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Hybrid Approach for Context Based Image Retrieval

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Abstract: *With the rapid development in multimedia and imaging technology, the numbers of images uploaded and shared on the internet have increased. It leads to develop the highly effective image retrieval system to satisfy the human needs. The content-based image retrieval (CBIR) system which retrieves the image based on the low-level features such as color, shape and texture which are not sufficient to describe the user's high-level perception for images. Therefore, reducing this semantic gap problem of image retrieval is challenging task. Some of the most important notions in image retrieval are keywords, terms or concepts. Terms are used by humans to describe their information need and it also used by system as a way to represent images. In order to measure the semantic similarity between images this hybrid approach focus on the textual context (e.g., tags) of an image in order to extract the group of text-based concepts, which characterize the image, which is certainly more effective for retrieval purpose. This semantic similarity measure can give deep concept similarity and relationship of images. This approach will also consider the content features of an image to measure the similarity of images. To express the deep semantic similarity this hybrid approach will integrate the context-based similarity as well as content feature-based methods to efficient retrieval of images.*

Key Words: *Context based similarity; Image retrieval; Semantic gap; Semantic distance.*

1. INTRODUCTION:

Due to the popularity of social networking and media sharing websites numbers of images uploaded and shared on the internet have increased. It leads to the availability of extremely large quantities images that are tagged by users. Social media sharing websites such as flickr, facebook, instagram, twitter, pinterest etc has given freedom of sharing and tagging images to users. So, the development of the highly effective image retrieval system to satisfy the human needs is required in spite of large scale of image data. Image retrieval systems have developed from text-based image retrieval (TBIR) to content-based image retrieval (CBIR). In TBIR images are retrieved from the database based upon the text associated with images. While In CBIR systems are based on the visual properties of the images. It uses image low level visual features such as color, texture, shape, spatial information to retrieve images from large set of databases. Following Fig. 1.1 shows the general flow of the CBIR system.

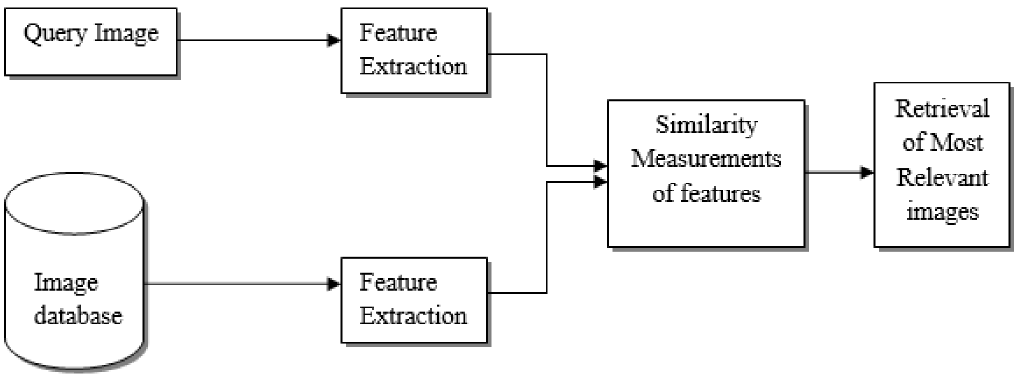

Figure 1.1 General flow of CBIR system

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Low level features extracted in CBIR systems are not sufficient to describe the user's high level perception for the query image. Therefore the semantic gap problem is arises in image retrieval systems which is the mismatch between the user requirements and capabilities of image retrieval systems. Human interpret the images using high level features such as keywords, text or tag associated to images. While CBIR system uses low level features to represent the images. Therefore semantic gap is always exists between human and image retrieval systems.

Various CBIR systems are developed and implemented in past decades such as QBIC, VisualSEEK, Blobworld, SIMPLicity [2] but still semantic gap problem is remains challenging in image retrieval task. Fig. 1.2 indicates the semantic gap in image analysis process.

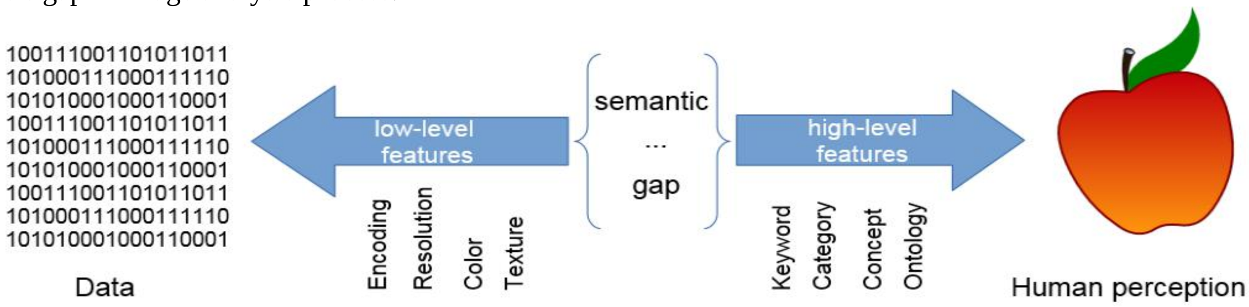

Figure 1.2 Semantic gap in image analysis [23]

Therefore, to reduce the semantic gap between human and image retrieval system we propose "Hybrid approach for context-based image retrieval". This hybrid approach is based on the image content that is image low level features (color, texture, shape) as well as image context that is image high level features (keywords, tags, captions). So that we can reduce the semantic gap between human and machine and can accurately retrieve the images. So basically, our approach is fusion of content-based similarity methods with image context-based similarity methods. This approach easily understands the user intention behind the query hence performance of image retrieval system will increase greatly. In Our approach context-based similarity techniques are used which is used to understand user's perception behind the query and gives better retrieval results. Our approach is also well suitable for large scale datasets.

2. THE PROPOSED HYBRID IMAGE RETRIEVAL SYSTEM

Hybrid image retrieval system which will retrieve images based on image low level features as well as image context that is image high level feature. So that it can bridge the semantic gap between human perception and machine understanding between human perceptions. The overview of our proposed system is given in following section.

2.1 System Overview

Workflow of our proposed image retrieval system is given in Fig. 2.1. In proposed work we have decided to use SVM as a classifier as it can give accurate classification compare to other classifier. In low level feature extraction for color feature FCH required less storage, less computation hence faster and also invariant to rotation, scaling and translation, insensitive to noise so we have extracted color feature using FCH.

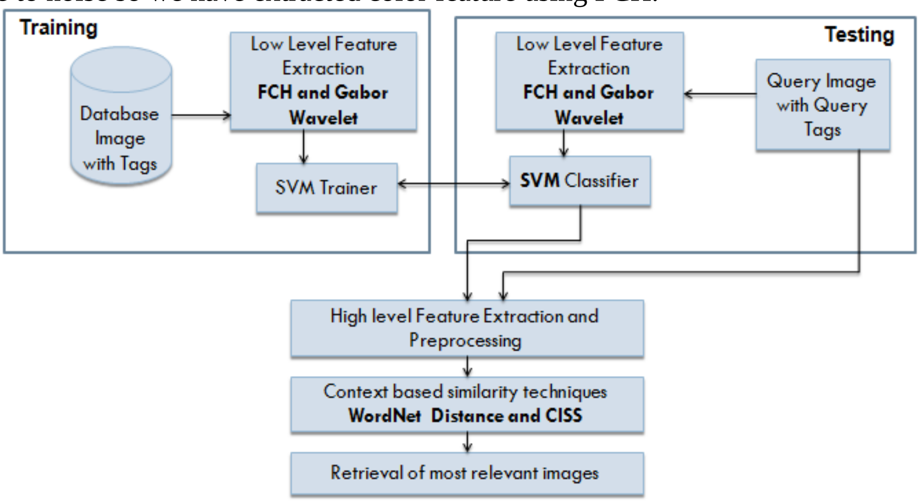

Figure 2.1 Workflow of proposed hybrid image retrieval system

For texture feature have decided to use gabor wavelet for accurately extract the texture pattern in images. For high level features, we have decided to use CISS method for calculate co-occurrence between tags of images as well as for calculate semantic relationships such as synonyms etc between tags we have decide to use WordNet distance.

