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An Overview of Relevance Feedback Methods Implemented in Content Based Image Retrieval

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Abstract: Content based image retrieval is a wide research area for manipulating bulky database. The retrieval process in content based image retrieval can be maximized by using relevance feedback technique. Relevance feedback is a mechanism for improving retrieval precision over time by allowing the user to implicitly communicate to the system to find which of the features are relevant and which are not that is it low down the semantic gap between low level and high level features. In this paper the different classifiers like SVM; Adaboost, Neural Network, and Decision tree with RF techniques are analyzed according to its performance.

***Keywords:* RF Techniques, semantic gap, classifiers, SVM, Neural Network, Adaboost.**

I. INTRODUCTION

From the decades there has been a tremendous growth of the images over the internet and in digital libraries. Also graphics and media format are the one that are important for communication as they provide dense information for people to understand.

In Content base image retrieval [1] data is retrieved according to its feature that is color, shape and texture. Basically Content base image retrieval is a challenge of multimedia database because there exist a vast difference in the perception capacity between a human and a computer known as semantic gap. A typical content based image retrieval [2] system includes the following steps-

1. As the first step the visual contents of the images in the database are extracted and described by feature vector database. To retrieve images, users provide the retrieval system with inquiry images. The system then changes these examples into low level representation of feature vectors. This is called feature extraction.
2. Similarity measurement between the inquiry image and the image in the database is done using different similarity matching techniques.
3. Appropriate image is retrieved with the aid of an indexing scheme. Relevance feedback technique is then applied to increase the accuracy in retrieval process.

II. RELEVANCE FEEDBACK

The research is on from decades but still it is a challenging task to reduce the semantic gap between high level and low level concept. For the proper extraction of image the concept of relevance feedback is used in which user is queried every time for a proper feedback so that the images can be classified relevant and irrelevant accordingly. [4] Relevance feedback has been used to modify the retrieval process and generate more appropriate result. Relevance feedback retrieval system prompts the user for feedback on retrieval result and then uses this feedback on subsequent retrieval for the goal of measuring retrieval performance. Different approaches have been used in explaining how actually CBIR system learns from feedback provided by user. The approach is either using short term learning or long term learning with relevance feedback.

A relevance feedback retrieval system has a few design requirements that allows the system to function in an efficient manner.

- After each iteration, when a set of images are retrieved the system must require a reasonable amount of feedback.
- The system must produce acceptable results after only a few iterations. If large numbers of iterations are required, the user will also tire.
- Also these low level features extracted and their semantic meanings may differ thus forming a gap known as the “Semantic Gap”. This problem is an important factor that affects the performance of RF in CBIR.

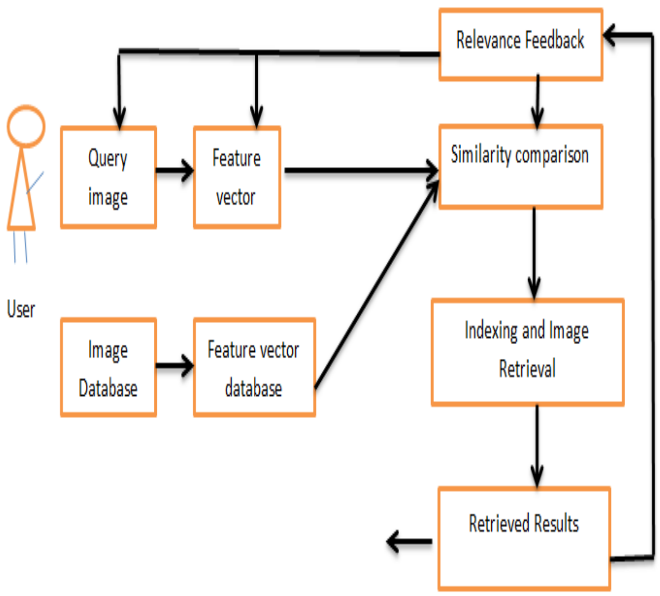

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Fig. 1 A Typical CBIR system with RF

III. APPROACHES TO RELEVANCE FEEDBACK

A. Short Term Learning Approach

This approach uses the algorithm in which feedback is taken only from the current session using the image feature as primary source of data. To find the best combination of image is the main challenge. The optimum set of features includes the features that can give the clear difference between positive with negative ones or the clear similarity between positive ones. The classical machine learning algorithms widely used in short term learning include Support Vector Machine (SVM), Bayesian learning, boosting, decision tree. The STL [4] approach requires less memory. However the STL approach has the limitations. The size of the training set is smaller than the dimension of feature space. There is too much imbalance between the users feedback.

B. Long Term Learning Approach

Long Term Learning [4] approaches are designed to use collected information of previous sessions aiming to improve the retrieval results for future sessions. This approach has been found unsuitable for applications that frequently add and remove images. This approach requires huge memory and computation to extend the knowledge across images as it strongly depends on the amount of user log that the system has stored for long duration.

