

Augmented Content Based Image Retrieval using Fusion Based on Self Organizing Map

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Abstract: Content Based Image Retrieval (CBIR) comprises the task of retrieving the image from a large database which matches the query image. The features like color, texture and shape are taken as multiple features and using fusion Self Organizing Map the matching process is carried out. Enhanced HSV-based Histograms for color, Active Contours for shape, DWT transformation for texture are applied and this work prove that the proposed CBIR system is an improved version in terms of precision, recall and speed of image retrieval.

Keywords: Content based image retrieval, enhanced HSV-based histograms, Active Contours, Discrete Wavelet Transform, Self Organizing Maps

I. I. INTRODUCTION

Day by day image database is expanding as digital images capturing has become very easy and is the cheapest. As the database grows retrieval from it becomes tedious. So image retrieval using text as its file name is not sufficient enough. So the concept of content based image retrieval (CBIR) emerged. CBIR concentrates on content like color, shape, texture and spatial features.

In spite of its wide popularity, the field has not yet reached its maturity and is not yet being used on a significant scale. The usage statistics shows a diversified opinion on the usefulness and effectiveness of CBIR systems in handling queries on large and diverse real-life image databases. This shows that the research area is still active and methods to improve existing solutions are in great demand.

A CBIR system is defined as a task which uses an amalgamation of techniques, like statistics, image processing and pattern recognition, with the aim of searching and retrieving images from a large image database that match a given query in an efficient manner. The query can either be an example image or a sketch, text or terms of keywords.

Traditionally, an image is represented by its features such as the color, texture and shape of objects. A great amount of work proposed use algorithms that perform similarity matching on any one of the various available features of the image. Only recently, the usage of multiple features for image retrieval is being gaining attention as in [9] and [15]. It has been discovered that the retrieval performance, in terms of recall and precision, is enhanced when multiple feature vectors are used. The reason for this performance increase is that single features extracted from images characterizes different aspects of an image content, which when combined to form multiple features, provide an adequate and more accurate description of image content as in [6]. CBIR system using multiple features extracts more than feature from the image and performs retrieval process in two manners. The first type merge the multiple feature vectors to create a global index while the second method create separate index structure for each feature and then merge the results. The result of fusion is then used during retrieval and indexing. This paper considers the first type, that is, feature level fusion.

II. II. PROPOSED METHODS

A. Color Feature

Color feature is the most attractive one. Color histogram retrieval method is enhanced with Self Organizing Map (SOM) for dimensionality reduction and to improve accuracy. SOM uses improved histogram as image feature vector. Feature vector $F(I)$ is generated for each image in the collection. When the query is made, the feature vector of query image is calculated and similarities between the two images are calculated using Euclidean distance. The weight vectors are stored using single color histogram. As each pixel stores three values of HSV color space to handle weight vectors of K dimensions the pixels are grouped in $K/3$ tiles. The weight vector factors are calculated using the equation

$$d(H_R(I), H_R(Q)) = \left[\sum_{j=1}^n W_j |H_R(I_j) - H_R(Q_j)|^2 \right]^{1/2} \quad (1)$$

where j indicates the color levels of color space C , W_j is the j th weight of H_R .

The image blocks are given as input to the network. These input vectors (X) are mapped with network weight vector (W_i). Then the similarity between X and W_i is measured in terms of spatial neighborhood N_m and is found best matching node m such that

$$\|x - w_m\| = \min [\|x - w_i\|]. \quad (1a)$$

The radius of N_m will be decreasing as the training progresses. Towards the end the neighborhood will have no cells other than the central winning one. The weight updating rule for self organizing feature map is defined as

$$\Delta w_i(t) = \alpha [x(t) - w_i(t)] \text{ for } i \in N_m(t) \quad (1b)$$

where $N_m(t)$ denotes the current spatial neighborhood and α denotes the learning rate. After training the weight vectors of each neuron of the Kohonen layer acts as code vectors.

B.Texture Features

To extract texture features standard DWT combined with Rotated wavelet filter [RWF] and dual tree complex wavelet transform [DT-WT] is used. For each sub band, 4 texture features are calculated they are energy, entropy, contrast & homogeneity.

$$\text{Entropy} = \sum_i \sum_j Co(i, j) \log Co(i, j) \quad (2)$$

$$\text{Energy} = \sum_i \sum_j Co^2(i, j) \quad (3)$$

$$\text{Contrast} = \sum_i \sum_j (i - j)^2 Co(i, j) \quad (4)$$

$$\text{Homogeneity} = \sum_i \sum_j \frac{Co(i, j)}{1 + |i - j|} \quad (5)$$

Where $Co(i, j)$ is the co-occurrence matrix and is computed for several values of displacements and the one which maximizes the statistical measure is used. The co-variance matrix and displacements are calculated for each color sub band and are used. The average value is used as the final texture feature set for an image.