2.2 Algorithm of Proposed System

Input: Query Image 'I' with associated tags $T = \{ t_1, t_2, \ldots, t_m \}$

Output: Top N retrieved images form database $D = \{ I_1, I_2, \ldots In \}$

- F_I = Feature vector of query image I
- F_D = Set of feature vector of n database images= $\{ F_1, F_2 \ldots, F_n \}$

Hybrid Image Retrieval Algorithm (I, T)

Begin

1.	For i=1 to n database images
2.	Apply FCH and gabor wavelet feature extractor to image i, combine them to obtain resultant feature vector Fi .
3.	Apply SVM Trainer to Fi for training and make SVM struck for each class.
4.	Apply step (2) on query image I and obtain F_I , Give F_I to trained classifier to obtain class C_I of the query image I.
5.	Extract the tags from images of query class C and query image and white spaces and duplicate tags are removed.
6.	Apply Context based similarity methods between tags of query image and tags of images in query class C_I.
7.	Most relevant images to query images are retrieved from class C_I.

END

Following sections discuss the main steps of our proposed hybrid image retrieval system based on image context. The main Steps of proposed system are as follows:

- Low level feature extraction
- Classification
- High level feature extraction
- Applying Context based similarity techniques between high level features of query image and images of query class identified from database.
- Retrieval of most similar images

2.2.1 Low Level Feature Extraction

For Color feature extraction as we have decided to use Fuzzy Color Histogram (FCH). We have use FCH and extracted the color features from the images. For FCH we have used the 27 fuzzy rules and for that used Mamdani type fuzzy inference system given in [19]. It gives the output as fuzzy histogram consists of only 10 bins. Output of the 10 bins histogram consist of black, dark grey, red, brown, yellow, green, blue, cyan, magenta and white respectively. So we got 1-D feature vector of size 1×10 for each image as a color feature of an image.

For texture feature extraction using Gabor wavelet transform first of all color image is converted in to grayscale image. Then Gabor filter is constructed using different number of frequencies and different phase angles. In last step, mean and standard deviation are calculated and store in feature vector. Here we have use 5 different scales and 6 orientations so we obtained total 60 features per image as a texture feature.

2.2.2 Classification

Initially in training phase using FCH and gabor wavelet feature are extracted of database images then combined resultant feature vectors have given to SVM for traning.SVM is trained using predefined classes of image database. After that in testing phase in our system we have taken query image as well as number of related tags or keywords from the use. So first using FCH and gabor wavelet query image feature are extracted after that combined feature vector has given to SVM for finding the appropriate class for the query image.

2.2.3 High Level Feature Extraction

Tags of the images in query class are required to extract from its respective annotation files. Tags of the images of query class is extracted as these tags are used by context based similarity techniques to measure the similarity between tags of the query image and tags of the images which are in query's class.

2.2.4 Applying Context based similarity techniques

After extraction of tags, semantic similarity between tags of query image and tags of images in query class are calculated. For finding out the semantic similarity CISS and WordNet distance have decided to use in our system. Here CISS only calculate the co-occurrence of tags so for calculating other relationships such as hypernmy, synonym etc WordNet distance is used.

2.2.5 Retrieval of most similar images

After that the most relevant images from database are retrieved using considering smallest semantic similarity measure. Our proposed work will retrieve the image using image low level features and image high level features so resultant images are very accurate to fulfil the user's perception. So, our proposed work will effectively bridge the semantic gap between human and machines in image retrieval tasks.

Here we have applied context base similarity methods on the images of the query class only so our system required less calculation since we have not decided to apply context similarity methods on whole image database. Therefore, our approach can also use for large database efficiently.

3. PERFORMANCE ANALYSIS:

For evaluating the performance of our proposed Hybrid image retrieval system, we have to select the appropriate image dataset which contains images and its associated tags. Therefore, we have chosen **8 Scene Categories Dataset** [21] which contain 2688 color images and its associated tags in the form of .xml file. 8 Scene categories dataset contains 2688 color images and 2688 .xml annotations files. This image dataset contains total 8 categories. All the categories' name and its sample images are shown in following Fig. 3.1.

Figure 3.1 Sample images of each category from 8 scene categories dataset

As in our proposed algorithm we have decided to use classification of image data. Therefore, this image dataset is divided into two parts since classifiers are work on the principle of testing and training.

- Training set
- Testing set

We have decided to take 80% of image data from each class as a training set and 20% of image data as a testing set. Since increasing number of training images increases the accuracy of classifier.

3.1 Performance Measures

To measure the performance of our proposed system we have used Precision [5] and Recall [5], which is most commonly used to evaluate the performance of retrieval systems. Precision measures the ability of the systems to retrieve only images which are similar to query image while recall measures the ability of the system to measure all the images which are similar to query images in the database. The precision and recall rates are computed by following equations:

$$\text{Precision} = \frac{TP}{TP+FP} \quad (3.1)$$

$$\text{Recall} = \frac{TP}{TP+FN} \quad (3.2)$$

TP= No. of retrieved images which are similar to the query.
FP= No. of retrieved images dissimilar to the query.
FN= No. of images in the database which are similar to query but not retrieved.

In our system we have used classifier so to evaluate the performance of classifier we have used confusion matrix. Confusion matrix, which is used to describe the performance of a classifier. Example of confusion matrix for binary classifier is shown in following table 3.1. In the context of classification precision and recall of each class is calculated using equation (1) and (2) and values of TP, TN, FP, FN are taken from confusion matrix.

Table 3.1 Example of Confusion Matrix

		Predicted Values	
		Positives	Negatives
Actual values	Positives	TP (True Positives)	FN (False Negatives)
	Negatives	FP (False Positives)	TN (True Negatives)

The performance of the classifier is measured in terms of accuracy. This term refers to the ability of the method to correctly predict the class of new unseen data. So classification accuracy is calculated by determining the percentage of cases in which the test sets are correctly classified in their respective classes. A good classifier always has a high accuracy. Accuracy of the classifier can be calculated as follows [5]:

$$Accuracy = \frac{TP + TN}{Total\ number\ of\ Images} \quad (4.3)$$

Here TP is number of correct predictions when instance is positive and TN is number of correct prediction when instance is negative.

3.2 Experimental Evaluation and Results

In this section we have implemented and evaluated the different steps of our proposed system. The main steps of our proposed system are as follows:

- Low level feature extraction
- Classification
- High level feature extraction
- Applying Context based similarity Techniques and Retrieval

We have designed the GUI of our proposed system using MATLAB 2013's GUIDE (GUI development environment). In which user can browse query image of his choice. User can select the number of query tags from the drop down list and give query tags related to query image. After that he can choose the query image's low level features i.e. color or texture or color and texture both. User can also specify the classifier. Classification result that is class of the user's query will be shown in GUI. User can also select the context base similarity techniques which will be applied between query tags and tags of the identified query class. After that by clicking on retrieve button user can show the image retrieval results. The design of GUI of our proposed system is given in following Fig. 3.2. Hence using this GUI user can easily interact with our proposed system.

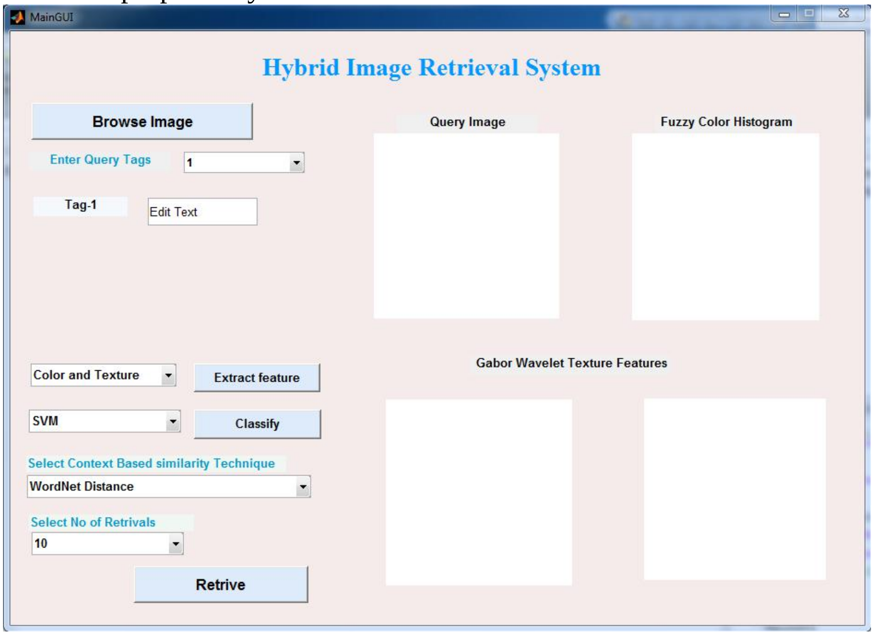

Figure 3.2 GUI of the Proposed System

3.2.1 Image Low level Feature Extraction

In our system we extracted color and texture features of image. For extracting the color feature we have used FCH and for texture feature extraction we have used Gabor wavelet.

