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Content Based Image Retrieval Based on Colour and Texture Features Using Hog Descriptor

Mr. Prashant Nair Christ University Faculty Of Engineering, Bangalore

Mr. Dhileep Kumar Christ University Faculty Of Engineering, Bangalore

Mr. Ramesh Shahabadkar Christ University Faculty Of Engineering, Bangalore

ABSTRACT

Content based image retrieval had been a prominent research field. As far as the need of people using digital images is been increasing enormously, there has been an increased need for study and extension for image databases. Lot of interest had been given in retrieving the images from the databases. So, an efficient way to do the same has become a specific requirement. Thus an efficient algorithm should be made out to do the same. The images have to be characterized with certain features in order to identify an image. The basic visual features are the colour and the texture features. Therefore, an algorithm which uses the colour and the texture features has been proposed. Initially the image in the database and query image are partitioned into 6 equally sized tiles. Colour feature is represented by HSV histogram. The texture features is obtained by grey level co-occurrence matrix(GLCM). The colour feature is added to histogram of gradient(HOG) features used for object detection. A one to one matching algorithm is used to find the similar images. A threshold number of similar images are retrieved. In our paper we have set the threshold as 9 images out of the given dataset. Euclidean distance is used to compute the similarity distance. The experiments are reflected with their results to show the efficiency.

KEYWORDS : grey level co-occurrence matrix, HOG, texture feature, colour feature

1. INTRODUCTION

Image retrieval [1] has been a great area of due to the proliferation of image and video data in digitized form. The increased availability of bandwidth and storage has boomeda number of users through Internet and other ways to search for and browse through video and image databases located at remote places. Thus efficiency needs to be addressed for quick retrieval of digital images from databases.

The proposed method has proved very efficient against the traditional retrieval methods and ensures accuracy in the result being returned. The primary need is to bring out an efficient method to deal with retrieval from large-scale databases.

It has been observed that efficiency is improved when focused on the low level features [2][3][4] of the image. Thus our system uses HSV and HOGdescriptors for colour and GLCM for texture features since, these are the best to characterize, especially used to compare and represent images[5]. So, a method that captures the colour and the texture features along with object detection using HOG has been introduced. For every sub-blocks statistical texture features and colour histogram is been calculated. One to one matching is done to check the similarity measure. The next section shows the proposed system followed by experimental setups.

2. PROPOSED SYSTEM

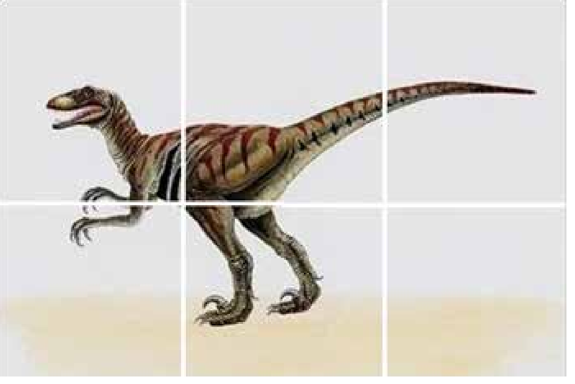
The proposed idea is about colour and texture descriptors along with HOG descriptor, followed by one to one matching of image sub-blocks.

Steps:

1. Dividing each image in the database and the query image into 6 equal sized tiles.
2. For each tile obtain cumulative HSV colour histogram.
3. Add the HOG features together with HSV histogram.
4. Obtain texture features for each tile using GLCM.
5. Construct combined feature vector for each tile.
6. Distance measure between feature vectors of query image and target image using Euclidean measure.
7. Sort the distances.
8. Retrieve the most 9 similar images with least distance.

3. SEGMENTATION INTO SUB-BLOCKS

The image is been segmented into 6 (2X3) tiles. The images with size 256 X 384 are partitioned into 128 X 128 sized blocks. The images that are not of this size are resized to 256 X 384. Each of the segments are then dealt with.



128 X 128 tiles
Fig. 1 Partitioning of image into 6 tiles

4. COLOUR FEATURE EXTRACTION

Colour is abasic visual attribute for both human perception and computer vision [12] and one of the most widely used visual features in image retrieval. An aptcolour space has to be mentioned along with the histogram representation including correct quantization techniques. The colour feature is been extracted from each sub-block using cumulative HSV histogram [6]. Hue (H) is used to distinguish colours, saturation (S) is the amount of white light inside the image and value (V) is the intensity of light fallingon the image [7]. We found, HSV colour space to be better than RGB colour space, from literature survey where each component is quantized in non-equal intervals, where H : 8 bins, S : 3 bins and V : 3 bins. Finally, these 8X3X3 bins are concatenated to obtain a 72 dimensional vector [10]. Cumulative histogram is adopted to reduce the number of zeroes in the concatenated vector.

