International Journal of Advanced Trends in Computer Applications
www.ijatca.com

Comparison of the Classifiers for the Efficient Content Based Image retrieval System

[1]HlaingHtakeKhaung Tin
Faculty of Information Science
University of Computer Studies, Yangon
Myanmar
[1]hlainghtakekhaungtin@gmail.com

Abstract: *The purpose of classification is to analyze the input data and to develop an correct description or model for each class using the features present in the data for its most effective and efficient use. This paper shows comparison of the classifiers for the efficient CBIR system. Image classification is also a machine learning field that uses algorithms mapping all attributes, variables or inputs - function X space - for the definition of class labeled Y. This algorithm is called the classifier. Basically what a classifier does assign a pre-defined class label to a sample. This paper introduces five classifiers (Naïve Bayes, K-Nearest, Artificial Neural Network, Rough Sets and Support Vector Machine). Among them this CBIR system is implemented a support vector machine classification. SVM depend on the concept of the decision plan that determines the boundaries of the decision. SVM classifiers can be learned from relevant and irrelevant user-generated image for training data.There are two major steps in the classification system such as training step and testing step. Training defines criteria based on recognized features.*

Keywords: CBIR comparison, feature extraction, matching, SVM, Rough set, Naïve Bayes, K-Nearest.

I. INTRODUCTION

Image retrieval that is user-defined image from a large image database is a critical image processing technique. The method for large collections of multimedia and digital libraries has created a great need for the development of search engines to index and retrieve data. There are now a lot of good search engines that can extract texts in a format that the device can read. However, there is no quick tool to extract intensity and color images. The traditional way to search and index image is slow and expensive. Therefore, there is an urgent require to progress an algorithm to retrieve embedded content images. The digital image features (shape, texture, color, object structure, etc.) can be used as an index button to find and extract images from a large image database. Image retrieval based on the content of the image is called the content-based image retrieval [12, l3].

An image retrieval system is a computer system for browsing, searching and retrieving images from a large database of digital images. Image retrieval is classified into two types of retrieval are Text Based Image Retrieval and Content Based Image Retrieval. Text Based Image Retrieval is having demerits of efficiency, loss of information, more expensive task and time consuming [15].

A growing interest in the area of CBIR is found in recent years due to the hope that the above-mentioned problems might be solved. It is a central issue in CBIR to identify a set of salient image features for indexing and similarity evaluation. Color, shape, texture and spatial relationships among segmented objects are typical features employed for image indexing. Some researches combine two or more ofthese features to improve retrieval performance.

The main goal in CBIR system is searching and finding similar images based on their content. To accomplish this, the content should first be described in an efficient way, e.g. the so-called indexing or feature extraction and binary signatures are formed and stored as the data. When the query image is given to the system, the system will extract image features for this query. It will compare these features with that of other images in a database. Relevant results will be displayed to the user. Fast and accurate retrievals among the data collections can be done according to the content description of the query image[16].

II. BACKGROUND THEORY

Image classification is also a machine learning field that uses algorithms mapping all attributes, variables or inputs - function X space - for the definition of class labeled Y. This algorithm is called the classifier. Basically what a classifier does assign a pre-defined class label to a sample. Figure 1 display the regular architecture of the classification system.

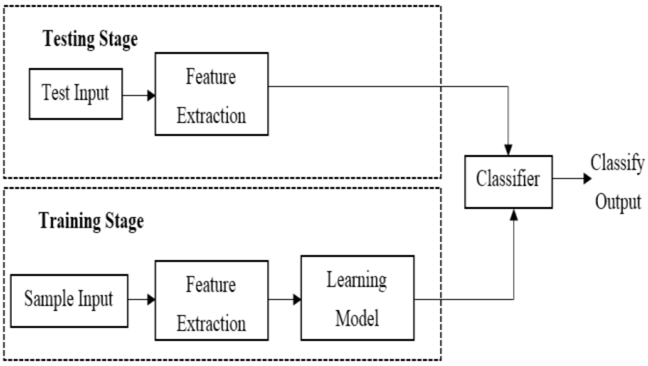

Figure 1: Architecture of the Classification System

Classification is the problem of determining which a set of categories (sub-populations) a new observation are based on all set of training data observed (or instances) whose category membership is known. The purpose of classification is to analyze the input data and to develop an correct description or model for each class using the features present in the data for its most effective and efficient use.