Color Feature Extraction: For Color feature extraction as we have decided to use Fuzzy Color Histogram (FCH). We have use FCH and extracted the color features from the images. Following Fig. 4.3 shows query images with their respective Fuzzy color histograms. It gives the output as fuzzy histogram consists of only 10 bins. Output of the 10 bins histogram consist of black, dark grey, red, brown, yellow, green, blue, cyan, magenta and white respectively. So we got 1-D feature vector of size 1×10 for each image as a color feature of an image.

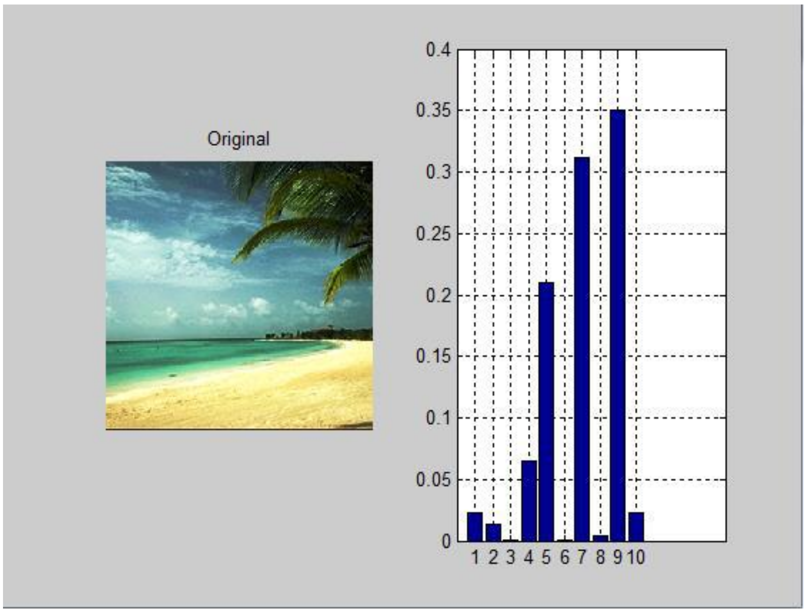

Figure 3.3 Query image coast_bea10 with its fuzzy color histogram.

Texture Feature Extraction: For texture feature extraction using Gabor wavelet transform first of all color image is converted in to grayscale image. Here we have use 5 different scales and 6 orientations so we obtained total 60 features per image as a texture feature. Feature extraction using Gabor wavelet transform for query image coast_bea10 is given in following Fig. 4.4. After that color and texture features are combined. In Fig. 4.6 color and texture, both features are extracted using GUI for query image coast_bea10.

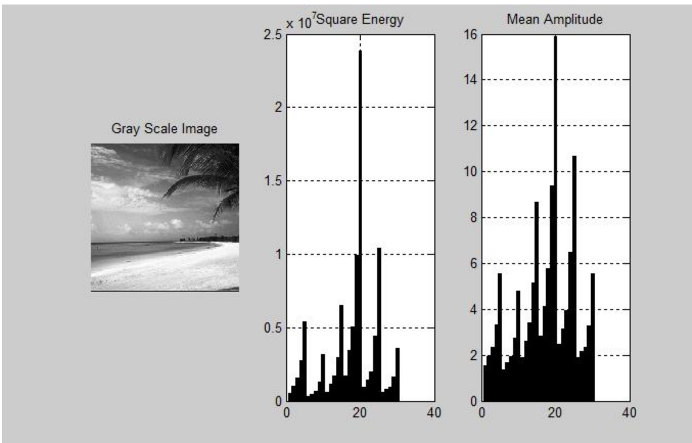

Figure 3.4 Texture Feature extraction using Gabor Wavelet of Query Image coast_bea10.

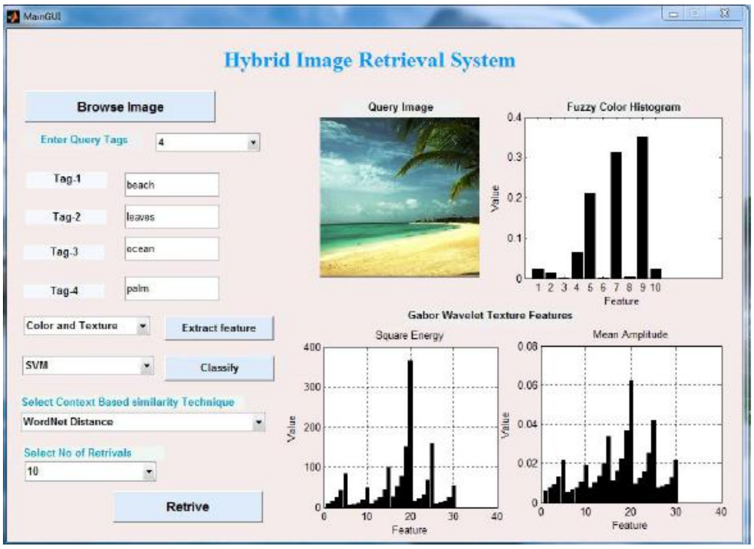

Figure 3.5 Color and Texture Feature extraction of Query Image coast_bea10.

3.2.2 Performance Evaluation of Feature extraction Techniques

In this section we have evaluated the performance of feature extraction techniques which are used in our proposed system. To evaluate the performance first of all we have extracted the color and texture features of the query image as well as database image as discussed in previous section. So we get feature vector of length 70 for each image.

To measure the performance of the feature extraction technique we have randomly taken 5 images from each class as query image. Then calculated the precision and recall of each 5 query image of every class then calculated the average precision and recall of each class by taking average of precision and recall of 5 query image of each class. The evaluation was carried out with the number N of the retrieved images set as 10 to compute Precision and Recall.

Here we have measured the similarity between query image feature vector and features vectors of database image using Euclidean Distance which is most commonly used similarity measure. We have compared the results of our feature extraction techniques i.e. FCH and Gabor wavelet Transform with existing feature extraction technique (Color Moment(CM) and Gabor wavelet) proposed in [11]. We have calculated the precision and recall for existing system [11] by taking the same 5 -5 query image of every class and calculated average precision and recall. Following figures shows the retrieval result of different feature extraction techniques when number of retrieved images set as 10.

