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An Improved CBIR System Using Low-Level Image Features Extraction and Representation

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Abstract

Nowadays, rapid and effective searching for relevant images in large image databases has attained an arena of extensive awareness in many applications. Content-based image retrieval (CBIR) supports an efficient way to retrieve images depending on automatically derived image features. It retrieves relevant images through diverse kinds of unique image features extraction techniques. Even though, the higher level attributes are employed to eradicate the semantic slit amongst the data that one could obtain from the visualized information, there is discrepancy in knowing graphical information for diverse individuals, these semantic differences are complex to remove. The utmost real-time CBIR system introduced depends on the low-level features. In this paper, the lower level attributes like color, texture and shape attributes are extracted through different techniques and all the information is stored in feature vector representation format that are amalgamated to generate a unique feature vector. Then these extracted image features are compared with other image features using Euclidean Distance Similarity Metric. This performance of the suggested approach is compared with three existing CBIR techniques using precision and recall rates. The performance showed that the suggested approach has higher precision-recall rates and better efficiency compared to other approaches

Keywords: CBIR, Crack Edge Detection, Similarity Measure, Euclidean Distance, Feature Vector Representation, Corel Images

INTRODUCTION

Presently, practically entire provinces of social life comprising commerce, government, colleges, hospitals, corruption preclusion, surveillance, engineering and historical investigation employ data as images, thus the size digital information is growing swiftly. These images and its information are classified and storages on machines and the issues occurs whenever obtaining these images from accumulated media. Thus, Content Based Image Retrieval (CBIR) from huge resources has attained an arena of extensive importance in current years specifically in previous decade. The "Content-aided" refers that the exploration investigates the information in the image excluding the metadata. In CBIR system, visual features of the image like color, texture, shape or any content could be autonomously mined from the image and employed to retrieve relevant images from the image data samples. These features are known as low-level features which have certain visual properties of an image. The obtained images are further graded conferring to similarities between the query image and images in the data samples using a similarity matching metric [1]. CBIR technique comprises of two significant approaches: feature mining and similarity matching [2].

Since images are high in information and deprived of linguistic restricted to assist worldwide interactions, etc., CBIR has very wide and vital appliances in numerous domains comprising military activities, medical science, education, architectural design, justice division and agriculture, etc. The common appliances of CBIR include customer digitalized photograph, digitalized gallery, Moving Picture Experts Group (MPEG-7) content descriptor, common image pool for authorizing and usual gatherings. In current years CBIR system have been introduced to function on the enormous image data samples efficiently. Fundamentally low-level features in the image are employed for obtaining identical images from an image dataset. Diverse CBIR approaches have implemented diverse approaches. Certain approaches have employed global color and texture attributes while certain had employed local colors and texture attributes. In addition to this, shape is also a feature for perpetual object recognition. Pertaining to the toughness, efficacy, execution easiness and less storing necessities benefits, color, texture and shape is the most effective feature in CBIR.

Rendering to the techniques employed for CBIR, attributes could be categorized into lower level and higher level attributes. The lower level attributes are employed to remove the sensual differences amongst the entity in the world and the data in a depiction resulted from a cassette of that sight. The higher level attributes are employed to eradicate the semantic slit amongst the data that one could obtain from the visualized information and the elucidation that similar information has for an individual in a defined circumstance. Since there is discrepancy in knowing graphical information for diverse individuals, these semantic differences are complex to remove. The utmost real-time CBIR system introduced depends on the low-level features

Addressing this issue, in this paper an improved CBIR approach is introduced that employed the color, texture and shape attributes for effective comparison of query image with large image database as to retrieve the similar images with higher precision and recall rate. Thus, color, texture and shape features of image database are extracted employing HSV color Quantization for color features, threshold technique on Binary image for texture features and radial Chabysev approach for shape features. The extracted features are represented in a vector format distinctively and added to a single image feature representation vector using equation (7) in section 3. Finally, the query feature vector is matched with target feature vector in image dataset employing the simple Euclidean distance as the similarity metric.

