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Support Vector Machine and Artificial Neural Network for the Classification of Images

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Abstract:
The CBIR term has been widely used to describe the process of retrieving desired images from a large collection on the basis of features (such as color, texture and shape) that can be extracted from the images themselves. In this paper, an image retrieval system on the basis of classification using Support Vector Machine (SVM), Artificial Neural Network (ANN) which is implemented in MATLAB with the help of Gabor Filtered image features. In this paper, develop a classification system that allows recognizing and retrieving the class of a query image based on its content. Such systems are called Content-Based Image Retrieval (CBIR).

Key words*: CBIR, Gabor Magnitude, Support Vector Machine*

1. Introduction

Databases of large images deal with the challenge of image indexing and retrieval which has become one of the promising and important research area for researchers from a wide range of disciplines like computer vision, image processing and database areas. The thirst of better and faster image retrieval techniques is still appetizing to the researchers working in some of important applications for CBIR technology like art galleries museums, archaeology architecture design geographic information systems weather forecast medical image in trademar databases criminal investigations image search on the Internet. Researchers are discovering that the process of locating a desired image in a large and varied collection can be a source of considerable frustration. Problems with traditional methods of image indexing have led to the rise of interest in techniques for retrieving images on the basis of automatically derived features such as color, texture and shape - a technology now generally referred to as Content-Based Image Retrieval (CBIR). After a decade of intensive research, CBIR technology is now beginning to move out of the laboratory and into the marketplace, in the form of commercial products like QBIC and Virage. However, the technology still lacks maturity, and is not yet being used on a significant scale.

2. Theoritical Considerations

2.1. Content Based Image Retrieval

The term has since been widely used to describe the process of retrieving desired images from a large collection on the basis of features (such as color, texture and shape) that can be automatically extracted from images themselves. The typical CBIR system performs two major tasks. The first one is feature extraction (FE), where a set of features, called image signature or feature vector, is generated to accurately represent the content of each image in the database. A feature vector is much smaller in size than the original image, typically of the order of hundreds of elements (rather than millions).

2.2. Support Vector Machine

Support vector machine (SVM) has been a promising method for data classification and regression. Its success in practice is drawn by its solid mathematical foundation which conveys the following two salient properties: Margin maximization: The classification boundary function of SVM maximizes the margin, which in machine learning theory, corresponds to maximizing the generalization performance given a set of training data. Nonlinear transformation of the feature space using the kernel trick: SVM handles a nonlinear classification efficiently using the kernel trick which implicitly transforms the input space into another high dimensional feature space. Support vector machines (SVMs) are a set of related supervised learning methods used for classification and Regression.

2.3. Artificial Neural Networks

ANN was designed to function as a human brain. This means that these networks process data, through artificial neurons as humans process information through neurons. Due to its ability to learn that, the ANN has been very successfully. The first neural networks were created by McCulloch and Pitt and the first classifier based on learning networks was developed by Rosenblatt. The most popular supervised learning network model is multilayer perceptron (MLP), which is an extension of Rosenblatt model.

The inputs create input nodes of the network. In the input layer, the output from each neuron is fed to all the neurons in the hidden layer. There can be one or more hidden layers. Connections between the layers are typically formed by connecting each of the nodes from a given layer to all neurons in the next layer.

3. Implementation

The CBIR system implementation consists, as previously cited, of three modules:

- Feature extraction of database ;
- Compute the distances between features;
- Results classification and retrieval.

Regarding the first module, feature extraction, the system randomly selects from collected database 50 images per class. The features are extracted in these images, through the dense SIFT descriptor. The dense representation is used instead of sparse representation due to its best performance. The SIFT descriptors are computed over the gray scale image and on a regular grid with spacing p pixels (p=3). At each grid point the descriptors are computed over. A spatial bin with size s (s=16) covers these p pixels. This bin size is related to the SIFT key point scale. This implementation does not use BoW representation, because it is a quantization technique which damages non-parametric classifier.It computes a dense set of multi-scale SIFT descriptors from a given input image. Vocabulary learning is then used to cluster a few hundred thousand visual descriptors into a vocabulary of 10^3 visual words. A spatial histogram calculates the joint distribution of appearance and location of the visual words in an image. For any object in an image, interesting points on the object can be extracted to provide a "feature description" of the object. This description, extracted from a training image, can then be used to identify the object when attempting to locate the object in a test image containing many other objects. To perform reliable recognition, it is important that the features extracted from the training image be detectable even under changes in image scale, noise and illumination. Such points usually lie on high-contrast regions of the image, such as object edges.

4. Results and Discussion

The methods ANN-Gabor Magnitude and only Gabor Magnitude Features were applied to the image database having 900 images spread across 10 categories. The query and database image matching is done using ANN classifier. The average precision and average recall are calculated by grouping the number of retrieved images sorted according to classification of database images as in figure 1&2.