There are two major steps in the classification system such as training step and testing step.

Training defines criteria based on recognized features. In this process, this is getting its individual rules for the classification of the set of training. In the training stage, images are took and saved in the database. And then this is the process of extracting features. The feature vector is considered an input variable and is included in the learning component. Output is a label associated with the class (e.g. plane, face and flower).

In component learning, this system is created by differentiating and situational models. The first model sends input to the output variable for classification. For field generative models, the distribution of attributes and learning depends on the availability of information. During the test, the query / test image functions as an input. The classification sets the foundation for the learning model with its own classification rules, the feature vector class.

Classification algorithm is separated into supervised and unsupervised algorithms. In the supervised classification, a labeled set of training examples to “train” the algorithm will be used, whereas in the case of unsupervised classifications, the data is collected into a particular cluster without using a training set. Parametric and non-parametric classification is another way of classifying the classification algorithm. The functional form of densities may be the feature vectors of each class known in the parametric method. Otherwise, it is not parametric. On the other hand, no particular form of function is assumed in advance; otherwise the probability density is estimated locally according to training data.

III. NAÏVE BAYES CLASSIFIER

Naive Bayes is one of the easiest ways to determine the density that can be achieved. Naive Bates classifiers classify patterns in the class primarily on the basis of prior knowledge.

This classifier can control the numbers representing independent variables, whether continuous or categorical.

Determine a set of feature vectors, = $\{X_{1,}X_{2,\ldots\ldots,}X_n\}$, the goal is to create the posterior probability for the class C_j among a set of possible results set of classes C = $\{C_{1,}\, C_{2,\ \ldots\ldots,}\, C_m\}$.

Using the Bayes theorem, the posterior probability of class C_j that corresponds to X is written as equation number 1.

$$p\left(C_j \middle| X_{1,} \ldots\ldots, X_n\right) = \frac{p(C_j)p(X_1,\ldots,X_n|C_j)}{p(X_1,\ldots,X_n)} \quad (1)$$

Where $p\left(C_j\right)$ is the prior probability of class C_j , $p\left(X_1, \ldots., X_n \middle| C_j\right)$ is the likelihood of X given class C_j and $p\left(X_1, \ldots., X_n \middle| C_j\right)$ is the evidence.

In practice, only the numerator of this fraction is important in equation 1, since the denominator does not belong to C and the value of the X character is indicated, the designation is sincere. The numerator corresponds to the typical probabilistic model that can be recorded handling conditional decision-making applications with repeated conditions, as equation 2.

$$P\left(C_j, X_1, \ldots., X_n\right) = p\left(C_j\right)p\left(X_1, \ldots., X_n|C_j\right) = p\left(C_j\right)p\left(X_1|C_j\right)p\left(X_2, \ldots., X_n|C_j, X_1\right) == \cdots = \cdots = p\left(C_j\right)p\left(X_1|C_j\right)p\left(X_2|C_j, X_1\right)\ldots p\left(X_n|C_j, X_1, X_2, \ldots., X_{n-1}\right) \quad (2)$$

The independence nave conditional assumptions ensures that each X_i feature vector is independent of the conditions of the other feature vector X_k for $k \neq i$ at equation 3.

$$p(X_i|C_j, X_k) = p(X_i \mid \mathrm{C}) \quad (3)$$

The Naive Bayes classifier combines this model with decision rules. A general rule is to choose the most likely hypothesis. This is called the maximum a posterior (MAP) decision rule.

In image classification, many complex applications using the Naïve Bayes classifier have been successfully implemented. They proposed a hierarchical classification method where they took images indoor or outdoor at first. Outdoor images are classified into images of the city or the landscape. In the end, the landscape image was classified as sunset, forest and a mountain.