LITERATURE SURVEY

Numerous CBIR techniques are being successfully introduced using different image features such as lower level and higher level features. Some of the techniques are briefly defined in this section. In [3], an ordered-dither block truncation coding (ODBTC) is adopted to wrap images to data streams and color and texture attributed are independently obtained from data samples for image retrieval. Aimed at the identical position of color and texture data in image retrieval, in [4] Global Correlation Descriptor (GCD) is suggested to mine color and texture attributes, correspondingly as these have similar effect on CBIR. These entire feature extraction procedures consume over and above single form of image information and attained adequate experimental outcomes. Nevertheless, entire attributes are mined autonomously, tending to its poor image-indexing. Global Correlation Vector and Directional Global Correlation Vector are likewise suggested that amalgamated the advantages of structuring entity correlation and statistics histogram to determine texture and color attributes. Corel-10 K and Corel-5 K data samples are employed for authentication, and performance evaluation of the machine is obtained using recall and precision rates.

In [5], multiple resolution image disintegration and color correlogram is amalgamated to acquire novel approach for indexing and retrieval. In this novel approach, single-direction autonomous correlograms of wavelet constants are estimated to obtain image index vectors. A methodology for retrieval of attributes using binarization of images is suggested to augment images retrieval and detection through content aided image detection. The approach is validated through two communal data sample with a total of 3688 images. This technique minimized the dimension of attributes to 12 irrespective of size of image. The arithmetical metrics (depending on precision and recall outcomes) are employed for the assessment. One drawback of this technique is the mis-categorization of query images that might influence the efficiency of the results when matched with other prevailing methodologies.

A Methodology for depiction of image and extraction of feature through bandelet conversion is given in [7], this methodology steadily gives back the key (fundamental) entities data which are present in an image. ANN was usages for image retrieval, the efficiency and success of the system was evaluated with the help of 3 publicly available data samples such as: Coil, Corel, and Caltech 101, precision and recall rates are employed to obtain the performance evaluation. In [8], a methodology for image retrieval employing statistical validations like Welch's t-tests and F-Ratio is specified. Both, structured or textured input images as query are scrutinized. In the experimentation, complete image is taken as the textured image, whereas in structured image, shape is parted into numerous areas depending on its environment. The initial phase of aforementioned assessment is accomplishing F-ratio and thereby accepted images progressed to energy spectrum validation. Thus, if images are passed in two assessments, then is declared that these images are identical. Otherwise are dissimilar. For authentication and verification of the methodology, Mean Average Precision rate was employed.

In [10], a localized structuring descriptor is suggested for image retrieval. This descriptor is generated depending on its local structures fundamental colors. It has amalgamated the color, shape and texture attributes as a single element as to obtain the images. Furthermore, they suggested a methodology for feature extraction that is capable to mine local structured histogram through local descriptor. In [11], a technique named as image retrieval functioning on cooperative genetic approach is given for estimating a higher value of selective attribute and further matched with associated images. The methodology was experimented on a collection of 10,000 common images to demonstrate the efficacy of suggested methodology.

LOW-LEVEL FEATURE EXTRACTION AND REPRESENTATION BASED IMPROVED CBIR SYSTEM

In this section, a new Content based Image Retrieval Methodology is introduced, where the contents of the images like color, textual and shape feature are extracted for the accurate image retrieval. The diagrammatic representation for suggested approach is given in Fig. 1. The proposed approach is elaborated and discussed in details using three different phases. They are Feature Extraction, Feature Representation and Similarity Measure for image comparison.

Image Feature Extraction

This is a method of mining compressed however semantically valued knowledge from images. This data is utilized like a signature for the image. Identical images ought to have identical signatures. The three different lower level attributes like color, texture and shape features are extracted using three different approaches. They are given as follows:

a) Color Feature Extraction: RGB color image is quantized to HSV color image that is widely employed in computer graphics. The color feature has generally been utilized as a part of CBIR system; because of its simplicity and fast computation. the HSV color space because it is the most suitable color space to mimic the human visual system. The color space will be quantized because human eyes cannot distinguish large numbers of colors at the same time. The color is also an intuitive feature and plays a vital role in image matching. The HSV space is uniformly quantized into 18 bins for hue (each bin consisting of a range 0 of 20), 3 bins for saturation and 3 bins for value for lower resolution and in turn quantized into 166 color bines.