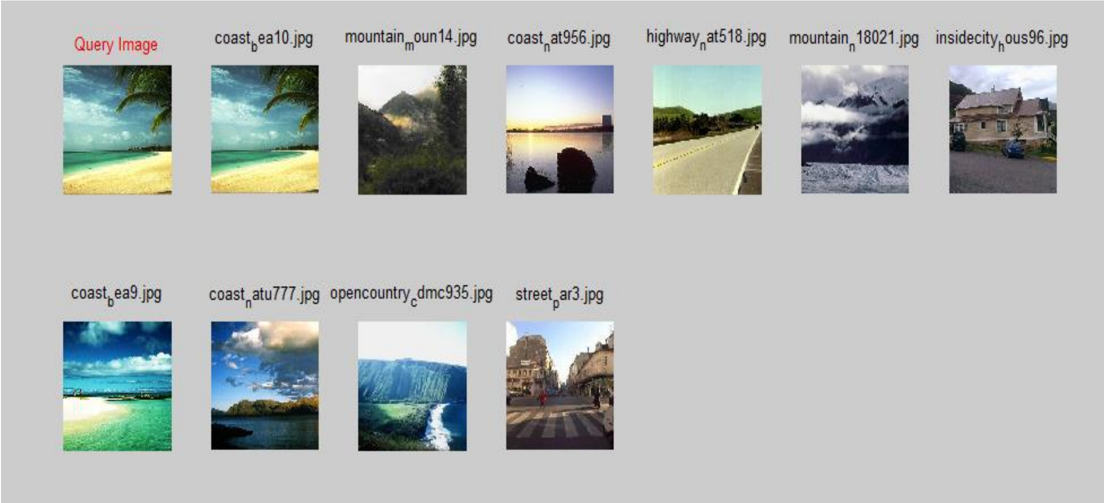

Figure 3.6 Retrieval Result using FCH +GWT and Euclidean Distance for coast_bea10.jpg

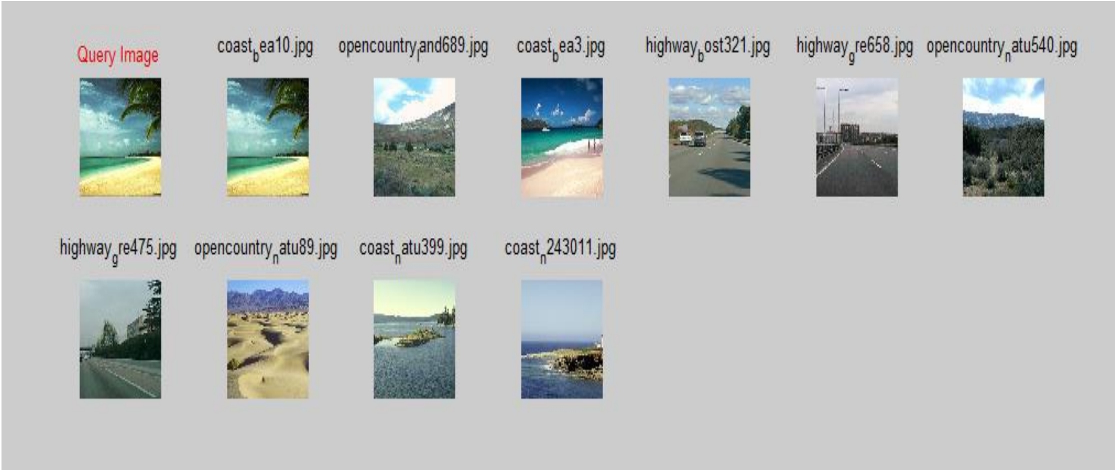

Figure 3.7 Retrieval Result using FCH + CM and Euclidean Distance for coast_bea10.jpg

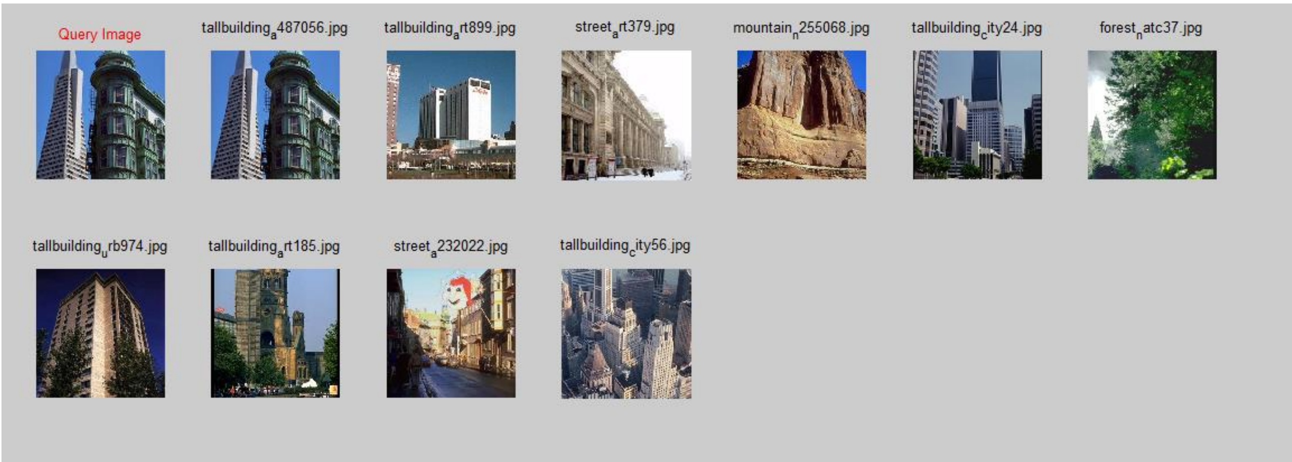

Figure 3.8 Result using FCH +GWT and Euclidean Distance for tallbuilding_a487056.jpg

Comparison between average precision and recall for proposed feature extraction techniques and existing feature extraction technique is shown in following Table 3.8. From the table we can conclude that the FCH and GWT gives better precision and recall than the existing GWT and Color moment features. The Euclidean distance is used for calculating the similarity measure between the query images and database images.

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Table 3.2 Comparison of average precision and recall for feature extraction techniques

Categories	GWT + Color Moment [11]		GWT + FCH	
	Precision	Recall	Precision	Recall
Cost	0.20	0.05	0.40	0.114
Forest	0.50	0.074	0.60	0.100
Highway	0.50	0.064	0.50	0.100
Inside City	0.30	0.093	0.60	0.187
Mountain	0.40	0.064	0.60	0.177
Open Country	0.40	0.190	0.50	0.240
Street	0.50	0.142	0.60	0.171
Tall Building	0.50	0.10	0.70	0.127
Symbols	0.50	0.25	0.60	0.30
Average	**0.422**	**0.114**	**0.566**	**0.168**

We have also calculated the time required for feature extraction and retrieval using Euclidean distance for our proposed system's feature extraction technique and Existing feature extraction techniques GWT and Color Moment. Following Table 3.3 shows the required time in seconds for various query images for GWT +FCH and GWT +CM.

Table 3.3 Comparison of Retrieval time using Euclidean distance for feature extraction techniques

Query Image Name	Image Retrieval Time using Euclidean Distance (S)	
	GWT + Color Moment [11]	GWT + FCH
coast_n203069.jpg	3.58	5.72
forest_for22.jpg	2.18	5.28
highway_bost169.jpg	2.08	5.17
insidecity_bo109.jpg	2.36	5.13
mountain_moun44.jpg	2.19	5.30
opencountry_file37.jpg	2.91	5.10
street_art764.jpg	1.99	5.37
Tallbuilding_a487092.jpg	2.25	5.05
Average	**2.44**	**5.26**

From the table we can see that the feature extraction techniques given in [11] required less time than the feature extraction techniques used in our system. But the difference is not major. Our proposed system's feature extraction technique required only 2.8 seconds more than existing one and give better precision and recall as we have already shown in Table 3.3. Therefore, despite of our proposed system's feature extraction technique required on average 2.8 seconds more than existing [11], it gives nearly 15 % more precision than existing techniques. Hence our proposed system's feature extraction techniques are proved more efficient than existing.

3.2.3 Classification

After feature vector is generated, next step is classification. We have used SVM classifier for classification. The performance of the designed classifier is measured in terms of accuracy using confusion matrix. As discussed in section 4.2 accuracy of classifier is measured using equation (3). Following Fig. 3.8 shows the results of SVM classifier using features FCH and GWT in MATLAB command window.

