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A Novel Approach for Image Retrieval Using Wavelet Transform and Hierarchical Neural Network

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Abstract :*The From last few decades Image retrieval is growing as an active research area because Image retrieval is related to various other research field and domains such as Image processing, computer vision, Human computer Interaction (HCI), Database, Statics, Pattern recognition and Artificial intelligence. But this multidisciplinary area was always restricted by some limited resources as it requires large storage area and high processing power. Due to information explosion on the internet the data available today on the internet is not in the form of traditional documents but nowadays the internet database has also seen a significant rise in the multimedia databases like images, video and audio. The efficient access to this information depends upon the efficient retrieval of this data. Hence image retrieval has been the area of active research in the past few decades.This paper involves retrieving images from large databases of images which are visually similar to a query image. Now days image database increasing day by day, and it's very useful in a various applications, therefore need for the development of CBIR arose. The main objective for this thesis work is to develop a Content base image retrieval system with an innovative approach to use wavelet transformation, F-norm theory, artificial neural networks and classification techniques to retrieve similar images to the input image. The purpose of this project work is to show my research and the solution to the design of the Image retrieval system. This report summarizes the problem, proposed solution, and the desired results. This system is based on the wavelet transform, uses artificial neural networks, and similarity matching after classification.In this system user give query as an image then wavelet transform of image used to calculate the features of the image, four layers feed forward artificial neural network is used to train the system and classify the training dataset using supervised training approach. After that use similarity matching to generate the rank of the retrieves images, on the instructions similar images to query image from image database. The similarity matching is used to improve the efficiency and accuracy of the system while neural network and classification techniques are used to reduce the time complexity of the system*

Keywords: *Content based Image Retrieval, Wavelet, Artificial Neural Network, F-norm Theory.*

1. Introduction

This From last few decades Image retrieval is growing as an active research area because Image retrieval is related to various other research field and domains such as Image processing, computer vision, Human computer Interaction (HCI), Database, Statics, Pattern recognition and Artificial intelligence. But this multidisciplinary area was always restricted by some limited resources as it requires large storage area and high processing power. Due to information explosion on the internet the data available today on the internet is not in the form of traditional documents but nowadays the internet database has also seen a significant rise in the multimedia databases like images, video and audio. The efficient access to this information depends upon the efficient retrieval of this data. Hence image retrieval has been the area of active research in the past few decades [1]. Now days The availability of huge amount of data in the form of images on the web underline the requirement of Image retrieval system that retrieve quickly and accurately the desired images that meet the user requirements from available image database. But earlier due to some technological limitations, it was not possible to retrieve quickly these desired images. Last few years has seen proliferation in the development of image retrieval system. Lots of efforts have been involved to develop fast and efficient image retrieval systems. Processing power, digitization and networking facilities play a significant role in development of quick and efficient Image retrieval systems. Hence before developing any image retrieval systems these parameters are taken into consideration. Various innovative techniques have been proposed for development of different CBIR systems. Some CBIR systems incorporate learning techniques and using these innovative techniques many Content base image retrieval systems have been developed [2]. Due to increase in the availability of data in the form of images, the existing method of text annotation and image indexing are insufficient for developing the image retrieval systems.

The basic concept of research in this field is to develop Content base image retrieval system that can retrieve most similar images using the content of images or visual features of the image. Hence there is large scope for development of Image retrieval system based on content of images and visual features. To the development of system require a strategy in order to balance the retrieval accuracy and computational complexity. Hence we are focusing on the newer and better algorithm for quick and efficient search.