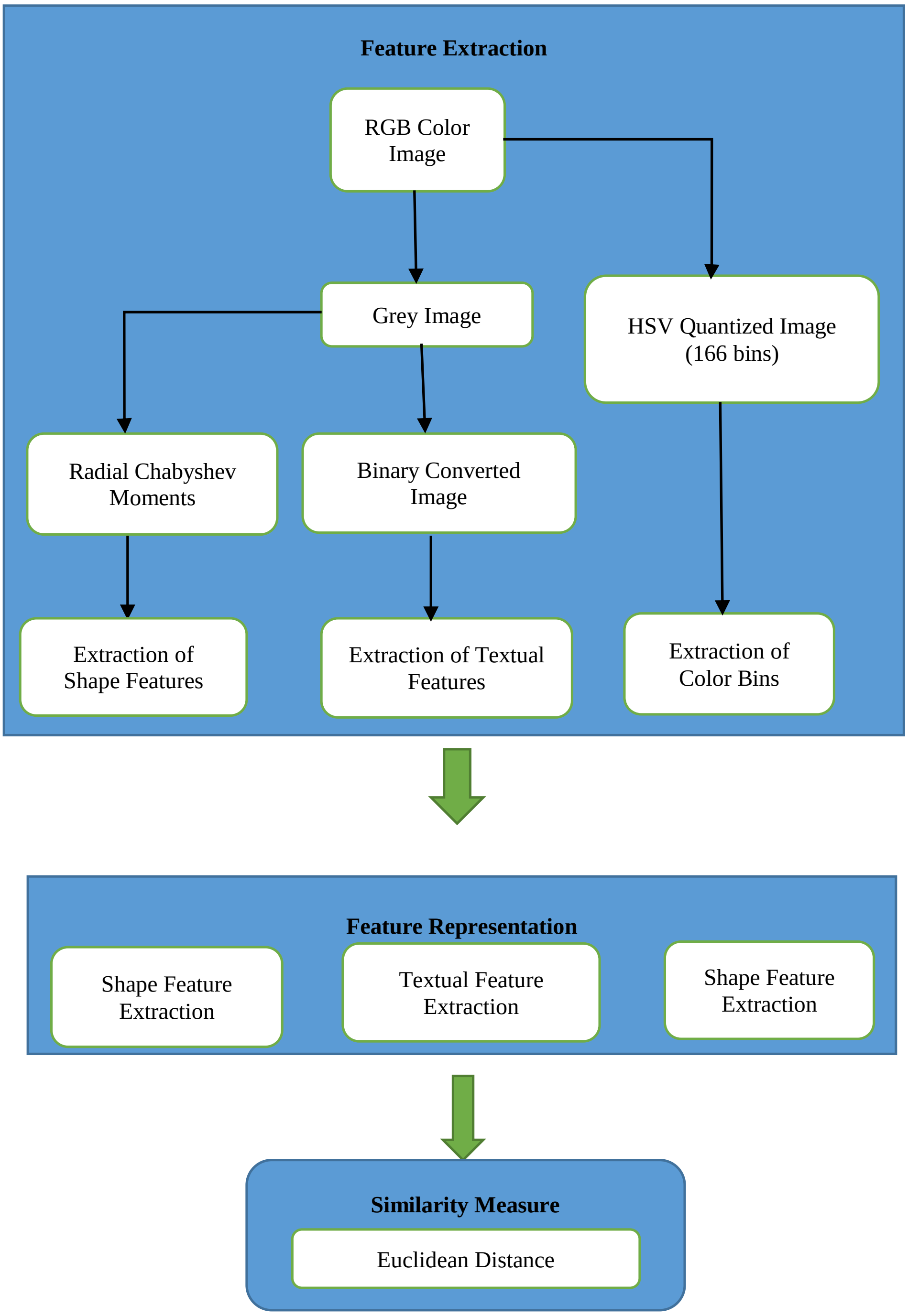

Figure 1: Diagrammatic Representation of Suggested Methodology

From these the color features are extracted.