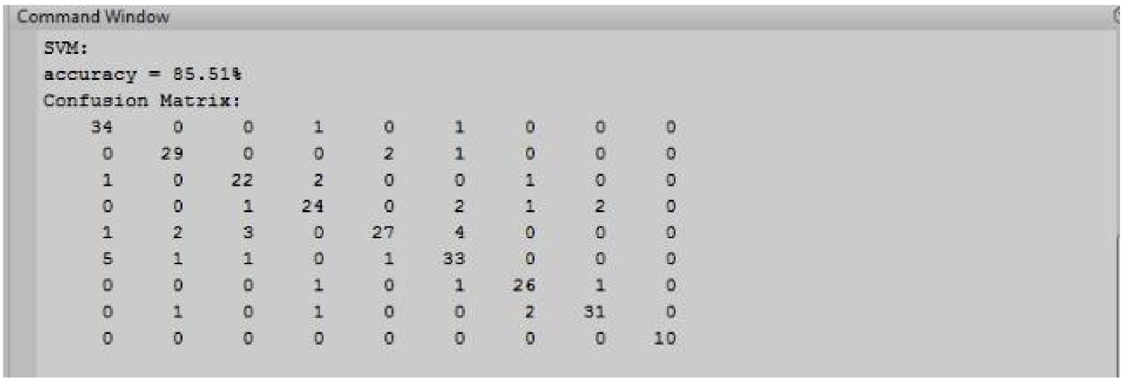


Figure 3.9 Accuracy and Confusion matrix of SVM Classifier

Here every row in confusion matrix represents Actual class and column value represents the predicted class. Here from Figure 3.9 we can conclude that Accuracy of classifier is 85.51 % . We have tested every class query images and most of the time classifier gives correct result which proves the efficiency of our approach. After feature extraction using color and texture feature, then selecting SVM classifier user will choose to click on classify button in GUI of our proposed system for identifying the class of the query image. Following Fig. 3.9 shows the classification result for the query coast_bea10.jpg.

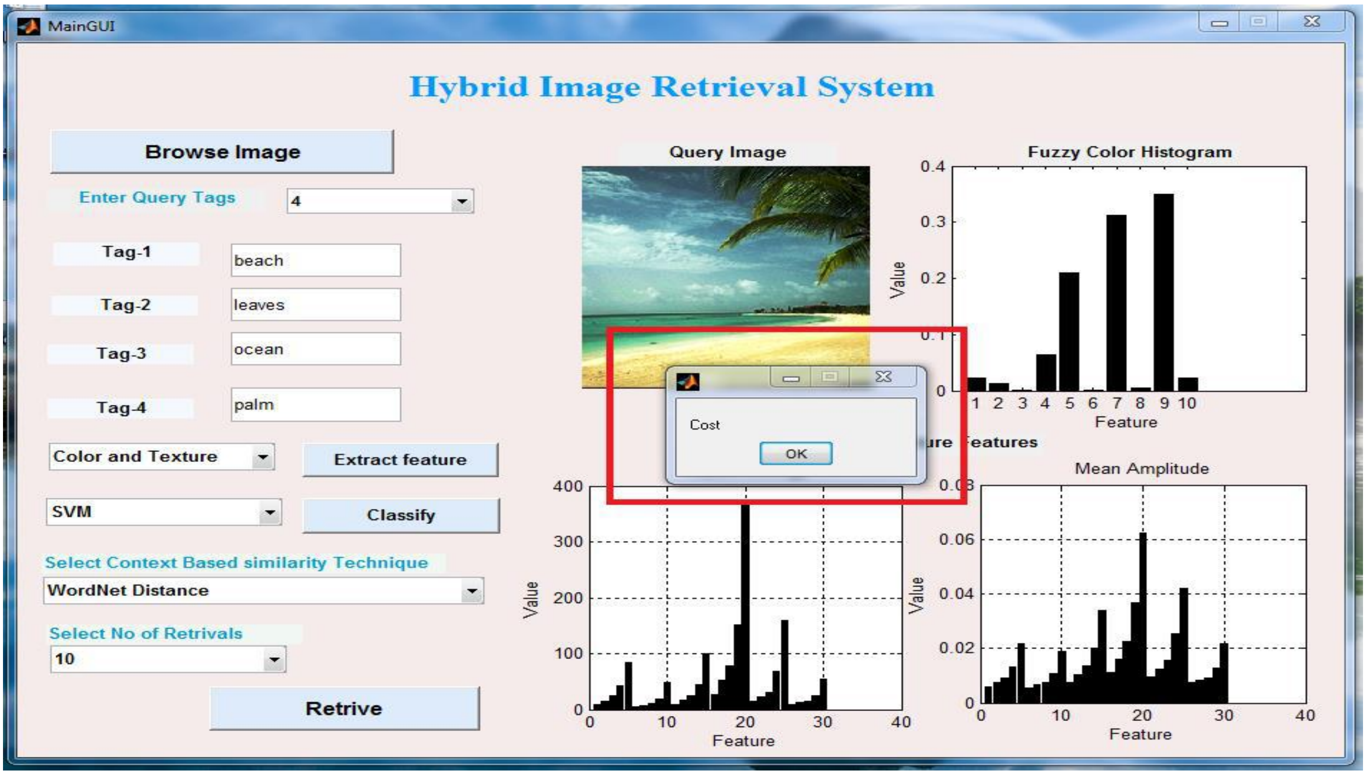


Figure 3.10 Classification result for query Image coast_bea10.jpg

3.2.4 High Level Feature Extraction

Using classification we have identified the class of the query image now next step is high level features extraction of query image. Then high level features of images in the identified query class are also extracted. Following Figures shows the examples of high level feature extraction of query images.

