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# Image Searching Algorithm based on the Partition of Multiple Scales and Levels

Lu Zhaogan and Bao Zhiguo
College of Computer and Information Engineering,
Henan University of Economics and Laws, Zhengzhou, 450002, China

**Abstract:** By the reasons of the bad accuracy of drawbacks of current image searching algorithms, the difficulties and uncertainties of image blocking procedures, one image searching algorithm with the partition of multiple scales and levels is proposed in this study, which is conducted by the classic wavelet multiple scale and level decomposition algorithm. According to the algorithm, the interest objects would be found in the image partitions at different levels with different scales, where the Gabor texture features, main colors and color invariant moments were used as the metric of image searching results. Based the numerical evaluation results with classical histogram and invariant moment approaches, the image searching accuracy is improved from 66 and 68-77% by the algorithm with feasible implementation.

**Key words:** Image partition, image searching, wavelet decomposition

## INTRODUCTION

Generally speaking, the image content is expected to be presented as the image features extracted from the images (Pujari and Nayak, 2010; Lin *et al*., 2004; Shao and Wang, 2012; Sahu *et al*., 2012), i.e., colors, textures and shapes so on. Then, these feature parameters would be used to search the images with similar features from image databases. Up to now, the researches about the image searching are mostly limited to the whole image searching, which could not obtain those images with similar contents. In fact, the simplest image searching method is template matching (Vu *et al*., 2003). However, the image template complexity is affected by the sizes, angles of objects contained in the image. So, the method is limited by its bad effects. Therefore, the classical methods (Jing *et al*., 2004; Rahman *et al*., 2010; Pratikakis *et al*., 2006; Lu *et al*., 2006) were proposed that the images are firstly segmented into different objects and then the image features such as colors, textures and shapes were extracted. These image features are invariant so that they could be used for possible image content searching. But, its performance is greatly affected by the bad image partition results in the case with complex backgrounds. Meanwhile, the extraction of the colors, textures and shapes of objects in images, would be involved to the image partition, image transformation and other algorithms with high complexity. And, they would also need a large number of storages. This lead it to be practical with bad feasibility for those image searching algorithms based on the image partitions. Except for image partitions, another image searching method based image contents is that the images are parted into several blocks with same sizes (Abubacker and Indumathi, 2010) and then each block would be matched to image content template. But, this method is one with good uniformity, which would lead to the same image object to be parted into different blocks. Thus, the method would fail to search the object. Furthermore, the image block size sould also be selected carefully and it's another unwieldy problems.

With considering the drawbacks of the existing image searching algorithms based on the image content, the difficulty and uncertainty of image block algorithm, one image searching algorithm based on the multiple scales with multiple levels, was proposed in this study. This proposed image searching scheme is based on the classical image partition scheme with multiple scale wavelet transformation. Its basic idea is to search the content contained in the image partition blocks, where the Gabor texture features, main colors and the color invariant moments were used as the typical measure degree of image contents.

## IMAGE SEARCHING ALGORITHM WITH MULTIPLE SCALES AND LEVELS

Suppose that the searching image or sample consist of $N_q$ components, whose features are given by their corresponding texture feature, main colors and moment invariant variances. Thus, the feature vector of the image searching algorithm is described by this Eq. 1:

$$F_q = \{T_g(i), M_c(i), C_c(i) | i = 1, 2, ...., N_q\} \quad (1)$$

**Corresponding Author:** Lu Zhaogan, College of Computer and Information Engineering, Henan University of Economics and Laws, Zhengzhou, 450002, China

Meanwhile, there are M images in the image database and each image is parted in L levels. Each image would be parted into $N^l_m$ blocks at the l levels. Furthermore, the i block could be parted into $N^l_{m,i}$ sub-blocks at its next level. Therefore, the number of blocks at the l+1 scale that the image would be parted into, could be given by Eq. 2:

$$N^{l+1}_m = \sum_{i=1}^{N^l_m} N^l_{m,i},\ l = 0, 1, \cdots, L-1,\ m = 1, 2, \cdots, M \tag{2}$$

When l = 0, we get $N^0_m = 1$, where $N^1_m$ could be considered as the number of blocks that the image is parted initially. The feature vector of the i blocks at the l level for the m image in the image database, could be presented as the following Eq. 3:

$$F^l_m(i) = \{T^l_{m,g}(i), M^l_{m,c}(i), C^l_{m,c}(i)\} \tag{3}$$

where, m = 1, 2,..., M, l = 1, 2,..., L, i = 1, 2,..., $N^{l-1}_m$.