The HSV colour space acquires large range of values that is not perceived by human vision and also becomes an overhead for calculations. So, it is better to quantize the colour space into non-equal intervals. As said, Hue is divided into 8 units, Saturation and Value are divided into 3 units each, keeping in mind ability of human eye to perceive colours of the range [6][8][9].

$$H = \begin{cases} 0 \text{ if } h \in [0, 20] \\ 1 \text{ if } h \in [20, 40] \\ 2 \text{ if } h \in [41, 75] \\ 3 \text{ if } h \in [76,155] \\ 4 \text{ if } h \in [156,190] \\ 5 \text{ if } h \in [191,270] \\ 6 \text{ if } h \in [271,295] \\ 7 \text{ if } h \in [296,315] \end{cases}$$

$$S = \begin{cases} 0 \text{ if } s \in [0, 0,2] \\ 1 \text{ if } s \in [0.2, 0.7] \\ 2 \text{ if } s \in [0.7, 1] \end{cases}$$

$$V = \begin{cases} 0 \text{ if } v \in [0, 0,2] \\ 1 \text{ if } v \in [0.2, 0.7] \\ 2 \text{ if } v \in [0.7, 1] \end{cases}$$

In accordance with quantization said above the colour space is quantized with apt weights, to form 1-dimensional colour space named G.

$$G = QsQvH + QvS + V$$

where Qs, Qv are quantized weights of S and V respectively. Here, the values are set as Qs=Qv=3, we get

$$G = 9H + 3S + V$$

The whole 3-dimensional space has been quantized to 72 bins of 1-dimensional vector. Quantization helps in reducing the computational complexity. Also, normalization helps in making vector components of equal importance. The HSV colour space is quantized initially to obtain the colour histogram. Then number of image pixels in each bin is counted. Here 1-dimensional vector is represented by constructing the cumulative histogram on quantization of HSV colour space in non-equal intervals [8][9].

5. HISTOGRAM OF ORIENTED GRADIENTS (HOG) FEATURE EXTRACTION

HOG is a feature descriptor that is heavily used in computer and human vision necessitating the object orientation. It is the descriptor that gives the local object appearance and shape within the image described by the intensity of gradient values.

The implementation is achieved by segmenting the image into small connected regions, called cells, where each cell compiles a histogram of gradient directions for the pixels within the cell. The combination of these histograms then represents the descriptor. We have assembled the histogram using 9 bins (each bin with a range of 20 degrees), after the number of HOG windows per bound was set, in our paper as 3.

In our paper, we have obtained the HOG feature descriptor along with the cumulative HSV colour histogram to extract the colour feature of the sub-blocks.

6. TEXTURE FEATURE EXTRACTION

GLCM [12][9] is made in the 4 directions with the distance between the pixels as one. The texture features is calculated from this matrix. The four texture features generally used is the Energy, Contrast, Co-relation and Homogeneity.

The GLCM is composed of the probabilistic value, which is the couple pixel values in θ direction and with d interval, represented by the expression P(i , j |d, θ). GLCM is a symmetric matrix whose level depends on the grey scale of the image. The elements in the matrix are computed by the equation :

$$p(i,j|d,\Theta) = \frac{p(i,j|d,\Theta)}{\sum i \sum j \; p(i,j|d,\Theta)}$$

The paper uses four texture features, given as :

Energy = $\sum x \sum y \, p(x,y)^2$

It is a texture measure of grey-scale image. It representslikeness changing,reflecting the distribution of image grey-scale uniformity of weight and texture.

Contrast = $\sum x \sum y \, (x-y)^2 \, p(x,y)$

Contrast measures how the values of the matrix are distributedand number of images of local changes reflecting the imageclarity. High contrast means deep texture.

Correlation S = $-\sum x \sum y \log p(x,y) \, p(x,y)$

Entropy measures arbitrariness in the image texture. It is low when the co-occurrence matrix for all values isequal, and if the value is very uneven, entropy is greater. Therefore, highentropy implied by the image grey distribution makes the image highly random.

Homogeneity H = $\sum x \sum y \frac{1}{1+(x-y)^2} \, p(x,y)$

It measures number of local changes in image texture.Here p(x, y) is the grey-level value at the co-ordinate (x, y).

These texture features are computed for all the tiles of an image and is used as the metrics. Integrated featurevector of colour and texture is formulated for each sub-block.