$$H = \cos^{-1} \frac{\frac{1}{2}[(R-G)+(R-G)]}{\sqrt{(R-G)^2+(R-B)(G-B)}} \quad (1)$$

$$s = 1 - \frac{3}{R+G+B}(\min(R, G, B)) \quad (2)$$

$$V = \frac{1}{3}(R + G + B) \quad (3)$$

The R, G, B referred to as red, green and blue elements severally with the value in between 0-255, where H denotes Hue, S for saturation and V for Value.

b) Texture Feature Extraction: The texture attributes are mined from the RGB color image. In this phase, the RGB colored image is converted to the 256 gray level images. So as to obtain the texture features, the gray image is transmuted to the binary image by means employing a threshold value. Texture is a vital attribute in the visualization that determines the physical composition of the surface. It is a crucial external property of an element and its association to the neighboring atmosphere. Numerous elements in an image could be differentiated merely through its textures attributes deprived of any further data. Texture might comprise of certain fundamental entities. It defined the complete information regarding the structural organization of a region and the association of the adjoining provinces [9].

The texture of an image could be deliberated as a group of smaller entities. These texture entities, determined as texture elements, replicate texture structure. The similar form of images typically has identical textures such as the permutation and amalgamation of entities within themselves ought to be identical. In this section, one set of texture entities are determined depending on the binary image. There are 16 dissimilar dimension units of 2 × 2 blocks. The colored part is “1” and blank part is “0”.

c) Shape Feature Extraction: Shape is foremost basis for the knowledge that is employed detection of objects. Lacking shape visual content object cannot be recognized properly. Image is incomplete without recognizing shape. The shape feature extraction mainly aims to capture the properties of the shape of the image items. This eases the process of shape storing, transmitting, comparing against, and recognizing. The shape features should be free of rotation, translation, and scaling [12, 13, 14].

The shape features using moments are extracted which reduced the drawbacks allied by the continuous orthogonal moments. The radial chebyshev moments have better image reconstruction capabilities discussed by R Mukundan [15]. Hence we have adapted the same. For a digital image f(x, y) with size N×N, and (n+m)th order, are described as follows.

$$f(i,j) = \sum_{m=0}^{M-1} \sum_{n=0}^{N-1} T_{mn} t_m(x) t_n(x) \quad (4)$$

The radial Chebyshev moment with order p and recurrence q is given as:

$$S_{pq} = \frac{1}{2\pi\rho(P,m)} \sum_{r=0}^{m-1} \sum_{\theta=0}^{2\pi} t_p(r) e^{-j2\theta} f(r,\theta),$$ where m refers to $\left(N/_2 + 1\right)$ (5)

$$t_p(x) = \frac{(2p-1)t_l(z)T_{p-l}(x) - (p-l)\left\{1-\frac{(p-1)^2}{N^2}\right\}t_{p-2}(x)}{p}; P > 1 \quad (6)$$

Feature Representation

Once, the lower level attributes descriptors are mined from the RGB color image, these features are represented in a vector format distinctively. And all the three features vectors are combine to generate a unique image feature representation vector. Color feature vector is represented as FV_c, texture feature vector is represented as FV_t, shape feature vector is represented as FV_s which are completely represented as:

$$FV = \alpha FV_c + \beta FV_t + \gamma FV_s \quad (7)$$

Where α =0.6, $\beta = 0.25$ and $\gamma = 0.15$.

