Contemporary Engineering Sciences, Vol. 7, 2014, no. 32, 1731 - 1738
HIKARI Ltd, www.m-hikari.com
http://dx.doi.org/10.12988/ces.2014.411232

Heuristic and Intermediate Features Based Image Retrieval

Dipankar Hazra

Computer Science and Engineering Department
OmDayal College of Engineering & Architecture
Uluberia, Howrah-711316, India

Debnath Bhattacharyya

Computer Science and Engineering Department
Vignan's Foundation for Science, Technology and Research
Guntur-522213, AP, India

Kil-hwan Shin*

Department of Public business, LIG System, Seoul, Korea
*Corresponding author

Abstract

In this paper, a new method for heuristics and intermediate features based image retrieval is proposed. Heuristic features are identified and directly stored into the database and easily retrieved also. An algorithm is used to convert low level features hue, saturation and intensity in HSI space to semantic based color names. Images can be retrieved by these semantic color names. For semantics based texture queries, statistical values of textures calculated from the image are used as the low level features in image retrieval. But these low level features are mostly not understandable by the general human. There is always a semantic gap between human understanding and low level features. Image database is constructed with low level texture features obtained from Gray Level Co-Occurrence

Matrix (GLCM). Semantic level queries from the user mapped to the low level features at retrieval time to retrieve the required images.

Keywords: Semantic Based Image Retrieval, texture retrieval, intermediate feature

1. Introduction

Content Based Image Retrieval systems (CBIR) use either query image or text query to retrieve similar images from an image database based on the user requirements. For query image based retrieval the visual low level features such as texture, color and shape of the images are extracted and stored in the image database. The visual low level feature of the query image is extracted and compared with the stored features to retrieve the similar images. But retrieving images for text queries required higher level semantics mentioned in the text. This is also called Semantic Based Image Retrieval (SBIR). Our system will be able to query images based on (i) heuristics like 'sky', 'water' etc. (ii) semantic colors like 'dark blue' ,'pale red' etc. (iii) intermediated level texture features like 'high contrast', 'medium coarse' etc. It is difficult to identify proper heuristics because same image can be associated with different heuristics. Our system will identify heuristics of unknown image will be identified at the time of segmentation and low level feature extraction.

2. Related Works and System Description

2.1. Related Works

For color images with irregular texture, color is the most important feature used for indexing and retrieval. There are different methods for color feature based image retrieval. Color Correlogram [1, 2, 3, 4, 5] outperform all the previous approaches. Correlogram can be stored as a 3-dimensional table where first two dimensions are number of possible color pairs of an image, whereas in third dimension is the distance between color pairs. An entry in the color correlogram table shows the probability of finding a color j from color i at distance d. Mathematically, the correlogram can be represented as shown below,

$$R(i, j, d) = P(i, j \mid d) \tag{1}$$

It is computational expensive but it yields good result.

Among low level texture feature extraction methods, statistical methods of Tamura [6] and gray level co-occurrence matrix or GLCM of Haralick [7] are most popular. Each element (i, j) in the normalized Gray Level Co-occurrence

Matrix is the joint probability occurrence of pixel pairs with a defined spatial relationship having gray level values i and j in the image. If p (i, j) represents the (i, j) th element of the GLCM and N is the number of gray levels then some of the important features calculated from GLCM. Zhang, Liu, and Hou [8] extracted both heuristic features like ‘sky’, ’water’ and also intermediate features of images to use as indexes and retrieved images through structure query language. Relevance Feedback (RF) can be done for a few times to improve the retrieval accuracy. Object Ontology [9] is one method that is widely used for Semantic Based Image Retrieval (SBIR). The intermediate level descriptor values like ‘very coarse’ are defined by object ontology.

2.2. Feature Extraction and Storage of an Image

2.2.1. Heuristic Features Extraction

Heuristic features for each image are stored in the database. ‘Water’, ‘Sand’, ‘Sky’, ‘Brick’, ‘Bark’, ‘Cloud’, ‘Grass’ etc. are some of the mostly used heuristic features. For color images color based recognition is used. Color correlogram is used as low level color feature. Calculating correlogram for so many colors are space and time consuming. It has been seen local correlation is more important than correlation with larger distances. Hence to reduce the space and time complexity correlogram is calculated is for 8 colors and 8 distances. But to differentiate almost same color images like water and sky texture based recognition is used. ‘Pedestrian’, ’car’ are some of the heuristic features used and can be efficiently recognized by shape based recognition method.