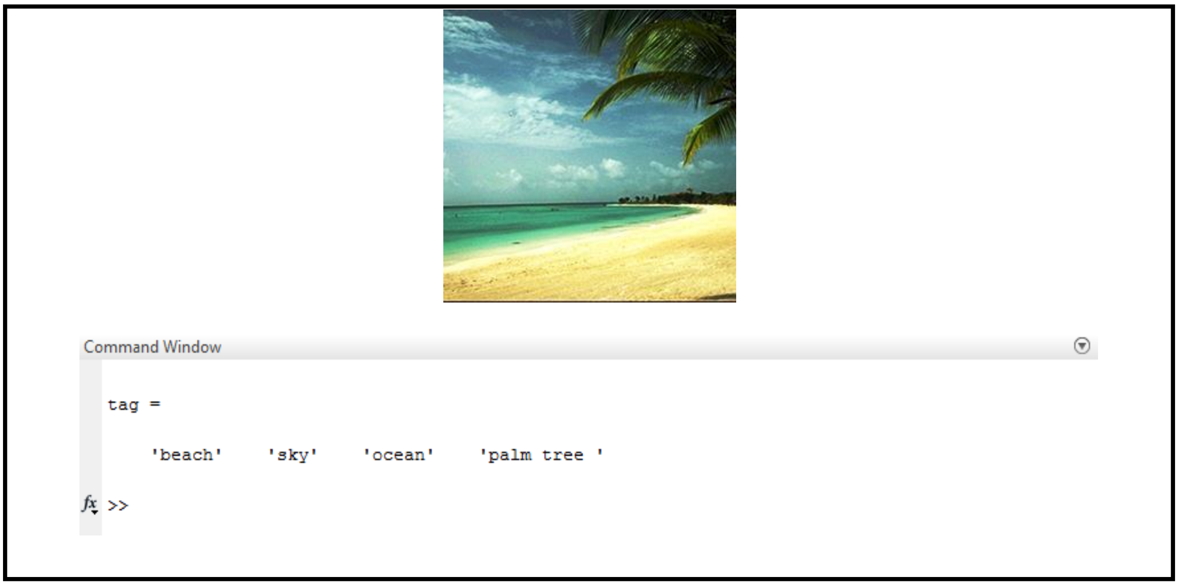


Figure 3.11 High level feature extraction of query image coast_bea10

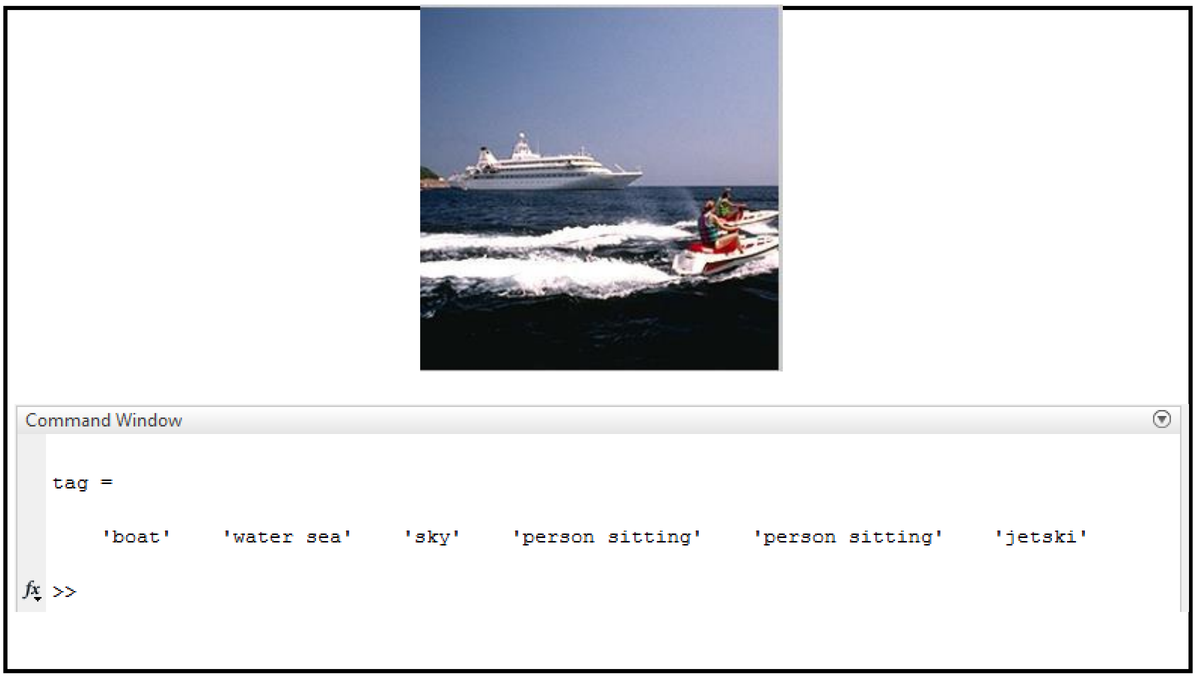


Figure 3.12 High level feature extraction of query image coast_arnat59

As in our dataset high level features (annotations) are available in the form of xml files, these high level features are extracted using MATLAB commands available for using the xml files. We have extracted high level features of all the images.

After tags are extracted tags are preprocessed. In preprocessing white spaces between tags and duplicate tags are removed using MATLAB functions. After that all the annotations of whole dataset is stored in one .mat file. This file is useful to calculate the context based similarity techniques between query image tags and tags of the identified class of the query image. So now next step in our proposed system is applying context based similarity techniques between high level features of query image and images of query class identified from database.

3.2.5 Applying Context based Similarity Techniques and Retrieval

We have applied context base similarity techniques between these high level features of identified query class and the query tags given by the user. Here from the. mat file which containing whole dataset annotations are used but only the tags which are of the query class are used. CISS and WordNet distance methods are applied between query tags and tags of the query class using group similarity algorithm given in [3]. Following Fig. 4.21 shows the concept of group similarity algorithm. In which each tag of one image is compared with all the tags of second image and semantic distance is calculated.

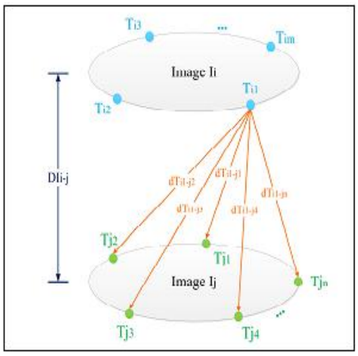


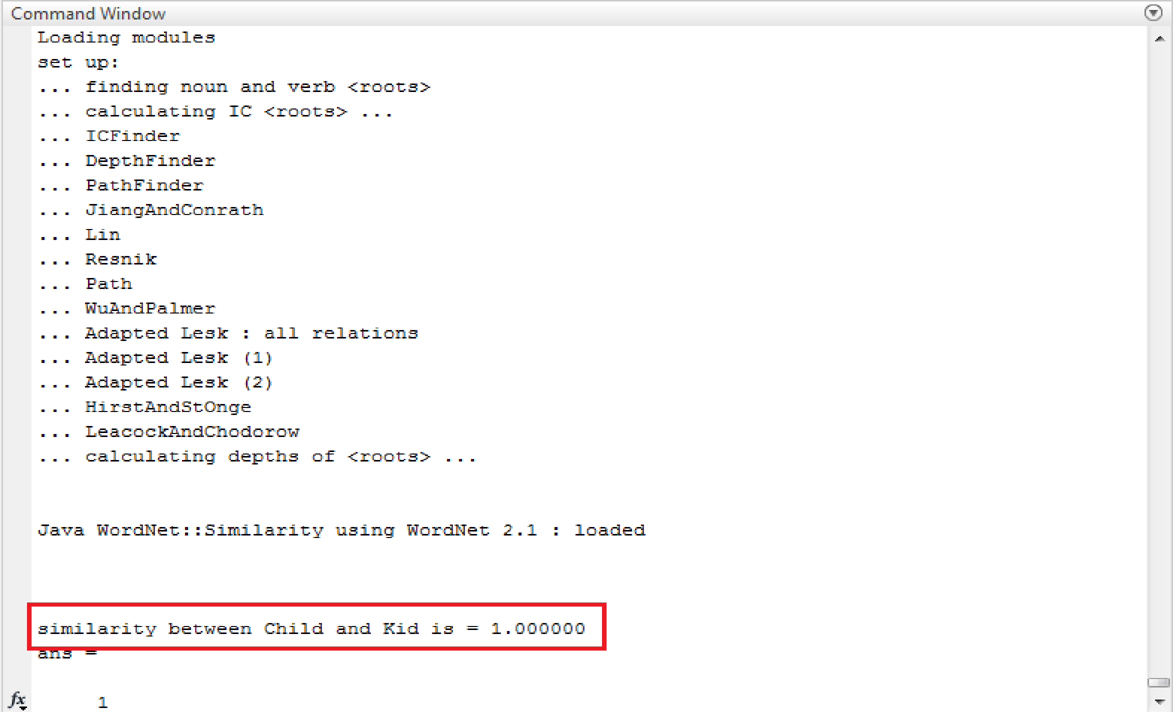
Figure 3.13 Group similarity algorithm [3]

WordNet Distance: For calculating WordNet Distance we have installed most recent windows version of WordNet i.e. WordNet 2.1. For calculating this semantic distance we have used JWS (Java WordNet Similarity), which is open source project based on java and WordNet semantic similarity. JWS is implementation of WordNet distance in java.

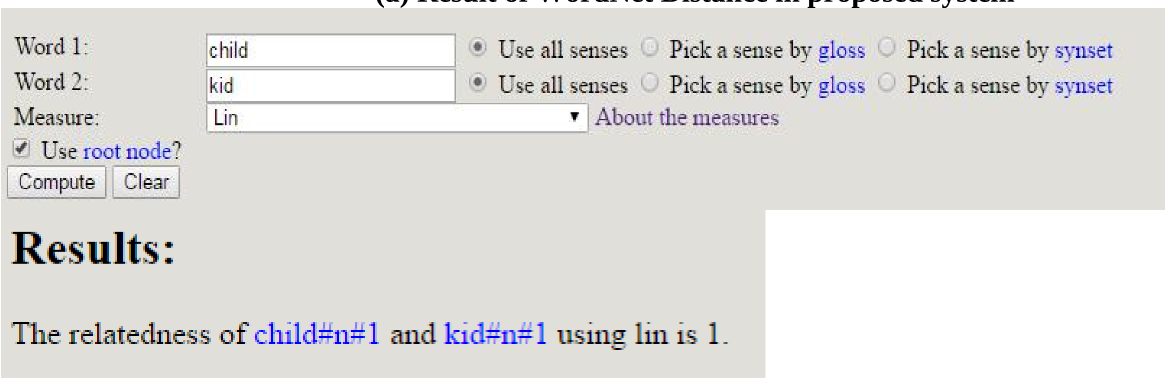
Another library named JWI (JAVA WordNet Interface) is also used. JWI is java library for interfacing with WordNet developed by MIT [26]. These two libraries are imported in MATLAB and WordNet 2.1 is installed in our system.

Here JWS package provides six measures of similarity all based on WordNet: res (Resnik, 1995), jcn (Jiang and Conrath, 1997), lin (Lin, 1998), lch (Leacock and Chodorow, 1998), wup (Wu and Palmer, 1994), and path. Among these six measures of similarity Lin's measure outperforms others [17]. Therefore for calculating WordNet Distance we have used Lin's semantic similarity measure in our system. Lin's measure uses the concept of Information Content (IC). The value of IC depends on the probability of encountering concept c in a given corpus. Therefore we have also included WordNet-InfoContent for version 2.1 and included this folder in WordNet installation directory.