7. INTEGERATED IMAGE MATCHING

We have used an integrated one to one matching mechanism to find the similar images from the database. The images in the database and the query image are divided into sub-blocks. The number of sub-blocks remains the same for all the segmentations. The matching scheme used here is the Euclidean distance measure. It is done by matching the sub-blocks of the query image with corresponding sub-blocks of the image sub-blocks in the database. The images having minimum distance is retrieved back.

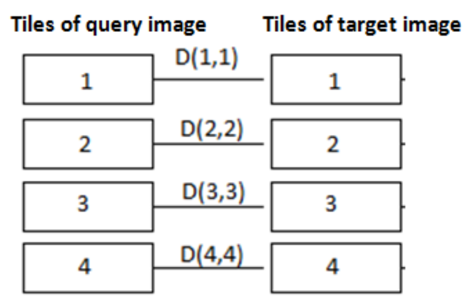


Fig. 2 Graph showing image matching

8. EXPERIMENTAL SETUP

Data set:Wang's [14] dataset comprising of 1000 Corel images with ground truth has been used. The image set comprises 100 images in each of 10 categories. The images have a size of 256 x 384. The images with other size are resized to 256X384.

Feature set: The feature set comprises colour, HOG and texture descriptors computed for each sub-block of an image.

Computation of Similarity: The similarity between tiles of query image and image in the database is done based on colour features that include the HOG descriptors, along with statistical feature vectors. Three types of properties represent different aspects of the image. A one to one Euclidean distance measure is done. Thus, apt weights are used in finding the distance measure.

The weighted equation can be framed as :

$$D(A,B) = \varphi 1 D(F_{CA}, F_{CB}) + \varphi 2 D(F_{TA}, F_{TB})$$

Here φ_1 is the weight of colour and HOG features, φ_2 is the weight of texture features, *FCA* and *FCB* represents the normalized colour features for image A and B. For a method based on *GLCM, FTA* and *FTB* on behalf of 4- dimensionalnormalised texturefeatures correspond to image A and B.

Here, we combine colour features and texture features. Thevalue of through experiments shows that at the time φ_1=φ_2=0.5 has better retrieval performance.

9. EXPERIMENTAL RESULTS

The experiments were carried out as explained in above sections. The results are benchmarked with some of theexisting systems using the same database. The quantitative measure is given below.The efficiency or performance in content based image retrieval is determined by three terms, precision, recall and the f-score.Precision (P) is the ratio of total relevant similar images retrieved to that of total images retrieved.

$$P = \frac{Total\ relevant\ similar\ images\ retrieved}{Total\ number\ of\ images\ retrieved}$$

Recall (R) is the ratio of total relevant similar images retrieved to that of total number of images in the database.

$$R = \frac{total\ relevant\ similar\ images\ retrieved}{Total\ number\ of\ images\ in\ database}$$

The precision and recall measure the accuracy of image retrieval with relevancy to the query and database images and always two values are computed to show the effectiveness of image retrieval.However these two measurements cannot be considered as complete accuracy for the effective image retrieval.

Hence they can be combined to give a single value that describes the accuracy of image retrieval and this combination is called *F*-Score or *F*-measure to measure accuracy. Both precision and recall measurements are combined to compute the score and it is also called as a weighted average.

$$F\text{-score} = \frac{precision\ *\ recall}{precision\ +\ recall}$$

The comparison of proposed method with other retrieval systems is presented in the Table 1retrieving 9 most similar images from the Wang's dataset comprising of 1000 images of different categories. Retrieval algorithm flow is as follows:

Table 1 Average precision

Class	HSV colour	GLCM texture	HSV colour + GLCM texture	HSV, HOG colour + GLCM texure (proposed method)
Africa	0.36	0.21	0.41	0.66
Beach	0.27	0.35	0.32	0.44
Buildings	0.38	0.50	0.37	0.44
Bus	0.45	0.22	0.66	0.88
Dinosaur	0.26	0.29	0.43	1.00
Elephant	0.30	0.24	0.39	0.88
Flower	0.65	0.73	0.87	1.00
Horse	0.19	0.25	0.35	0.55
Mountain	0.15	0.18	0.34	0.33
Food	0.24	0.29	0.31	0.44

10.CONCLUSION

In this paper, a new image retrieval method based on HSV colour together with HOG descriptors and GLCM texture features of image sub-blocks with one to one matching is proposed. We combined colour, HOG and texture features with normalized distance measure. The experimental results shows that the proposed method based on combined colour, HOG and texture features of image sub-blocks has better retrieval performance compared with the Image retrieval system using only one feature descriptors and combined HSV colour and GLCM texture. The proposed retrieval method has to be evaluated with other integrated matching techniquesas further studies.

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