Similarity Measure

The similarity measure that is used in this approach is Euclidean distance. This distance is straight-line distance amongst two pixels.

$$Euclidean\ Distance = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2} \quad (8)$$

Where, (x_1, y_1) and (x_2, y_2) are two pixel points or data points

EXPERIMENTAL RESULTS AND ITS ANALYSIS

The experimental outcome for the suggested Improved CBIR system is carried out on general purpose images such as Corel-

1k [16], Corel-10k [16]. The approach is implemented on Matlab r14b version. These images are accumulated in JPEG form with dimensions 384 x 256 or 256 x 384. The Corel-1k data sample comprises of 1000 usual images clustered into 10 categories each where every category comprises of 100 images. These 1000 images are grouped into numerous semantic classes like beach, monuments, vehicles, dinosaurs, elephants, flowers, horses, mountains, foods, and African people. The Corel-10k data sample comprises of 10,000 general images that are grouped to 100 categories like beach, fish, sunset, bridge, airplane, etc.

Performance Evaluation: Average precision rate $Precision(I)$ and recall rate $Recall(I)$ used to validate the retrieval influence are specified in [17] as:

$$Precision\ (I) = \frac{1}{N \times L} \sum_{i=1}^{N} N_I(L) \times 100\% \qquad (9)$$

$$Recall\ (I) = \frac{1}{N \times N_c} \sum_{i=1}^{N} N_I(L) \times 100\% \qquad (10)$$

Where I, N and N_c refers to query image, number of entire images present in the dataset, and number of appropriate images on every category amongst N, correspondingly. L and $N_I(L)$ refer the number of obtained images and appropriately obtained amongst L, distinctly. More $Precision(I)$ and $Recall(I)$ means good retrieval outcomes.

A sequence of experimental outcomes is given to state the legitimacy of the suggested approach. For each image dataset, entire images within it would be considered as the query image to accomplish the retrieval and further estimate its average precision value whenever its recall rate is 10%, 20%, 30%, 40%, 50%, and 60%, consecutively. The precision and recall values of suggested CBIR approach is compared with three existing CBIR techniques such as structure elements histogram [18], integrated LBP-based approach [19] and. Considering, the block division in the image in the process of color attributes mining, numerous image block dimensions like $2 \times 2, 4 \times 4, 6 \times 6$ *and* 8×8, and the undivided condition are considered.

Table 1: Precision Values for diverse block dimension on Corel-1k dataset

Different Block Sizes	Recall					
	0.1	0.2	0.3	0.4	0.5	0.6
No Blocks	0.663	0.612	0.5012	0.4679	0.4248	0.3901
2X2	0.6856	0.6385	<u>0.5526</u>	0.4820	0.4345	0.3812
4X4	<u>0.7009</u>	<u>0.6545</u>	0.5259	<u>0.5148</u>	<u>0.4687</u>	0.3899
6X6	0.6998	0.6421	0.5348	0.4946	0.4470	<u>0.4108</u>
8X8	0.7001	0.6520	0.5399	0.4539	0.4498	0.3792

Table 2: Precision Values for diverse block dimension on Corel-10k dataset

Different Block Sizes	**Recall**					
	0.1	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**
No Blocks	0.682	0.633	0.5532	0.5012	0.4781	0.4516
2X2	0.7002	0.6789	<u>0.5716</u>	0.5126	0.5068	0.453
4X4	<u>0.712</u>	<u>0.6791</u>	0.5624	<u>0.5429</u>	<u>0.5271</u>	0.4619
6X6	0.7012	0.6534	0.5639	0.5316	0.5201	<u>0.4732</u>
8X8	0.711	0.6618	0.5706	0.5399	0.5096	0.4516

Table 1 and Table 2 showed the Precision values for the recall rate of 10%, 20%, 30%, 40%, 50% and 60% by considering different block sizes distinctively for two different data samples such as Corel-1K and Corel-10K. From the table 1 and table 2, it can be inferred that for different recall rates, the precision rate varies for different blocks. For recall rate 0.1, 0.2, 0.4 and 0.5, 4X4 image blocks has the highest precision rate. For recall rate 0.3, 2X2 image blocks has the highest precision rate and for recall rate 0.6, 6X6 image blocks has the highest precision rate. Fig 2 and Fig 3 represents the comparison of Average Retrieval Performance of the suggested approach with the existing CBIR approaches on both databases such as crel-1k and corel-10k. from Fig 2 and Fig 3, it can be understood that, the suggested low-level features extraction and representation based CBIR approach has higher precision-recall curve when compared with the other three existing CBIR approaches. It is observed that, for the recall rates from 10% to 60%, the precision rate is also decreasing linearly which follows a trend line.