According to the image partitions and corresponding image searching algorithm, the feature as shown above are used to conduct image searching for one given image template. Here, the image searching algorithms with multiple scales and multiple levels could be finished according to the following steps:

- For the image to be searched or image sample, it would be parted into different blocks according to its content, then the Gabor texture feature, main color and color invariant moments are computed. Otherwise, the property features are given directly for the researching image objects in the form as Eq. 1
- By iterating all the images in the image database, each image would be check if there are containing the content as specified in the searching images. For the m image in the image database, where m = 1 is supposed, the image searching algorithm with multiple scales and multiple levels could be conducted as the following steps:
  (a) The m image in the image database is filtered by the Gabor filtering banks with P frequencies and Q levels
  (b) As the reference presented, the classical image partition algorithm is conducted to the m image at the L scales with multiple scales and multiple levels
  (c) Obtain the image features, i.e., the Gabor texture feature, mainly color and color invariant moments, for the m image at each partition scale. Thus, the feature vector for the i partition block at the l scale could be formatted into the form as the Eq. 2 displayed
  (d) Suppose l = 0, the total about $N_q$ combinations of the parted blocks at the l scale for the m image, are checked if being matched to that of image searching samples. Thus, the same processing is conducted for all the objects in the image and the multiple object searching could be finished according the Eq. 3. At the same time, their similar degrees are evaluated according to the results of Zhang (2012) by Zhang mingxin, Xi'an Jiaotong University, 2012. Based on the similarity values, the searched images are justified if they are the searching objects in the images from the image databases
  (e) Let l = l+1 and if l>L-1, the searching process would continue. Otherwise, the searching process would return to the step d) and the content in the next image would be conducted in the image database by image partition
  (f) Now, let m = m+1 and if m>M, the searching processing is continue. Otherwise, return to a) for the next image content searching
- The images searched from the image database are brought to the user interfaces
- The image searching process is finished with multiple scales and levels

In order to present the whole process of the proposed searching image algorithm with multiple scales and levels, its flow chart is described by Fig. 1. According to the flow chart, its key to conduct image searching is the image partition with multiple scales and levels, which are also the fundamentals for the image searching scheme with multiple scales and levels. Meanwhile, the texture features, invariant moments, main colors, have the characteristic with invariant for the scale, orthogonal transformation. It's very appropriate to use these invariant features as the characteristics for the image content searching for the possible objects with different scales, orientation and locations.

## NUMERICAL RESULTS

In order to verify the image searching algorithm with multiple scales and blocks proposed in this study, the image database consists of about 500 pictures with about 5 typical categories, i.e., flowers, plants, birds, cars, nature scenes, animals and so on. Furthermore, these pictures are different in their size and formats and used to verify the robust performance of the image searching algorithms. The typical images are displayed in Fig. 2 for the five