2. Motivation

In recent days processing power has become increasingly more powerful and storage and memory has become cheaper. Hence for various application huge image database have now become realizable. Now various applications exist with large image database, which can be huge in size, contain millions of images. Image databases comes from various fields such as satellite images, medical, art work, fashion, design, advertising, geography, architecture etc. Today it is a need of time to develop such systems that can retrieve images from this vast database more accurately and quickly. This is the main motivation behind this thesis. The aim of this thesis is to design and develop a quick and efficient retrieval system that retrieves images from large database. If we manually associate the keywords for each image in database and search the image based on keyword matching, it is very difficult and tedious job to develop such systems from large database. And it requires more time as well as there is more possibility of error. Thus by developing a fast and efficient CBIR system for image retrieval, access to the vast image database can be made easy. A lot of noteworthy research has been done in the field of content base image retrieval. There are also many content based image retrieval systems like visual seek, QBIC, photobook, Chabot, Jacob, Pichunter, Virage available today. All these CBIR systems are domain specific and work on particular domain of images. So still there need for a fast, free, efficient and generalized CBIR system. A generalized system can work on different kind of images irrespective to the domain of the images. In this thesis we aim at developing a CBIR system using novel approaches and techniques that can work on large domain. Considering the generalization of the domains the factors such as efficiency and reliability also needs to be considered. Basic approach of image retrieval is to manually associate the keywords with each images, then for searching match the query image keywords with associated keyword in the database images. But content base image retrieval is based on the content or features of the images. Content based image retrieval is computationally expensive while accurate and efficient than the conventional keyword based retrieval. In order to balance the computational complexity and accuracy design more efficient algorithm and developed.

3. Methodology

We pretend to retrieve images from a database by taking into account their content, and this in terms of object's shape and image's color distribution. To efficiently retrieve an image, we propose to combine the well-known multi-resolution approach, histogram computation, wavelet transformation and neural network processing. In a first training step, our procedure computes a Daubechies 4 wavelet transform to get the desired describing features. These features are represented by the wavelets coefficients of the Daubechies 4 wavelet transform. These coefficients tend to represent the semantics of the image, that is, the distribution and size of the forms in the image plus the local variation of the color of the objects and background. In this work we use the three bands Red, Green and Blue (RGB) of a color image to extract the describing features and this because RGB is the more commonly used color space [10]. Seeking for a compact signature, we experienced with 8, 16 and 32 wavelet coefficients; best results were obtained with16 coefficients. For each color band, we process each image to get the 16 wavelets coefficients of the 256 bins of the histogram of the biggest circular window inside the whole image (Figure 2). We focused on the centered circular window because the principal contentof the scene is generally located at the center of images; furthermore, the histogram calculation is invariant to rotations. Due to a histogram does not provide sufficient information about the position of pixels; we decided to combine it with well-known multi-resolution approach to take into account this fact.

4. Neural Network Architecture

It is a network of perceptrons composed of three layers:

1. The input layer with 48 nodes, corresponding to the48 elements of the describing wavelet vector
2. A hidden layer with 49 nodes. We tested with different numbers of nodes for this layer and selected that with the best classification results.
3. The output layer with 6 nodes, one for each airplane class.

5. Neuronal Network Training

Several procedures to train a NN have been proposed in the literature. Among them, crossed validation has shown to be one of the best suited for this goal [3]. It is based on the composition of at least two data sets to evaluate the efficiency of the net. Several variants of this method have been proposed.One of them is the π-method [4] and [5]. It distribute sat random with no replacement of the patterns in attaining sample. For training we used 192 images. We have taken180 of these 192 (30 of each class), and distributed into 5 sets C1,…,C5 . Each set of 36 images contains six images of each one of the six image classes. We perform NN training as follows:

1. We took sets C2 ,C3,C4 ,C5 and with them train the NN. 1000 epochs where done. We tested the NN with sample C1and we got the first set of weights for the NN.
2. We then took sets C1,C3,C4 ,C5 and with them train the NN. Again 1000 epochs where performed. We tested the NN with sample C2 and we got the second set of weights for the NN.
3. We repeated this process for training sets:*C*1,*C*2 ,*C*4 ,*C*5 , *C*1,*C*2 ,*C*3,*C*5 and *C*1,*C*2 ,*C*3,*C*4 , to get third, fourth and fifth weighting sets for the NN. As a final step, we have taken the 192 images for training, by observing that the performance of the NN is predictable when using cross validation. The set of weights thus obtained, is used as the weights of neural network to be next tested.