IV. THE K-NEAREST NEIGHBOR CLASSIFIER

The K-nearest neighbor classifier is an example of a classifier that does not use parameters. The basic algorithm of these classifiers is simple. For each input feature vector to be classified, the search is performed to find the location of the K-nearest training sample, and then assign the input to the class having the largest members in this location. Euclidean distance is often used as the metric to measure neighborhoods. In the particular case of K=1 the system will receive the nearest neighbor classifier, which will assigns the input feature vector to the same class as the nearest training vector. The Euclidean distance between feature vectors $X = \{x_1, x_2,......,x_n\}$ and $Y= \{y_1, y_2, \ldots, y_n\}$ are obtained from equation 4.

$$d = \sqrt{\sum_{i=1}^{N}(x_i - y_i)} \quad (4)$$

However, some elements must be taken into account when using the KNN classifier. Euclidean distance measurements are often used in KNN algorithms. In some cases, using this metric may result in undesirable results. For example, in the case of several sets of features (the feature set is large enough), used as input combined with the KNN classifier, KNN will have a higher value than terrible performance the possible way to avoid this problem is to make the set of normal functions.

The KNN algorithm is as simple as described above. However, there are things must be taken into account when using KNN classifiers. The Euclidean distance measurements are often used in the KNN algorithms. In some problems, the use of this metric can lead to undesirable results. For example, in the cases of several sets of features (the feature set is large enough), used as input combined with KNN classifier, KNN is affected by a larger amount. This leads to a poor performance. The possible way to avoid this problem is to make the set of normal functions.

In Figure 2, show examples of three class assignments. The goal is to apply the KNN classifier to find the class of unknown features X. As shown in the figure, the nearest neighbor's image (K = 5 neighbors) is four in class a and there is only one class b, so X is assigned to class a.

The disadvantages of the nearest K classifier include:

- Need all the vector features of all training data when the new feature of the vector. It will be classified and the need for large data storage.
- Longer classification times analyze with another classifiers. The K nearest neighbor classifier has some important qualities.
- Does not require training, which is especially useful when new data on training is added.
- Use local information and learn complex functions without having to specify them clearly.

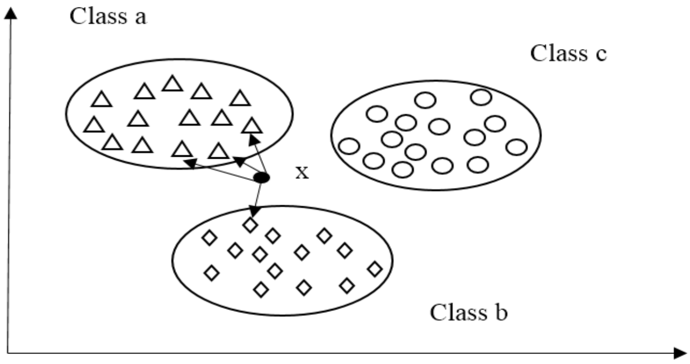

Figure 2: The K-nearest Neighborhood Rule (K=5)

V. ARTIFICIAL NEURAL NETWORK

The Artificial Neural Network (ANN) is a group of interconnected artificial neurons that use mathematical models or computation models for information processing using the connection to calculations method. Neural networks have at least two physical components: the processing elements and the connections between them. A processing element is called neurons and connections between neurons, also called links. Each link has associated weight parameters.The weight of these links represents the knowledge of the network. The knowledge is expressed in artificial neural networks by the form of connection between the processing elements and by the adjustable weight of these links. Each neuron is stimulated by neighboring neurons connected to it, processing the information and generating an output. Neurons that receive stimuli from outside the network (that is, not from the network neurons), called input neurons [14].

Neurons used externally are called output neurons. Neurons that are stimulated by other neurons and by other neurons in the neural network are called hidden neurons. Several methods make it possible to process data by neurons and different ways of connecting the neurons to each other. Different neural network structures can be created using different processing elements and the specific manner in which they are connected. In many networks, neurons are organized in multiple layers. The neural network has one or more layers of neurons, followed by output neurons.

Artificial neural networks have more than one class of neurons are sometimes called multilayer neural networks. Several neural network structures have been developed for signal processing, pattern recognition, data classification, and so on.

VI. ROUGH SETS CLASSIFIER

The biggest advantage of an approximate set is the excellent ability to calculate the reduction of information systems. In information systems, some attributes may not be related to the objective concept (decision function) and some redundant attributes. Reduce the need to create a simple and useful knowledge from it. Reduction is an important part of the information system. It is the smallest subset of conditions attributes related to the decision attributes. When there is an incoming e-mail, the system must first select the attributes best suited to the classification. Then, the input dataset become a decision system, which will be divided into training datasets (TRs) and testing datasets (TEs). Classifiers will be induced by TR and applied to TE to obtain a performance evaluation.