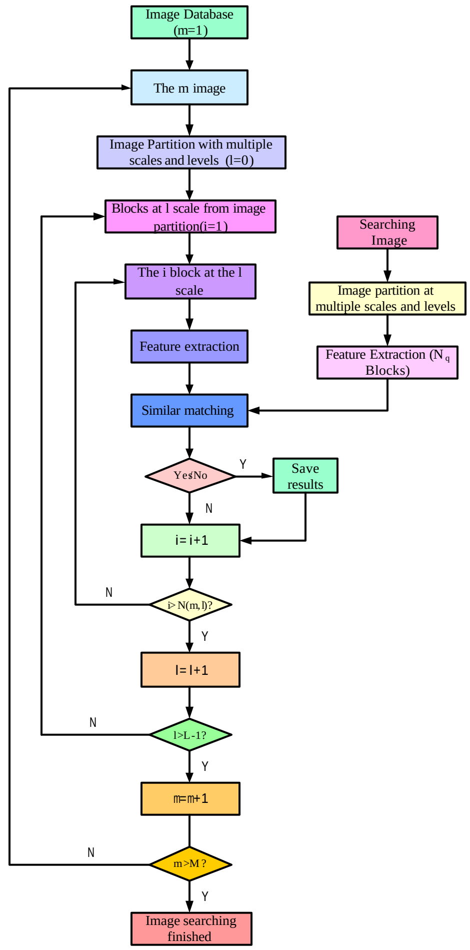


Fig. 1: Basic flow chart of image searching with multiple scales and levels

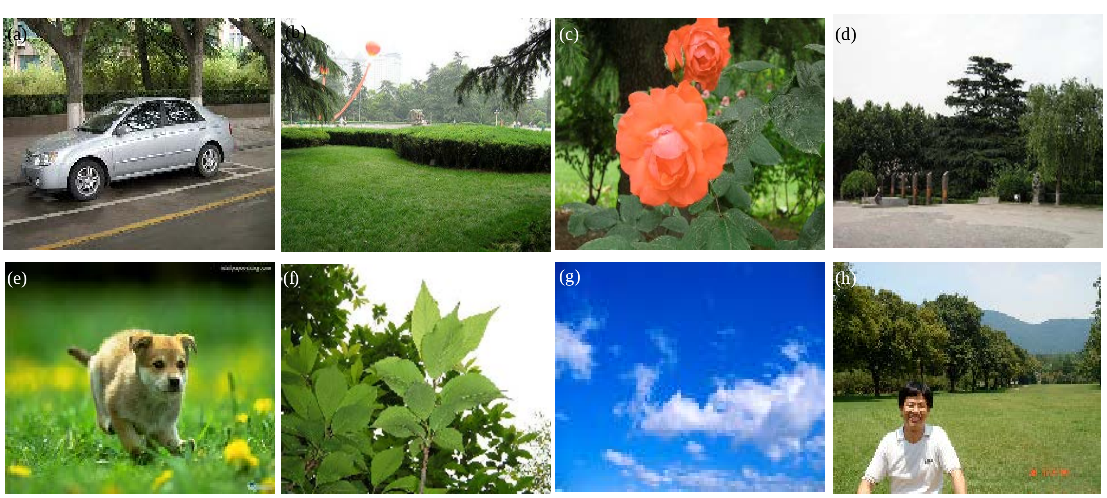


Fig. 2(a-h): Typical images in image databases


Fig. 3(a-i): Searching results for the proposed image searching algorithm with multiple scales and blocks, (a) Query image, (b) $d_{mahal}$ = 0.95, (c) $d_{mahal}$ = 0.89, (d) $d_{mahal}$ = 0.83, (e) $d_{mahal}$ = 0.72, (f) $d_{mahal}$ = 0.61, (g) $d_{mahal}$ = 0.59, (h) $d_{mahal}$ = 0.54 and (i) $d_{mahal}$ = 0.49

typical categories. The searching precision and recall are used to evaluate the performance of the presented image searching schemes. In the following content, the searching results at different levels are showed for typical images in the databases at different searching levels to evaluate the performance. At the same time, the classical image searching algorithm, i.e., histograms and geometry invariant moments are also implemented for the comparisons between the proposed image searching schemes and the classical schemes with multiple scales and blocks. Here, the Ma distance is used as one metric to measure the similarity of the searching images to that in the image databases.

Firstly, for the same searched image, three typical image searching algorithms are conducted to image searching based contents in the image database, i.e., the image searching schemes based multiple scales and blocks, the scheme based histogram and the scheme based color invariant moments. According to the sequence of similar values for the recalled images in the image database to the searching image sample, the searching results are analyzed as indicated in the Fig. 3-5. The similarity size of the recalled images to the searching image, are marked respectively, where three levels are conducted for the image searching based multiple scales and blocks. Furthermore, the case of multiple blocks is considered when the image partition was conducted for the searching images.

By the comparisons of searching results via the three different searching results, we could find that the image searching results based the scheme with multiple scales and blocks could reach to the expected


Fig. 4(a-i): Searching results for the image searching algorithm with color invariant moments (a) Query image, (b) $d_{mahal}$ = 0.91, (c) $d_{mahal}$ = 0.83, (d) $d_{mahal}$ = 0.79, (e) $d_{mahal}$ = 0.69, (f) $d_{mahal}$ = 0.61, (g) $d_{mahal}$ = 0.59, (h) $d_{mahal}$ = 0.52 and (i) $d_{mahal}$ = 0.51


Fig. 5(a-i): Continue


Fig. 5(a-i): Searching results for the image searching algorithm based histograms, (a) Query images, (b) $d_{mahal}$ = 0.97, (c) $d_{mahal}$ = 0.95, (d) $d_{mahal}$ = 0.91, (e) $d_{mahal}$ = 0.87, (f) $d_{mahal}$ = 0.82, (g) $d_{mahal}$ = 0.77, (h) $d_{mahal}$ = 0.68 and (i) $d_{mahal}$ = 0.61