2.2.2. Semantic Color Extraction

Image will be converted from RGB (Red-Green-Blue) to HSI (Hue-Saturation-Intensity) model. HSV color spaces is somewhat similar, but it more meaningful in terms of artist’s view. HSI model [10] is more meaningful in terms of user’s view, because it decouples color carrying information (hue and saturation) from intensity component and intensity component take equal value from R, G and B component of image.

The storage is dependent upon accuracy of segmentation algorithm because segmentation algorithm created initial segments on the basis of semantic colors only. Hue, saturation and intensity values will be converted to semantic color names using following algorithm.

Algorithm in HSI space for storing semantic color features

```
If I<0.1 color=’BLACK’
Else If     S<0.15 and I<0.75 color=’GRAY’
Else If S<0.15 and I>0.75 color=’WHITE’
Else If     H<0.03 color=’RED’
```

```
Else If     H<0.1 color='ORANGE'
Else If     H<0.18 color='YELLOW'
Else If     H<0.4 color='GREEN'
Else If     H<0.63 color='CYAN'
Else If     H<0.75 color='BLUE'
Else If     H<0.9 color='VIOLET'
Else If   H<0.95 color='MAGENTA'
Else    color='RED'.
If (color<>'BLACK' OR color<>'GRAY' OR color<>'WHITE')
Then
If S<0.5 Saturation='PALE'
Else If S>0.8 Saturation='PURE'
End;
If I<0.3 Intensity='DARK'
Else If I>0.75 Intensity='BRIGHT'
End;
End;
```

2.3. Design Relations for Storing Extracted Features

Following relations can be used to store features in image database. Heuristic, saturation, intensity and color are string components, whereas all other attributes except imagename and heuristic of Image_texture are contains numeric values.

Image_color (Imagename, heuristic, saturation, intensity, color);
Image_texture (Imagename, heuristic, contrast, entropy, energy, homogeneity, coarseness)

2.4. Advanced Relation Design

A relation will be created with heuristic features and its type of recognition (like color, texture or shape) method that will be useful for increasing the speed of the retrieval.

Method (heuristic, method_name)

A relation can be used to store heuristic feature along with its category. For example, 'sky' will be associated with category 'nature'. This will be required for category based image retrieval.

Category_map (heuristic, category)

Another relation can be created using each image and its synonymous image retrieved from relevance feedback. These feedbacks can be stored in feature database will later be used for image retrieval.

Feedback (imagename1, heuristic1, imagename2, heuristic2)

3. Analysis of Proposed Algorithm

Color correlogram is used for calculation heuristic features and GLCM is used for low level texture features. If we use all possible color values for color correlogram or all possible intensity values for Gray Level Co-occurrence Matrix size and computation time of each will be unmanageable. Hence we choose color ranges for color correlogram and intensity ranges for GLCM. Also large distance between two pixels does not affect quality of color based heuristics recognition in case of color correlogram. For m color d distance color correlogram, size of color correlogram is O (m^2d). In this case size is 8^2x8=512. Similarly L intensity level GLCM, size of GLCM is L^2. Size of the GLCM for the proposed system is 8x8=56.

If there are p number of color images with dimension of each is [m n], calculating color correlogram, Gray Level Co-occurrence Matrix and semantic color names take O (mnp) time. Since intermediate texture features are not being stored in the database, the time and space for that operation is nil. The retrieval from any feature database for semantic queries take O (p) time where p is the number of records. Time complexity can further be decreased if proper indexing is used.

4. Experimental Result

Images downloaded from the online Google search engine with various heuristics are being included for forming image database. Images from the Brodatz image database [11] and VisTex color image database [12] have also taken for forming image database with texture and color features. Texture database consists of images with heuristic features like ‘water’, ‘sand’, ,’grass’, ‘brick’, ‘bark’ etc. Figure.1. shows ‘Pale violet flower’ images. Figure.2. shows the images for the semantic query ‘Find coarse brick images’. Figure.3. shows the images for the query ‘Find fine brick images’. Whereas Figure.4.shows the ‘high contrast brick images’.

Image-1

Image-2

Figure1. Pale violet flower images retrieved by the system.