VII. SUPPORT VECTOR MACHINES

A supervised learning model involving learning algorithms that analyzing data. It works by accepting the complete set and then reading it so that each of the relevant input, relevant outputs are extracted. The whole process is considered a classification. Classifying the data by looking for the best hyperplane separates all the data points of a class from the other classes.

Support vector machines depend on the concept of the decision plan that determines the boundaries of the decision. The decision plan is a plan that separates sets of objects with different members in the class. Support vector machine learning algorithm is used to produce the classification parameters according to the calculation feature.

Results can be received in two discrete or continuous formats. The classifier assigns the input space and the feature space. Feature spaces are defined as stored space to calculate similarities using kernel functions.

Support vector machine (SVM) formerly separated binary classes (k = 2) with the maximum margin criteria. However, problems in the real world often require more than two categories of discrimination. Therefore, the recognition of multi-class has a wide range of applications, including optical character recognition, inclusion detection, speech recognition and bioinformatics. In practice, the classification problems of multi classes (k> 2) are generally divided into a set of binary problems, so that the standard SVM can be directly used. The set of two schemesareone-versus-rest (1VR) and one-to-one (1V1) guidelines.

A. One-Versus-Rest Approach

One-versus-one (1VR) method creates a different binary classifier k for k-class classifications. The m-th binary classifier is trained using the m-th class data as a positive example and the remaining k-1 classes is a negative example. During the test, the class label is determined by the binary classifier that gives the highest output value. Imbalanced training is a major problem of 1VR approach. Suppose that every class has an equal training size. The proportion of positive and negative samples in each individual classifier is k-1. In this case, the symmetry of the original problem is lost.

B. One-Versus-One Approach

Another classical method of multi-class classification is a one-to-one d (1V1) or pairwise decomposition. It evaluate all possible pairwise classifiers and thus induces k(k-1)/2 individual binary classifiers. Applying each classifier to a test example would give one vote to the winning class. A test example is labeled to the class with the most votes. The size of classifiers created by the one-versus-one approach is much larger than that of the one-versus-rest approach. However, the size of Quadratic Programming (QP) in each classifier is smaller, which makes it possible to train fast. In addition, compared with the one-versus-rest approach, the one-versus-one method is more symmetric. The following steps and figure is the SVM classifier algorithm:

Step1. Training vectors: x_i, i = 1. . . L

Step2. Consider a simple case with two classes:

Step3. Define a vector y:

$$y_i = \begin{cases} 1 \;\; if \;\; x_i \; in \; class \; 1 \\ -1 \; if \; x_i \; in \; class \;\; 2, \end{cases}$$

Step4. A hyperplane which separates all data and separating hyperplane with:

$$w^T x + b = 0 \qquad (5)$$

$$(w^T x_i) + b > 0 \qquad if\ y_i = 1$$

$$(w^T x_i) + b < 0 \qquad if\ y_i = -1$$

Step5. Decision function

$$f(x) = sign(w^T x + b), x\text{:test data} \qquad (6)$$

Variables: w and b are coefficients of a plane

Step6. Select w, b with the maximal margin.