After JWI and JWS are imported in MATLAB we have created the object for Lin class which available in JWS and using Lin object we have calculated the WordNet Distance. Following Fig. 4.22 shows the example of WordNet distance between two words in our system and the results with online WordNet similarity Interface [25] and results are matched with online WordNet similarity Interface.



(a) Result of WordNet Distance in proposed system



(b) Result of WordNet Distance in online WordNet similarity interface [27]

Figure 3.14(a) &(b) Result of WordNet Distance in Proposed system and online WordNet similarity interface

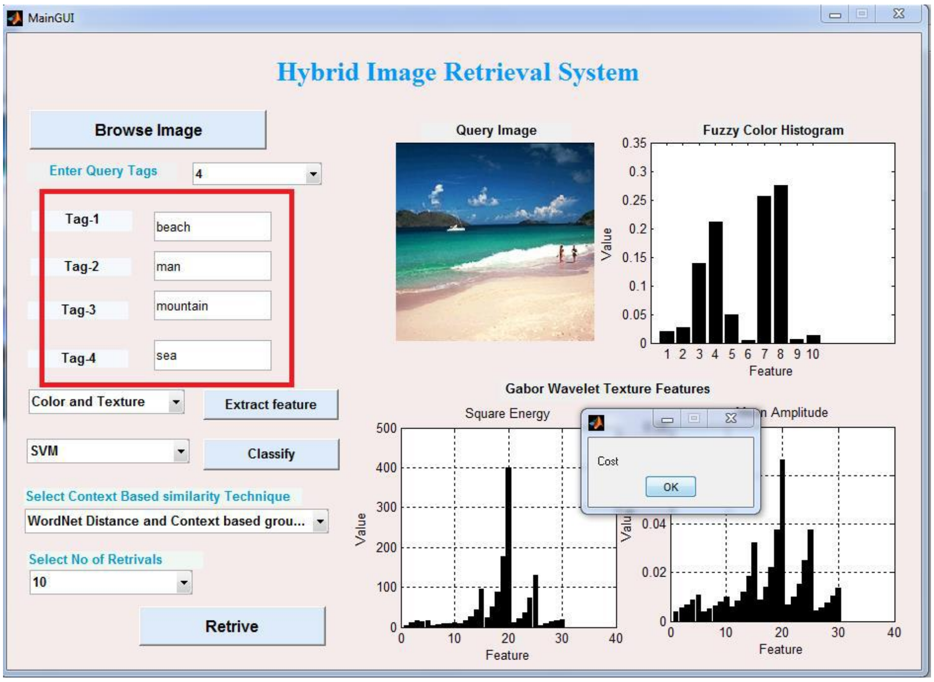
CISS: As we have discussed in chapter 2 WordNet is very close to human perception but the number of concepts used in WordNet are very less compared to the concepts used in Web. Therefore WordNet cannot be applied to measure semantic distance between most of the concepts on Web. So to deal with user-friendly tags and tags whose concepts are not available in WordNet we have used CISS similarity measure along with WordNet.

In CISS similarity measure each query tag is compared with every tag in database using MATLAB functions, frequency of tags are calculated which is used as similarity measure. Here this distance reflects the frequency of two tags occurring in same image. So this technique can handle the concurrence relationship.

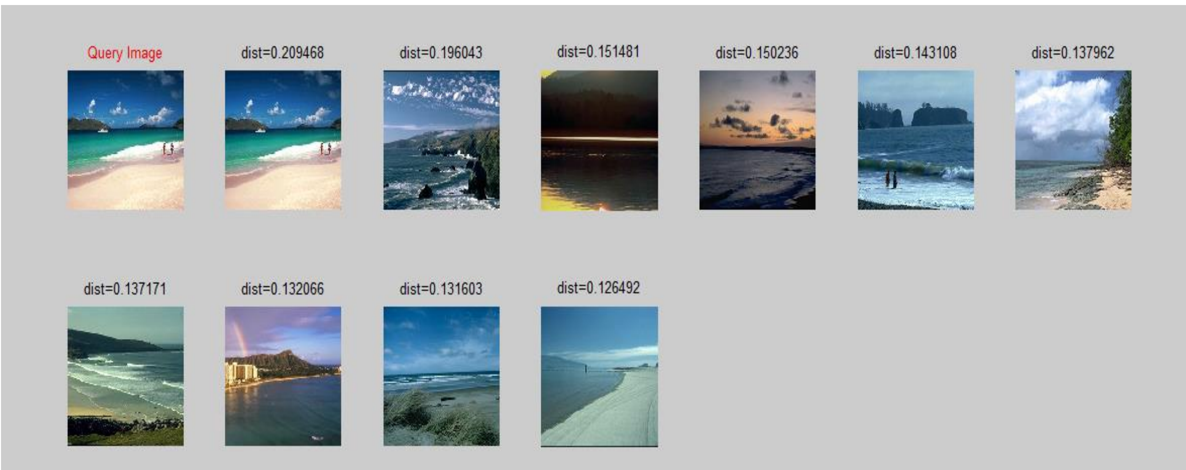
Here final similarity measure is obtained by taking the average of the WordNet distance and CISS distance of semantic similarity. Using this final distance the images which are most relevant to query images are retrieved from the database.

Here we only need to applied the context based similarity techniques on high level features of images in the query class and not for the high level features of whole dataset, which indicate that our proposed system required low computation as well as less time. Hence our system is scalable for large datasets.

After identifying the class of the query image from the classifier by applying context based similarity techniques between tags most relevant images are obtained. Following Fig. 4.23 to 4.31 shows some example of the image retrieval for our proposed system.

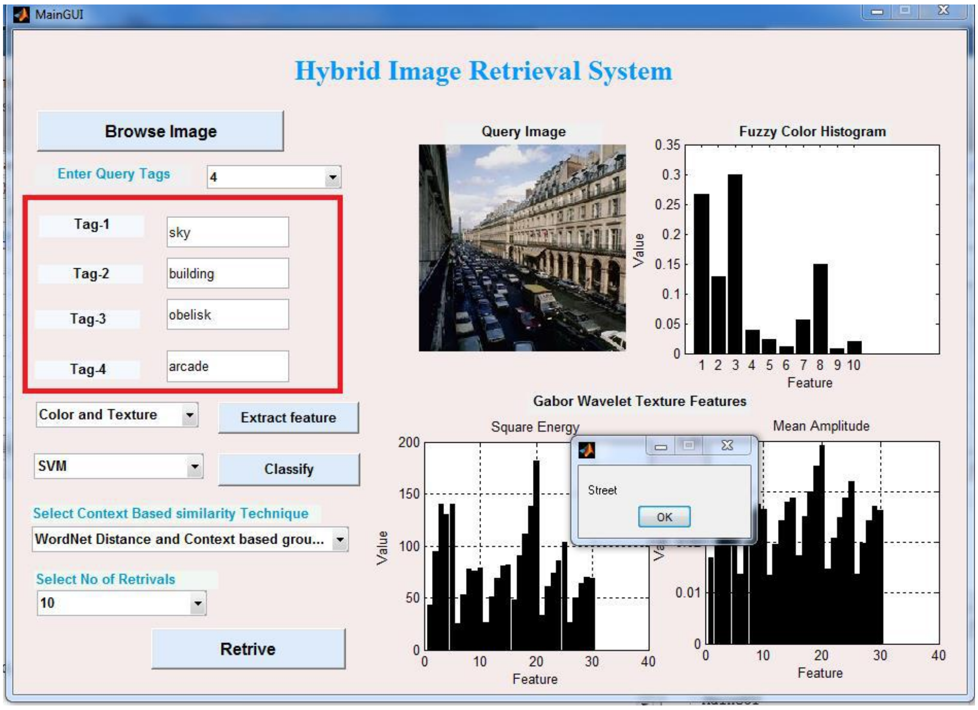


(a) Feature extraction and classification of query image with query tags given by user are highlighted in red box



(b) Result of Retrieval for query image using context based similarity methods of proposes system using query image and query tags given by user

Figure 3.15 (a) and (b) Image retrieval result of proposed system for query image coast_bea3.jpg



(a) Feature extraction and classification of query image

In this way we have analyzed our proposed system by taking various types of query images from different class of the database. To measure the performance of the proposed system we have randomly taken 5 images from each class as query image. Then calculated the precision and recall of each 5 query image of every class then calculated the average precision and recall of each class by taking average of precision and recall of 5 query image of each class. The evaluation was carried out with the number N of the retrieved images set as 10 to compute Precision and Recall.