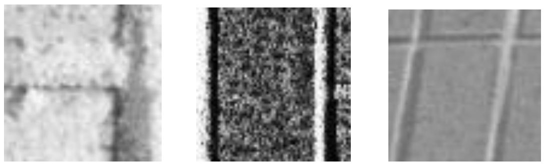

Image-1 Image-2 Image-3

Figure.2. Coarse brick images retrieved by the system.

Image-1 Image-2 Image-3

Figure.3. Fine brick images retrieved by the system.

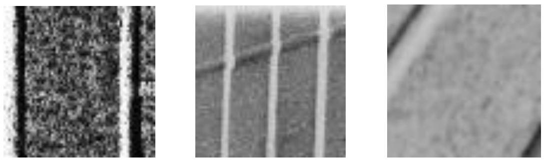

Image-1 Image-2 Image-3

Figure.4. High contrast brick images retrieved by the system.

5. Conclusion

The proposed image retrieval system retrieves images on the basis of user defined heuristics and semantic features. Heuristic Features can be directly retrieved from the database. Semantic color naming algorithm is used to retrieve images based on semantic colors. Low level texture features are stored in the database. Instead of storing intermediate level texture features, they are mapped to low level texture features at the time of retrieval only. If collection of images are increased, mapping will be changed accordingly and give more accurate result. Category also can be stored and retrieved from the database.

References

[1] J. Huang, S. R. Kumar, M. Mitra, W. J. Zhu, R. Zabih, "Image Indexing Using Color Correlograms", *Proc. IEEE Int. Conf. on Computer Vision and Pattern Recognition*, (1997), 762 - 768.
http://dx.doi.org/10.1109/cvpr.1997.609412

[2] J. Park, S. Han, Y. An, "Heuristic Features for Color Correlogram for Image Retrieval", *Proc. International Conference on Computational Sciences and Its Applications ICCSA*, (2008). http://dx.doi.org/10.1109/iccsa.2008.50

[3] W. Rasheed, Y. An, S. Pan, I. Jeong, J. Park, "Image Retrieval using Maximum Frequency of Local Histogram based Color Correlogram", *International Conference on Multimedia and Ubiquitous Engineering*, (2008). http://dx.doi.org/10.1109/mue.2008.27

[4] I. Kunttu, L. Lepisto, A. Visa, "Image Correlogram in Image Database Indexing and Retrieval", *Proc. 4th European Workshop on Image Analysis for Multimedia Interactive Services*, (2003). http://dx.doi.org/10.1142/9789812704337_0016

[5] A. Tungkasthan, S. Intarasema, W. Premchaiswadi, "Spatial Color Indexing using ACC Algorithm", *7th International Conference on ICT and Knowledge Engineering*, (2009). http://dx.doi.org/10.1109/ictke.2009.5397321

[6] H. Tamura, S. Mori, T. Yamawaki, "Textural Features Corresponding to Visual Perception", *IEEE Transaction on Systems, man and Cybernetics*, Vol. 8, No. 6, 1978W.-K. Chen, Linear Networks and Systems (Book style).Belmont, CA: Wadsworth, 1993, 123 – 135.

[7] R. M. Haralick, K. Shanmugam, I. Dinstein, "Textural Features for Image Classification", *IEEE Transaction on Systems, man and Cybernetics*, SMC-3, (1973), 610 - 621, B. Smith, "An approach to graphs of linear forms (Unpublished work style)," unpublished. http://dx.doi.org/10.1109/tsmc.1973.4309314

[8] D. Zhang, Y. Liu and J. Hou, "Digital Image Retrieval using Intermediate Semantic Feature and multistep search", *Digital Image Computing: Techniques and Applications*, (2008). http://dx.doi.org/10.1109/dicta.2008.16

[9] V. Mezaris, I. Kompatsiaris and M. G. Strintzis, "Region-based Image Retrieval using Object Ontology and Relevance Feedback", *Eurasip Journal on applied signal processing*, Vol.2004, No. 6,(2004), 886 - 901. http://dx.doi.org/10.1155/s1110865704401188

[10] Rafael C. Gonzalez, "*Digital Image Processing*", Pearson Education India, (2009).

[11] P. Brodatz, *Textures: A Photographic Album for Artists And Designers*, Dover, New York, (1966).

[12] MIT Vision and Modeling Group, "*Vistex: Vision texture database*", (1995).

Received: October 28, 2014; Published: December 2, 2014