6. Result

The image database used for the sake of testing and training consists of 450 images. It consists of images from different classes. Each image is of size 256 X 256. Each class consists of approximately 45 images. The experimentation shows that the accuracy of the system is about 70%. The image database was constructed from the images collected from http://wang.ist.psu.edu/docs/related/. It is a standard database provided over the internet and the results of experimentation on these images was also quite promising.

Some of the training and testing images:

Bus Dinosaur


Monuments Food


Figure 1.1

Output of Neural network on a query image:

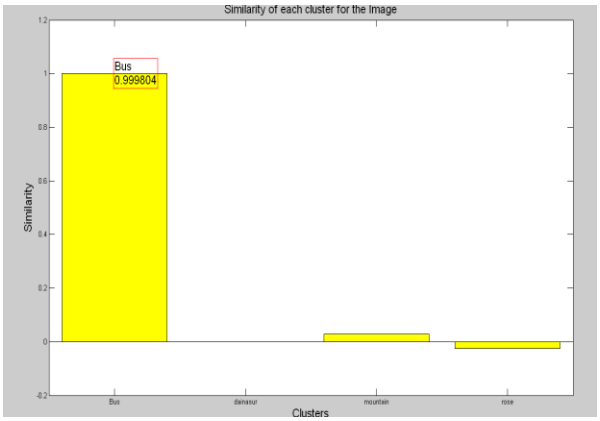

Figure 1.2 Output of Neural Network

Figure 1.2 shows the output of neural network that showing the similarity is higher for cluster Bus. Hence system retrieves the images from that cluster. Ranking of retrieved images is calculated by similarity matching and to display the images according to ranking.

The table 1.1 below gives the output of the similarity matching algorithm. The table below highlights the image index within the class and the related probability matching with the query image.

The table 1.1 shows the image index and their similarity probability values in descending order

Table 1.1 Image Index with Similarity Probability

The table 4.1 shows the image index and their similarity probability values in descending order

Intermediate Results

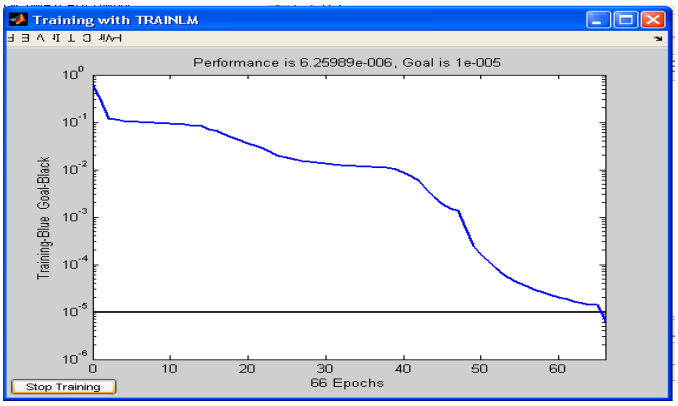

Figure 1.3 ANN trained by wavelet features

Fig 4.3 shows the neural network training where goal for training is mean square error of 10-5 in less than 500 epochs and learning rate was set at 0.1.

In wavelet based image retrieval, we computed wavelet based features of the images in the three domains of the RGB color model and have used them for training the ANN. The figure 4.3 is the snapshot of the effect of the training of these extracted wavelet features.