Table 1: Performance test metrics for three typical image searching schemes

| Precision (%) | | | Recall (%) | | |
|---|---|---|---|---|---|
| MSMA | Histogram | Invariant moments | MSMA | Histogram | Invariant moments |
| 79.7506 | 65.0305 | 68.0772 | 82.4828 | 75.1312 | 75.7878 |
| 76.1557 | 66.4936 | 68.9597 | 84.4988 | 74.6940 | 76.8096 |
| 78.0342 | 65.8902 | 69.6091 | 84.1081 | 75.0620 | 76.1384 |
| 77.4299 | 66.8636 | 68.6910 | 83.2246 | 74.3358 | 76.2636 |
| 79.4565 | 65.9320 | 66.8813 | 84.0899 | 74.7316 | 75.4688 |
| 78.8105 | 65.8373 | 67.0285 | 83.3011 | 73.9038 | 76.0976 |
| 77.2823 | 66.6924 | 69.6773 | 81.7099 | 75.3192 | 76.8632 |
| 75.0925 | 66.0503 | 69.5845 | 81.4486 | 76.0415 | 75.6704 |
| 79.107 | 65.4053 | 67.0514 | 81.7060 | 75.1193 | 76.3111 |
| 77.2235 | 66.3443 | 69.4682 | 82.6704 | 75.5621 | 76.0838 |
| **Average** | | | | | |
| 77.8343 | 66.0540 | 68.5028 | 82.9240 | 74.9900 | 76.1494 |

precision and recalls. The good searching accuracy is higher than that based histogram and invariant moments. While, the latter two image searching algorithms are based the global image features, which lead to low accuracy and few successful searching results.

In the following, ten images are used to conducted image searching algorithms by the three typical image searching algorithms in the image database. For each image searching schemes, the image searching results are evaluated by average according to the searching precision and recall as the performance metrics. The performance evaluated results are presented in Table 1, Fig. 6 and 7, where three level image searching processes is conducted for the scheme with multiple scales and blocks. According to the numerical results, compared with the scheme based histogram and invariant moments, the image searching algorithm based multiple scales and blocks improves the precision from 66 and 68-77%, while the recall from 74 and 76-83%. Therefore, the image searching scheme based multiple scales and blocks improved the image searching performance, which could be used for possible applications.

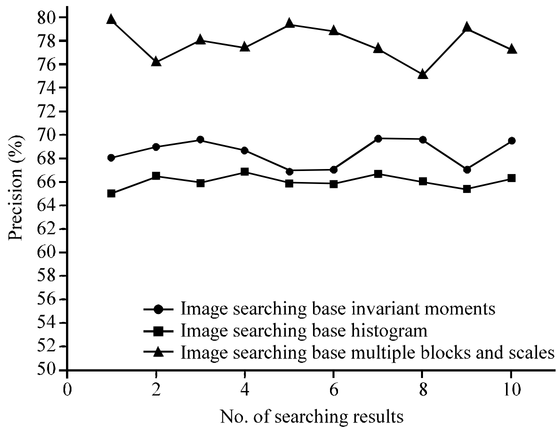


Fig. 6: Precision comparisons for different image searching algorithms

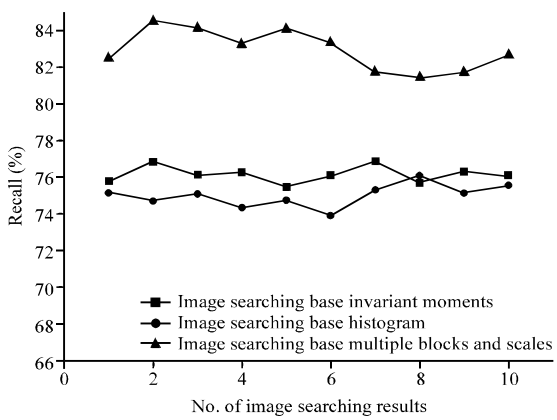


Fig. 7: Recall comparisons for different image searching algorithms

## CONCLUSION

According to the researched results, the image searching based contents is actually the image searching schemes based blocks. Its performance is mainly determined by the performance of image partition schemes for the possible objects in the images. As one searching image consists of many different contents or blocks, the classical image partition schemes based wavelet transformation with multiple scale, is given in this study. The performance of the proposed image searching algorithm is tested by its numerical results.

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