ISSN:0975-9646

A Review of Image Classification Techniques in Content Based Image Retrieval

Neera Lal, Neetesh Gupta, Amit Sinhal

IT Dept
TIT,Bhopal, India

Abstract -As the growth and development of various multimedia technologies in the field of CBIR many advanced information retrieval systems have become popular and has brought the new evolution in fast and effective retrieval. In this paper the techniques of image classification in CBIR are been discussed and compared. It also introduces classifiers like support vector machine, Bayesian classifier for accurate and efficient retrieval of images.

Keywords- Content Based Image Retrieval, RLS classifier, Bayesian classifier, support vector machine, relevance feedback.

I. INTRODUCTION

Content Based image Retrieval is the main concept to retrieve the image that matches some criteria namely color, shape or texture, It is one of the popular research area of one's interest. Image retrieval or the term image search is data search specialization used to search images. For the searching procedure a query image is being provided such as keyword or image and then the system will return image which is similar to the query. Content Based Image Retrieval is also known as Query Based Image Content and Content Based v Image Retrieval. Basically it is the application of computer vision techniques to the image retrieval problems. The term content Based means that the search will analyze the actual contents of the image rather than metadata.

With the advances in computer technologies and increased amount of World Wide Web, there has been explosion in amount of digital data been accessed. Hence in order to make use of these data efficient and effective techniques of information retrieval based on content needs to be developed.

Keyword based annotation is earlier technique of information retrieval. It mainly includes annotations of images mainly by keywords. With the effectiveness there are limitations too i.e. it requires large amount of efforts manually, image contents differ in their interpretations and assigning keywords among various indexers was not consistent.

In order to overcome the difficulties of earlier retrieval approach CBIR has been proposed in 1990's. CBIR systems greatly uses the visual content of an image i.e. color, texture and shape. This greatly has helped in increasing and making extraction process automatic and consistent. Various types of MPEG-7 descriptors have been introduced for feature extraction. There are also color moments, color histograms, color correlogram for color feature extraction. The tamura texture features, Gabor filters are also being used for texture extraction. There are also RGB and HSV spaces are also introduced [3].

Despite of the best retrieval techniques most CBIR systems lag behind in terms of the system performance due to main reasons 1) gap between the high level concepts and low level features 2) subjectivity of human perception. These difficulties are solved by [3] using relevance feedback with the classifiers. Relevance feedback is the powerful technique in earlier systems. It involves automatically adjusting an existing query using user feedback by the relevance of previously retrieved objects. The use of support vector machine with relevance feedback is the common practice. Although many classifiers can be used with RF like Bayesian, RLS to make the CBIR effective and efficient.

Due to the limitations of the low level based approach, there was the need of the interactive learning mechanism. The basic concept is to build a model by relevance information in which feedback by the user is used to show which images he or she thinks is relevant to the query and to the retrieval again for better result. In the query point movement, query is used to improve the query point by moving positive examples far from negative examples. The re-weighting technique is also being used to alter the distance metric in order to make relevant images nearer[4]. In [6] a semantic network is given by a set of keywords which have links to images in the database. In this concept weight associated to each link use feedback techniques to get updated.

Although with the advanced techniques in Content Based Image Retrieval is regarded as the search problem to find more images similar to query image. In the feedback techniques the information is not only the feature space but also the relevance information provided by the users. Therefore we can build a classifier by separating images as relevant and irrelevant. Using the classifier much and many more images can be retrieved which are relevant to the query image.

The whole paper is organized as Section II includes related work, Section III includes Bayesian classifier, Section IV RLS, Section V includes support vector machine.

II. RELATED WORK

Early work on the image retrieval can be traced back to the late 1970s and 1979. But the result of advances in the Internet and digital image technologies took place in 1990s. The years of 1994-2000 can be seen as the primary phase of research and development on Image Retrieval by content.[1] In the survey how the visual features of the image being extracted can be divided into two parts image

processing and feature construction [1]. In further survey there was the introduction of semantic and sensory gap [2]. Then the idea of multimedia image retrieval was proposed. In this we learn about semantics and the relevance feedback.