IV. CLASSIFIERS

A. Support Vector Machine

Various studies have been done on classifiers that are good in performance wise. Basically classifiers maximize the difference or say margin between the positive samples and the negative samples so that the retrieval can be efficient. One such classifier is support vector machine (SVM) [5]. It is a kind of learning methods that are governed and is used in discriminating the images. Under this, database of images is divided into group of vectors in a 'k' dimensional space by constructing a hyper plane that maximizes the margin between two vector sets .It is a kernel base approach and the kernel function helps an important role in determining performance of relevance feedback. The main motive of this classifier is to find an optimal hyper plane that discriminates the margin between relevant and irrelevant between two classes. This approach helps in reducing prediction error as it clearly sketch the line between relevant and irrelevant images .This approach helps in reducing the time complexity of the retrieval as prediction error is low. SVM RF [5] approach ignores the basic difference between positive and negative samples that is it treats both the samples in the same manner though their feature space is entirely different. Over fitting problem can become more severe, as training samples.

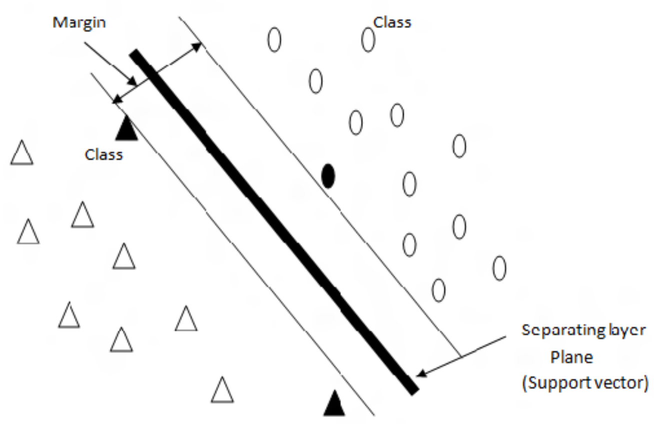

Fig 2. A SVM Classification of images

Biased maximum margin analysis and semi supervised margin analysis are used with the SVM classifier to remove the problem of SVM [5] that it treats the positive and negative samples equally. Biased maximum margin analysis is mainly used to map positive samples i.e. relevant images closer and negative samples i.e. irrelevant images are separated from positive ones by maximum boundary in the feature space. So it is easy to map relevant and irrelevant images onto feature space. In Semi supervised Margin analysis unlabeled samples are also considered. So that the retrieval should be more accurate .No information is associated with unlabeled samples.

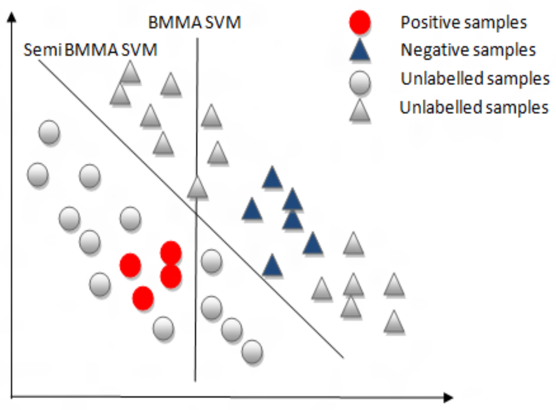

Fig 3. An illustration of the SVM hyperplance comparison between BMMA SVM and Semi BMMA SVM for two classes of feedbacks

B. Decision Tree

The main objective of learning algorithm is to build a predictive model that accurately predict the class labels of unknown records .Decision tree classifier[6] is a

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simple and widely used technique in which each time it receive an answer when a follow up question is asked until a conclusion about the class label of the record is reached. The algorithm runs recursively until all instances within each partition are of the same class .The learning process creates a decision tree that can classify the outcome standards based on the standards of given attributes. Each leaf node of the decision tree represents a decision and each non leaf node represents the standards associated with it. Different methods are deployed to differentiate the data that can lead to trees of different complexities, sizes and levels. Based on learned inferences this method not only improves the retrieval precision but also provides user to provide feedback only to a handful of images.

The algorithm operates as follows. Starting from the first iteration there is no feedback information exists, so the retriever performs an unweighted K nearest neighbor retrieval. The user then marks the retrieved images as relevant or irrelevant accordingly. This feedback is relayed back to the system and the second iteration begins. Under this, the algorithm is presented with the labeled images. Our algorithm doesn't operate on the images themselves but on the associated feature vectors. From these training instances, we induce a decision tree via C4.5. A decision tree is a method for recursively partitioning a feature space such that each partition is associated by a single class value. The criteria for having sequential "cuts" in the feature space is a product of information called "entropy". The algorithm makes cuts until all instances within a partition are of the same class, the partition is then labeled with that class value. The next step is to classify the entire database of feature vectors through the learned tree. That is with the help of tree each image's feature vector is routed down to a leaf node that has class relevant or irrelevant. On routing an image to a particular leaf, the unique index of the image in the database is stored in that leaf. Thus a leaf has a record of all of the images that have been routed to it. When all instances in the database have been filtered then all the instances that filtered down into a leaf with class "relevant" are assembled into a list. The K images closest to the query are retrieved by executing an unweighted K nearest neighbor retrieval on the list. On the next iteration, the retriever's operation is identical to that on the second iteration except that now there are a total of K instances of user feedback from which the system will induce a decision tree. Similarly every subsequent iteration allows the retriever to learn from K more images than previous iteration. This process continues until the user gets satisfaction from the result.