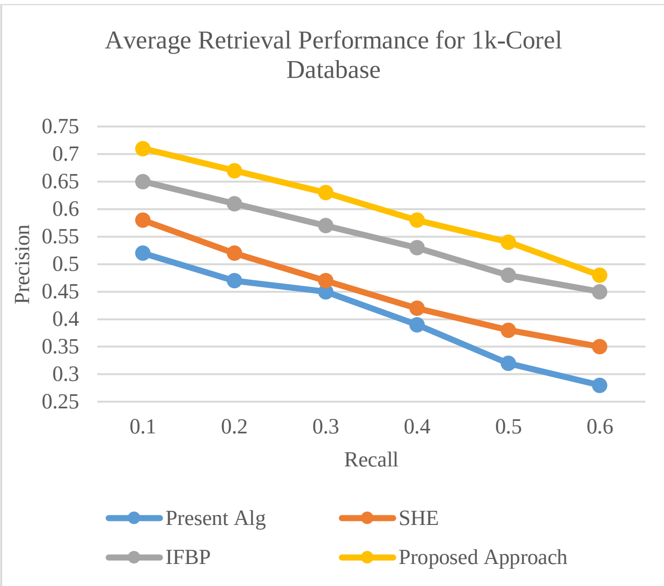

Figure 2: Comparison of Average Retrieval Performance On Corel-1k Dataset

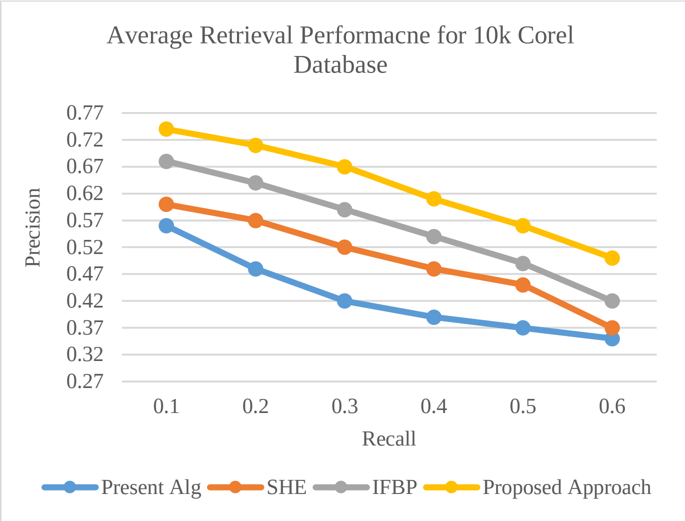

Figure 3: Comparison of Average Retrieval Performance On Corel-10k Dataset

CONCLUSIONS

An Improved CBIR approach is introduced in this paper that employed color, texture and shape attributes for effective matching of query image with enormous image database as to retrieve the similar images with higher precision and recall rate. Thus, color, texture and shape attributes of image database are extracted employing HSV color Quantization for color features, threshold technique on Binary image for texture features and radial Chabysev approach for shape features. The extracted features are represented in a vector format distinctively and added to generate a unique image feature representation vector. Finally, query feature vector is matched with target feature vector in image dataset employing simple Euclidean distance as the similarity metric. The experimental result for the suggested approach is carried out on two databases such as Corel-1K and Corel-10K and experimented on Matlab tool. The performance of the suggested approach showed that, it has better performance and higher precision-recall rate compared to other existing CBIR approach.

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