As with the growing technologies limitations of the CBIR have become popular. Most CBIR systems faces two problems [1,2] a) gap between high level concepts and low level features b) subjectivity of human perception to visual contents. In 1998 [3] relevance feedback was introduced. It was the process of automatically adjusting the query using feedback by the user by the relevance of previously retrieved images. Along with relevance feedback it also introduced the multimedia object model. But the problem of weight adjusting is based on heuristics which do not provide the best solution. In 2000 [4] the novel learning approach based on SVM is proposed. In this the classifier can be learned from training data of relevance images marked by the users. In 2001 [5] use of SVM with RF has been proposed. In this type of learning method both positive and negative feedback is preference weights and also uses the negative weights information. Although this method showed the best result but the optimal selection of the kernel function needs to be studied. In 2000[6] a new framework which used semantics and low level features based feedbacks is proposed. It also $_z$system which allows multiple users to perform retrieval simultaneously at a given time. In 2004 [7] random sampling based SVM is proposed. It overcomes the three problems of SVM 1) instability of SVM classifier on small training set 2) SVM optimal plane is biased 3) over fitting due to the feature dimension. In this asymmetric bagging based SVM is proposed and random subspace method for SVM-RF is implemented. In 2004 [8] log based relevance feedback technique is proposed. In this the user logs are used to increase the performance. This also uses the soft label SVM. But noisy logs degrade the performance. The dimensions of the log sessions degrade the efficiency. In 2005 [12] SVM is used by using the retrieval prior knowledge in the kernel. The criterion measures the goodness of the kernel space and optimal parameters fort kernel is obtained by maximizing the criterion.

III. BAYESIAN CLASSIFIER

Broadly speaking classifier is a system that performs mapping from a feature space X to a set of labels. The basic function of a classifier is to assign a predefined class label to sample. It is often confused with the clustering method. The main difference between the two is that classification is a supervised learning method where we need to define and decide classes whereas clustering is an unsupervised method where an algorithm combines the data autonomously. There are basically of three types of classifiers a) Bayesian classifier b) Regularized least square classifier c) Support Vector Machine.

The term 'Naïve' comes from the fact that the model assumes that all features fully independent are almost never are. It is well suited for solving normal distributions. It is very popular algorithm due it simplicity and computational efficiency and provides good performance for all real world problems. Since there are many learning algorithms but they are complex and cannot be analyzed. Bayesian classifier is the supervised learning method. It comes into picture from the work defined in pattern recognition. This type supervised learning method stores a probabilistic summary of each class. It mainly contains conditional probability of each class attribute as well as the probability or base rate of the class. We can define the classifier a :-

$$\text{Classify}(f_1, \ldots, f_n) = \text{argmax } p(C=c) \prod_{i=1}^{n} p(F_i = f_i / C = c) \quad (1)$$

It means that for each possible class label we need to multiply the conditional probability of each feature which is given to class label. Now to implement the classifier we need to compute these individual conditional probability for each label and for each feature.

IV. REGULARIZED LEAST SQUARE CLASSIFIER

Another type of image classifier is regularized least square. The training of RLSC only requires solution of a single system of linear equations. RLS minimizes a function directly by reproducing kernel Hilbert space given and defined by a kernel. It can be defined by – given a set of training data :(x_i, y_i) where X_i represents i^{th} feature vector and y_i is the label of x_i where labels of y_i € {-1, 1}

Starting from the training data $z = (xi, yi)_i^m$ and the unknown true function $f\rho$, instead of finding the empirical optimal classifier that minimizes $\frac{1}{m}\sum_{i=1}^{l}(y_I - f_z(x_i)^2$, RLS focuses on the problem of estimating

$$\int_X (fz - f\rho)^2 d\rho X \quad (2)$$

For fz, it begins with a hypothesis space H.
The "true optimum" fH relative to H i.e.,

$$fH = \min \int_X (f - f\rho)^2 d\rho X. \quad (3)$$

The problem can be given by

$$\int_X (fz - f\rho)^2 d\rho X = S(z,H) + \int_X (fH - f\rho)^2 d\rho X \quad (4)$$

where $S(z,H) = \int_X (fz - f\rho)^2 d\rho X - \int_X (fH - f\rho)^2 d\rho X.$

On the right-hand side of the first term is called sample error , while the second term is called approximation error .The RLS algorithm chooses RKHS as the hypothesis space HK, and minimizes the following regularized functional:

$$\frac{1}{m}\sum(yi - f(xi))^2 + \gamma \; \| f \|^2_K \quad (5)$$

where $\| f \|^2_K$ is the norm in HK defined by the kernel K, and γ a fixed parameter. The minimizer exists and is unique. It seem that the solution to the above optimization problem is : Compute $c = (c1, c2, \ldots\ldots, cm)^t$ by [13] solving the equation

$$(m\gamma I + K)c = y \quad (6)$$

V. SUPPORT VECTOR MACHINE

It is different type of classifier that performs classification by generating a hyper plane. The optimal hyperplane separates data in two categories. SVM are close cousin

multilayer perceptron neural network. Support vector machine can be defined as the training method if polynomial radial basis function where the weights are calculated by solving QP problem. According to the support vector machine predictor value is called an attribute and transformed attributes which is used to define the hyperplane is known as feature. The method of selecting the appropriate representation is called feature selection. Now the vector can be defined by set of features that describes predicted values. The aim of support vector machine is to find the optimal hyperplane that is used to distinguish group of vectors in a way that one category of the required variables is on one side of hyper plane and the other class of variables are on the other side of plane. Vectors nearer to the hyper plane are called as support vectors. The optimum hyper plane can be defined as the linear classifier with the maximum margin for a given set of variables.

VI. CONCLUSION & FUTURE WORK

We have reviewed various papers related to CBIR and different classification methods for the improvement of image retrieval. In future we will introduce sampling technique for the improvement of classifier in CBIR.

REFERENCES

[1] Ritendra Datta, Dhiraj Joshi, Jia Li, and James Wang *Image Retrieval : Ideas , Influences, and Trends of New Age. In ACM Computing Surveys, Vol. 40. No.2, Article 5, 2008*

[2] Arnold W.M. Smeulders, Marcel Worrimg, Simone Santini, Amarnath Gupta, Ramseh Jain *Content Based Image Retrieval at the End of Early Years.* IEEE Transactions On Pattern Analysis and Machine Intelligence. Vol. 22, No.12, pp. 1349-1380, 2000.

[3] Y. Rui, T.S. Huang , et al ., *Relevance Feedback: A Power Tool for Interactive Image Retrieval.* IEEE Trans. on Circuits and Video Tech., 1998.

[4] Lei Zang, Fuzong Lin, Bo Zhang *Support Vector Machine for Image Retrieval*. pp. 721-724, 2001.

[5] Pengyu Hong, Qi Tian, Thomas S. Huang *Incorporate SVM to CBIR with Relevance Feedback.* In Proceedings of IEEE ICIP, Vol. 3, pp 750-753, 2000

[6] Y. Lu, C. Hu, X. Zhu, H.J. Zhang, and Q. Yang *A Unified Framework for Semantics and Feature Based Relevance Feedback in Image Retrieval Systems, ACM multimedia, 2000.*

[7] Dacheng Tao and Xiaoou Tang *Random Sampling Based SVM for Relevance Feedback Image Retrieval.* In Proceedings of IEEE Computer Society Conference on CVPR. 2004.

[8] Chu-Hong Hoi and Michael Ri Lyu *A Novel Log Based Relevance Feedback Technique in CBIR, ACM, pp 24-31, 2004.*

[9] Chu- Hong Hoi, Chi- Hang Chang, Kaizhu Huang, Michael R. Lyu and Irwin King *Biased Support Vector Machine for Relevance Feedback in Image Retrieval*

[10] Zhong Su, Hongjiang Zhang, Stan Li, and Shaopin Ma *Relevance Feedback in CBIR :Bayesian Framework, Feature Subspaces, and Progressive Learning.* In IEEE Transactions on Image processing. Vol. No. 12, pp 924-937, 2003.

[11] Pat Langley, Wayne Iba, Kevin Thompson *An analysis of Bayesian Classifier.*In Proceedings of Tenth National Conference on Artificial Intelligence. pp 223-228, 1992.

[12] Lei Wang, Yan Gao, Kap Luk Chan, Ping Xue, Wei-Yun *Retrieval with knowledge driven kernel design: An Approach to Improving SVM based CBIR with RF*. In Proceedings of Tenth IEEE International Conference on Computer Vision 2005.

[13] Peng Zhang, Jing Peng *SVM vs RLS classification. 2004.*