C. Boosting Technique

Yet another example of classifiers that helps in maximizing the size of space between positive and negative samples is boosting [4]. Boosting provides a good practical and theoretical convergence to a low error rate in less number of iterations also on comparing to other methods namely SVM, the speed of boosting algorithm is more. Suitable combination of weak classifier is combined to make strong classifiers. Selection of classifiers is done on the basis of error rate, the error rate of week classifier should be less than 0.5. Combination provides weight to each of the classifiers based on the importance. Adaboost is often regarded as boosting algorithm, since it is first practical algorithm that used boosting. Combination provides weight to each of the classifiers based on the importance. Adaboost has been found to perform better than other classification algorithm and it also does not get to the problem of over fitting. Adaboost maintains a distribution over the training examples and selects weak classifiers from the weak learning algorithm at each iteration.

D. Neural Network

A major problem that arises in image retrieval techniques is the meaningful representations and similarity models with proper indexing to provide perfect similarity matching [2] in large databases. Retrieving methods are based on the similarity measures between the feature vectors of the inquiry image and the images in the database. One of the main difficulty is searching , most of the time has to be done with imprecise key features. Neural networks can be put to work along with feedback from the user to low down this problem. This feedback improves the procedure of image retrieval significantly. From the initial set of images the user selects the best matched samples and annotates these images appropriately. From these samples weights of pre-extracted features are updated, according to subjective perception of visual content. The feature vectors [4] extracted from such ranked images are then used as training examples for updating weights in neural network. These systems have good accuracy and retrieval speed. Better accuracy is obtained when larger feature vectors are used.

The neural networks have attracted research because of the following points.

- Neural Networks have universal approximation
- They have very compact topology.
- The learning speed of the neural network is very fast.

The two important factors that should be taken in consideration for efficient image retrieval is working with high dimensional feature vectors that is very time consuming and the semantic gap problem. The power of multilayer neural network along with its learning ability via a fuzzy radial basis function network (FRBFN) and relevance feedback reduces the data dimensionality and semantic gap in parallel.

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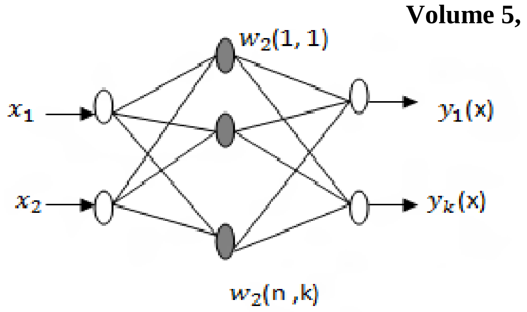

Fig 4. Radial Basis Function Neural Network

The output of the ith RBF unit is as follows:

$$R_i(X) = R_i\left(\frac{||X - c_i||}{\sigma_i}\right)$$

Where X is an input feature vector with r dimensional, c_i is a r-dimensional vector named center of RBF node, n is the number of hidden node. R(X) is chosen as a Gaussian function.

V. COMPARISON OF CLASSIFIERS

Table 1. A Comparison of Various Classifiers

S. N	Classifier	Advantage	Limitation
1	SVM	I) Maximize the margin between positive and negative samples. ii) The separation of margin denotes the quality of image. iii) Helps to reduce the prediction error.	i) Ignores the basic difference between positive and negative samples. ii) Selection of appropriate kernel function leads to proper margin.
2	Decision Tree Learning	i) It has the Hierarchal Clarity.	i) Appropriate selection of key attributes is crucial. ii) Complexity of tree increase with the size of tree.
3	Boosting	i) Helps to classify weak classifiers to combine a strong classifier. ii) Over-fitting problem is eliminating.	i) Adaboost can learn only one category at a time which makes it time consuming.
4	Neural Network	i) Searching can be done by Precise features. ii) Neural network with RBF trains faster and has universal approximation.	i) The network becomes very slow after learning is finished.

VI. CONCLUSION

The efficiency of CBIR system using relevance feedback depends on the choice of type of algorithm we are implementing with it. Good results are achieved when we use combination of techniques of relevance feedback technique .Difficulties that arise when learning from small training set is discussed and drawback of semantic gap can be eliminated by using various RF techniques. This paper throws highlight on the detail of different kinds of classifiers that using relevance feedback technique gives precise result.

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