Figure 1: Sample of Image Database

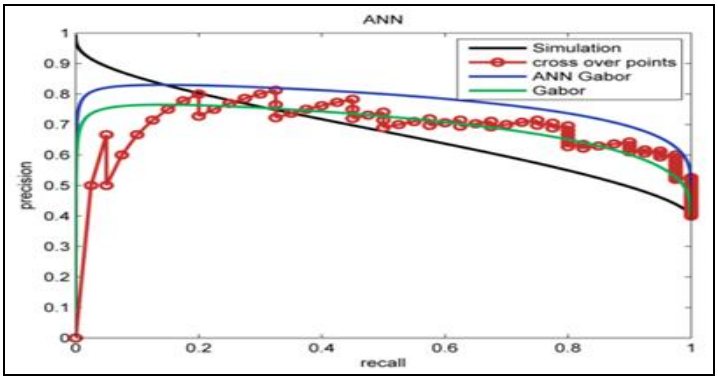

Figure 2: Precision Recall and Crossover Plot with ANN

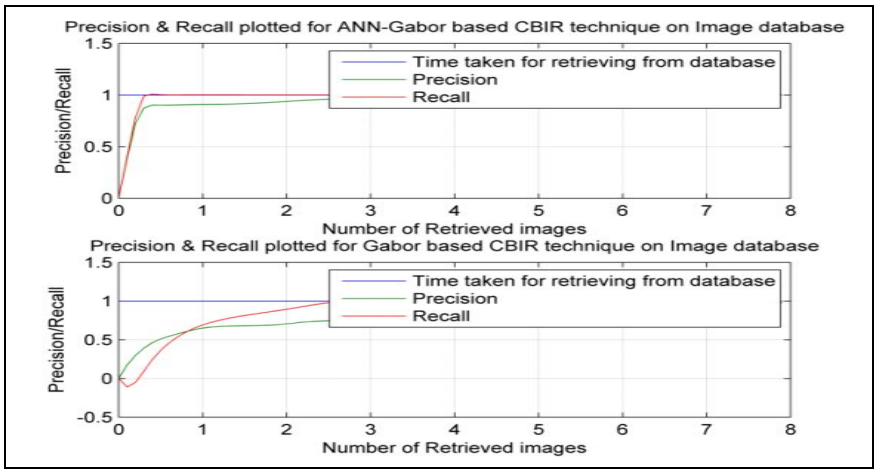

Figure 3: Precision Recall Comparative Plot for Gabor with ANN and without ANN

Figure3 shows the graph of precision/recall values plotted for proposed image retrieval techniques. It can be seen that ANN-Gabor based image retrieval technique gives the highest precision/recall crossover values specifying the best performance. The crossover point varies for different image category. Figure 8 shows results obtained using Gabor Filtered image features based CBIR technique and results obtained using ANN-Gabor based CBIR technique. The precision/recall values and crossover points from the plot proves that the discrimination capability of ANN - Gabor Magnitude based CBIR technique is better than Gabor Filtered image features based CBIR technique. However the distinction in the performance of all these techniques is not very clear. The height of crossover point of precision and recall curves plays very important role in performance comparison of CBIR methods. Ideally this crossover point height should be one. Higher the value of this crossover point better the performance is. A sample of the classified and retrieved images of 2 general categories is also shown below.

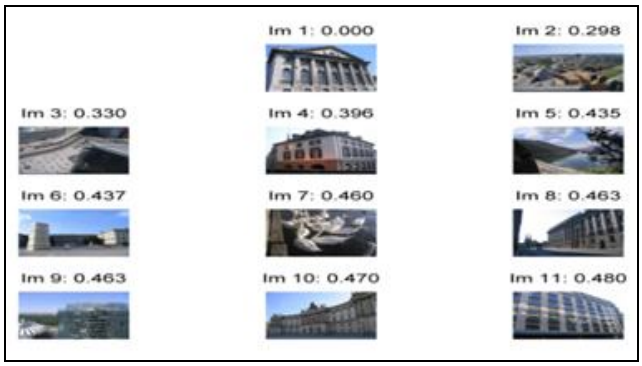

Figure.4 Sample of Retrieved ImageClass

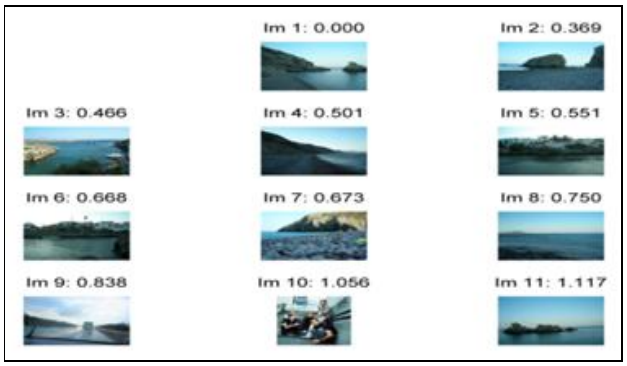

Figure.5 Sample of Retrieved Image class

In this work we have proposed a Content Based Image Retrieval System using Artificial Neural Network based on Gabor Filter's Response. The proposed system is giving higher Precision and Recall as compared to the CBIR technique when only Gabor magnitude features are used. The superiority of the system is because of the Gabor feature gives good response to texture of the image and makes it very clear and simple for ANN to classify and retrieve the required image.

5. Conclusion

In this paper we have proposed a Content Based Image Retrieval System using Support Vector Machine and Artificial Neural Network based on Gabor Filter's Response of an image. The proposed system is giving higher Precision and Recall as compared to the CBIR technique when only Gabor magnitude features are used. The superiority of the system is because of the Gabor feature gives good response to texture of the image and makes it very clear for SVM and ANN to classify and retrieve the required image.

6. References

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