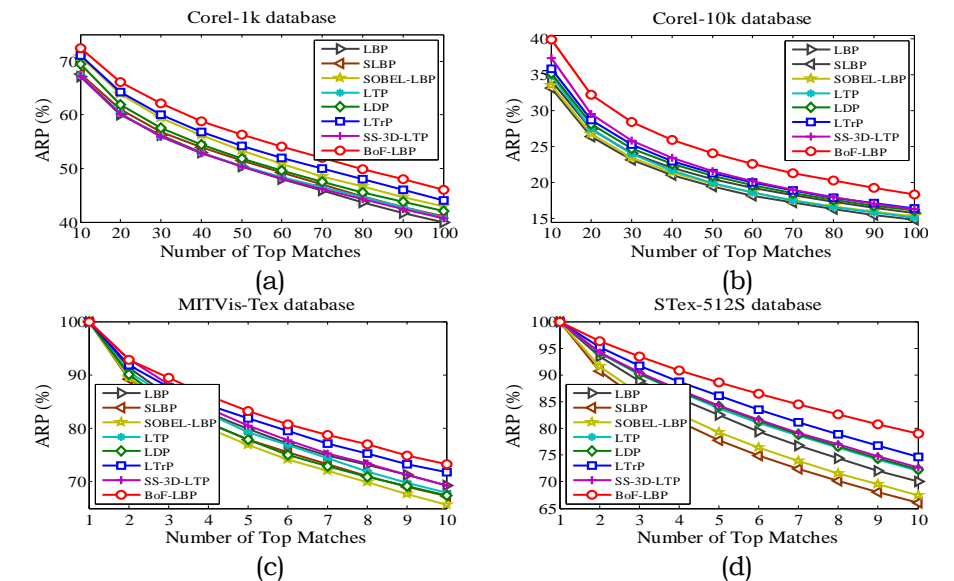


Fig.4. The retrieval results over (a) Corel-1k, (b) Corel-10k, (c) MITVis-Tex, and (d) STex-512S databases.



Fig.5. The top 10 retrieved images (in the last 10 columns) for a query image (in the first column) from Corel-1k database using LBP, SLBP, SOBEL-LBP, and BoF-LBP (in 1st to 4th row respectively). The incorrect retrieved images are enclosed in 'Red' rectangles.

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