C.Shape Features

For extracting shape features, active contour model as in [16,] is used to detect the various regions of an image and the shape features are retrieved using the method proposed in [17]. The energy function of the active contour model is defined by the following equation.

$$E^*_{snake} = \int (E_{internal}[v(s)] + E_{image}[v(s)] + E_{constraint}[v(s)]) ds \quad (6)$$

The minimum of the energy function locates the final template of the active contour model.

D.Feature Fusion

Let C be the set of color features, T be the set of texture features and S be the set of shape features. Let R be the resultant feature vector after concatenating C , T and S . The average of all the respective features over the entire database is used to normalize the individual feature components. Let the normalized vectors be C' , T' and S' . To avoid the curse of dimensionality, a k-means clustering algorithm is used. The k-means algorithm performs a two step procedure, where the first step removes redundant features and the second step retains points and removes points that are very near to the specific point. These points are removed because they may not provide additional information because of being in vicinity. The distance classifier used is Euclidean distance and the number of clusters is determined using the PBM cluster validity index as in [18]. To further select optimum feature vector, the SOM method proposed in [20] is used.

E. Fusionbased on SOM

A self-organizing map (SOM) or self-organizing feature map (SOFM) is a type of artificial neural network that is trained using unsupervised learning to produce a low-dimensional (typically two-dimensional), discretized representation of the input space of the training samples, called a map. Self-organizing maps are different from other artificial neural networks in the sense that they use a neighborhood function to preserve the topological properties of the input space.

Like most artificial neural networks, SOMs operate in two modes: training and mapping. Training builds the map using input examples. It is a competitive process, also called vector quantization. Mapping automatically classifies a new input vector.

A self-organizing map consists of components called nodes or neurons. Associated with each node is a weight vector of the same dimension as the input data vectors and a position in the map space. The usual arrangement of nodes is a regular spacing in a hexagonal or rectangular grid. The self-organizing map describes a mapping from a higher dimensional input space to a lower dimensional map space. The procedure for placing a vector from data space onto the map is to first find the node with the closest weight vector to the vector taken from data space. Once the closest node is located it is assigned the values from the vector taken from the data space.

This paper is an extension of the authors' previous work in [20], where an enhanced CBIR system based on Self Organizing Map (SOM) and histogram was proposed. This system integrated the spatial information with enhanced color histograms. In this paper, this work is extended to consider multiple features, enhanced color histogram, texture and shape that are combined with SOM for dimensionality reduction. The initial work is referred to as 'SOM-Color CBIR System', while the proposed system is referred to as 'Fusion based on SOM CBIR System' in this paper.

III. III.EXPERIMENTAL RESULTS

A collection of around 650 images are taken randomly from the web as the image database. The system is developed in MATLAB7.3. The histograms for all the images were in 72 color bins in HSV color space. The performance metrics taken for evaluation is precision-recall measure and retrieval time.



Figure 1. Sample Images of test database

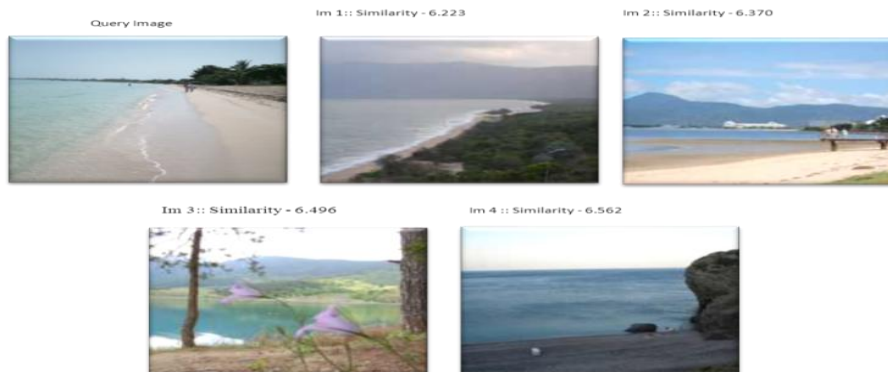


Figure 2. Query image & Retrieved Images

The result shows that Fusion SOM CBIR system is improved than the SOM Color CBIR. Thus the proposed system shows 14.37% of speed efficiency than SOM color CBIR..

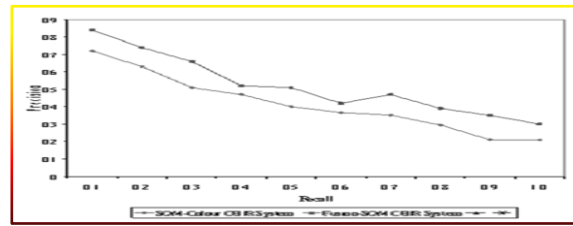


Figure 3. Experimental result of precision recall values

IV. CONCLUSIONS

This paper considers the multiple features color, texture and shape along with Fusion based on Self Organizing Map CBIR for image retrieval. For color feature it uses enhanced histogram, for texture dual tree complex wavelet transform and for shape active contour model. The experimental result shows that this combination is more efficient than the previous one in terms of precision-recall. Further the research can be continued with multiple query images for retrieval. Further the efficiency can be improved by best method of feature selection.

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Biography

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