Following Table 3.4 shows the average precision and recall of the proposed system on different categories of the dataset. The last raw of the table shows the overall average precision and recall of the system. This precision and recall are obtained when number of retrieved images are set as 10 (N=10).

Table 3.4. Average Precision and Recall of Proposed Hybrid Image Retrieval System

Categories	**Precision** $_{N=10}$	**Recall** $_{N=10}$
Cost	0.82	0.12
Forest	0.94	0.11
Highway	0.82	0.13
Inside City	0.80	0.13
Mountain	0.86	0.14
Open Country	0.88	0.12
Street	0.82	0.14
Tall Building	0.98	0.19
Symbols	1.0	1.0
Average	**0.867**	**0.227**

From the Table 3.4 we can conclude that the our proposed system gives high precision and recall. Here precision is 86.7 % which indicate that our system satisfactorily understand the user requirement behind the query compare to other CBIR methods. Here we have taken query tags from the user and applied context based similarity measures to retrieval of images which prove very efficient in terms of understanding the user perception behind query hence high precision is obtained. Here context based similarity techniques required very less time and also this similarity method is applied only on the identified class of the query image and not on the whole dataset ,so number of computation are reduced.

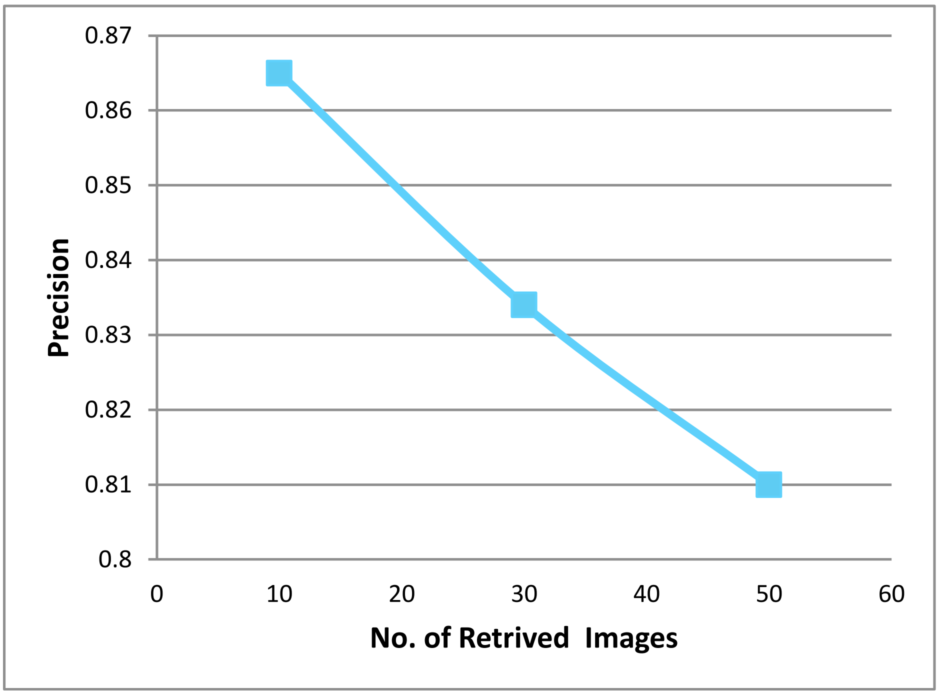
3.2.6 Performance Evaluation of Proposed Image Retrieval system

In this section we have calculated the average precision and average recall values for number of retrieved images like 10, 30 and 50 are calculated. To measure the performance of the proposed system we have randomly taken 5 images from each class as query image. Then calculated the precision and recall of each 5 query image of every class then calculated the average precision and recall of each class by taking average of precision and recall of 5 query image of each class. The following Table 3.5 shows the image precision and recall values when N=10, 30 and 50.

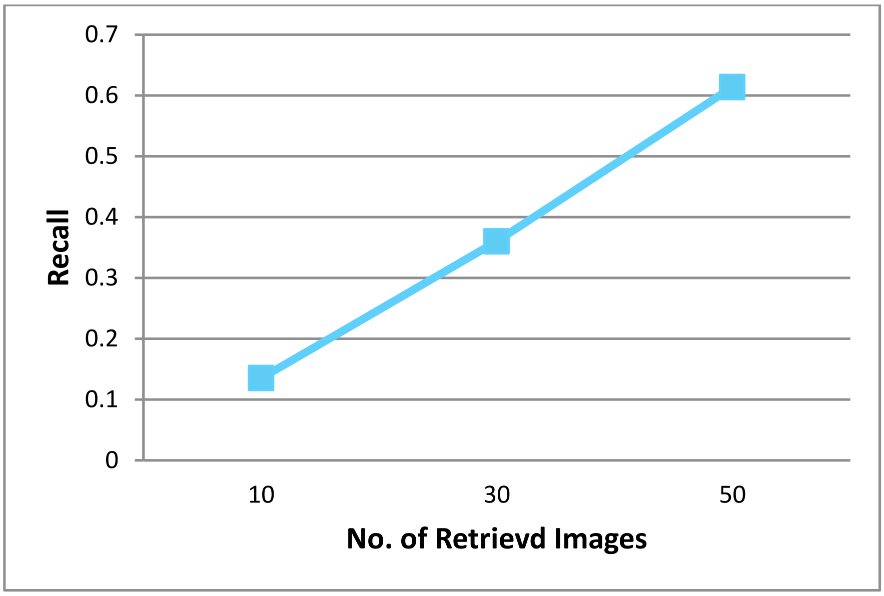
Table 3.5 Average Precision and Recall of Proposed Hybrid Image Retrieval System with different number of retrieved images

Categories	N=10		N=30		N=50	
	Precision	Recall	Precision	Recall	Precision	Recall
Cost	0.82	0.12	0.81	0.37	0.79	0.60
Forest	0.94	0.11	0.91	0.32	0.89	0.52
Highway	0.82	0.13	0.81	0.39	0.78	0.65
Inside City	0.80	0.13	0.78	0.37	0.76	0.80
Mountain	0.86	0.14	0.80	0.39	0.76	0.61
Open Country	0.88	0.12	0.86	0.35	0.84	0.57
Street	0.82	0.14	0.76	0.38	0.74	0.65
Tall Building	0.98	0.19	0.94	0.32	0.92	0.51
Symbols	1.0	1.0	0.33	1.0	0.20	1.0
Average	**0.865**	**0.135**	**0.834**	**0.360**	**0.810**	**0.6137**

Following Fig. 3.16 shows the graph of average precision and recall versus no of retrieved images (N).



(a)



(b)

Figure 3.16 (a) and (b) Average precision versus different number of retrieved images and Average recall versus different number of retrieved images

Results show that precision value is gradually decreases when the numbers of retrieved images are increased and the recall value is gradually increases when the numbers of images are increased. The results show that the precision is good achieved when the total number of retrieved images is 20.

We have compare the retrieval result of our proposed system which used context based similarity techniques for image retrieval after classification using tags of the identified class and retrieval results of the proposed system without context based similarity techniques that is without using query tags and retrieval based on image low level feature similarity. Here we have considered Euclidean distance which is most widely used similarity measure used for measure the low level feature based similarity. Following Figure shows retrieval result of proposed system with context based similarity techniques and without context based similarity techniques.

4. SUMMERY:

In our proposed system we have evaluated the performance of our feature extraction techniques i.e. FCH and GWT using precision and recall metric and compared the result with existing feature extraction approaches i.e. color moment and GWT. Implementation results show that the feature extraction techniques for the proposed system are better than the existing techniques. SVM Classifier also gives good accuracy using these feature extraction techniques. We have evaluated the performance our classifier using confusion matrix. We have applied the context-based similarity techniques between query image and images of identified query class. Using this similarity measure we have retrieved the most similar images to query images. Retrieval time of our system is reduced because query image is only compared with specific class determine from SVM.

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