Sr. No	Image Index	Probability of similarity
1	41	0.9148
2	37	0.9134
3	40	0.9089
4	35	0.8957
5	13	0.8797
6	6	0.8679
7	44	0.8636
8	25	0.8496
9	15	0.8439
10	7	0.8361

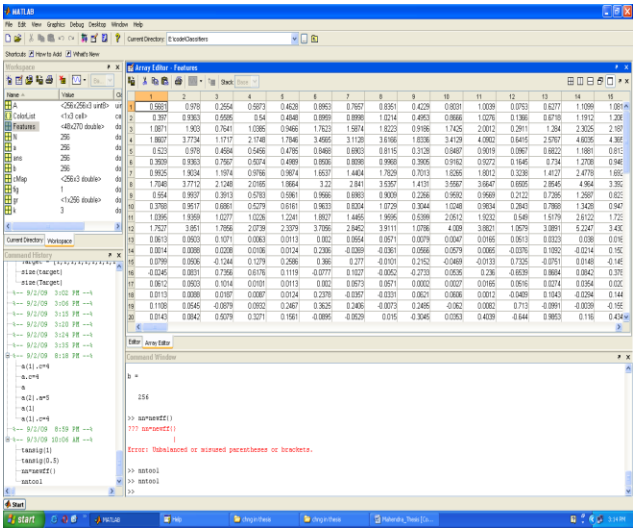

Figure 1.4 Wavelet Features

These features are passed to neural network for training and testing. The goal for training is mean square error of 10-5 in less than 500 epochs and learning rate was set at 0.1.

Trained ANN with wavelet features is shown in figure 1.5.

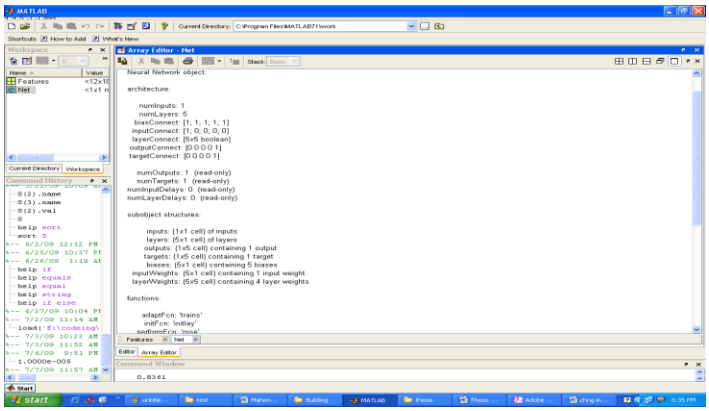

Figure 1.5 Trained ANN with Wavelet features

Graphical User Interface The GUI of the proposed system has two parts: Training interface and testing interface. A snapshot of GUI for the training of the system is shown in the figure 1.6In this the user gives input to the system. The input is the directory path of the images which are used for testing. All the images from the specified directory are retrieved and the system is trained accordingly by extracting features and feeding them to the neural network.The testing interface of the system takes an input image as the query and displays the probabilities calculation of the query images and its clustering details along with the most similar images matching the query image from the image database. Figure 1.8 Shows the snapshot of the testing interface of the system

Figure 1.9 shows snapshot of images retrieved.

S.No.	Test Image	Correctly Matched	Incorrect	Acuracy
1	Bus	9	1	90
2	Mountain	10	4	60
3	Dinosaur	18	2	90
4	Flowers	14	4	70
5	Food	7	3	70

Search Results To The Image Query

Table 4.2 shows the accuracy of the system. It shows percentage of correct images retrieved for a particular search. Here the search results and the accuracy for different categories such as bus, monuments, roses, mountains and food are given. Roses and Bus categories have high accuracy while monuments have comparatively low accuracy. There are various factors causing variations in the accuracy of results such as type of training images, testing image and their wavelet properties.

7. CONCLUSION

The system has approached the novel way of using the wavelets features for image retrieval. In this system D4 Daubechies wavelets function is used for image decomposition, F-Norm theory is used for feature extraction and ANN classifier is used for image classification. Yet a lot of work needs to be done in this direction. New possibilities in using more accurate and new horizons in wavelets need to be discovered. Some other wavelet functions can be used, derive various other feature extraction technique and experiment with other classifier. It would be quite interesting to observe the results and compare with the method proposed in this thesis.

The following future work is proposed:

Investigation of the effectiveness of other features and feature extraction techniques.
Investigation of other classification techniques.

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