Maximal distance between $w^T x + b = \pm 1$

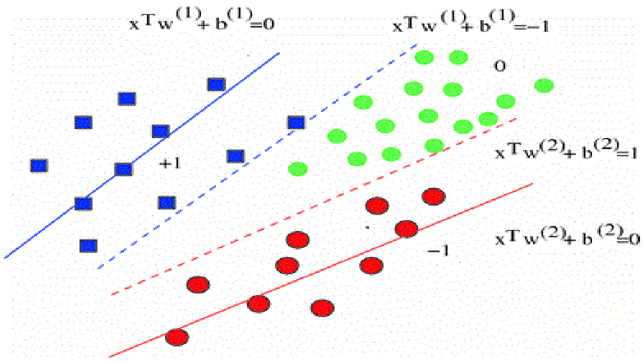

Figure 3: Hyperplane of the support vector machine

VIII. THE PROPOSED SYSTEM

The system has the three main processes. The first process is the creation of images features database. The system extracts the Color Moment, Color Auto-correlogram and Gabor Wavelet features of each image from images database to get the characteristics of images. The second is image retrieval based on the three types of visual features. In these stages, the feature of query image which is the user input extracts to get the features of image. And then, the system continues to match the feature values of query image with the values from image database by using the fusion of features. The final one of these stages is the retrieval of similar images from database by matching the feature of query image with similarity value. The third step is the combination of classification and image retrieval with SVM to get better results of the CBIR. Figure 4 shows the process flow of the Contents Based Image Retrieval System (CBIR) and compute the performance of model using the next part of remaining data to classify the category of images with SVM classifier.

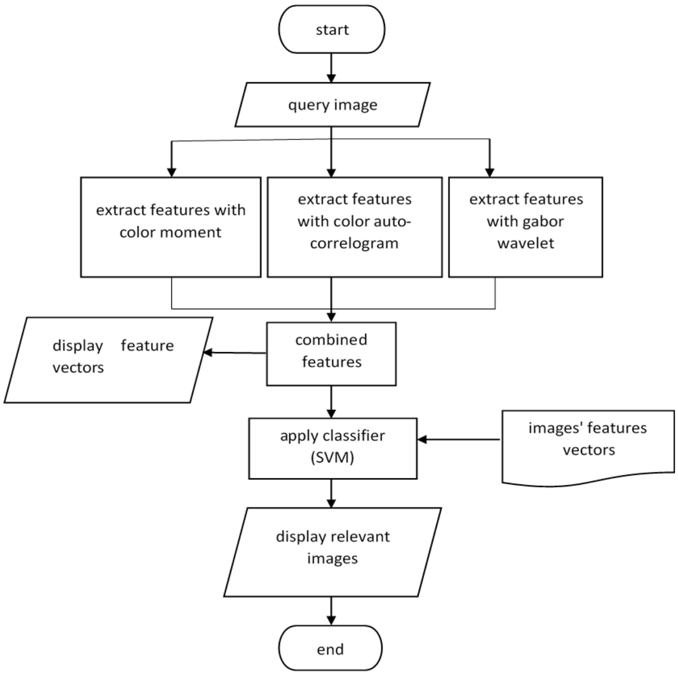

Figure 4: The process flow of the proposed system

IX. CONCLUSIONS

In this CBIR design accepted input images from users. After thatfeatures are extracted from the query image, and then the system extracted the image by comparing the similarity of the measurement between the query image and the images of the database stored with the SVM classifier to efficient query results. Finally, the system comparing the similarities values of these features with the features of the image database. The same value for each feature for query image, and database images are calculated by Euclidean distance. The process flow of the five classifiers Naïve Bayes, K-Nearest, Artificial Neural Network, Rough Sets and Support Vector Machine are described in above. Among them the Support vector machine can support the best results and design for content based image retrieval system upon the training and testing results.

Acknowledgment

I would like to thank all of my teachers and colleagues at University of Computer Studies, UCSY for their support and encouragement during my research work. Big thanks to my colleagues at Faculty of Information Science from UCSY for their help and support.

References

[1]. Amit Singla1, MeenakshiGarg, "*CBIR Approach Based On Combined HSV, Autocorrelogram, Color Moments and Gabor Wavelet*," International Journal of Engineering and Computer Science ISSN: 2319-7242 Volume 3, Issue 10 October, 2014 pp. 9007-9012.

ISSN: 2395-3519

[2]. C. S. Gode, A. N. Ganar,"*Image Retrieval by Using Colour, Texture and Shape Features*", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering , Vol. 3, Issue 4, April 2014.

[3]. Emile Karamutsa, Cheruiyot W.K, Anthony luvanda, "*Similarity Image Retrieval using Enhanced Color Histogram Based on Support Vector Machine*," International Journal of Innovative Science, Engineering & Technology, Vol. 2 Issue 10, October 2015.

[4]. H. Mohamadi, A. Shahbahrami and J. Akbari, "*Image retrieval using the combination of text-based and content-based algorithms*," Journal of AI and Data Mining, Published online: 20 February 2013.

[5]. K.ValliMadhavi, R.Tamilkodi, R.BalaDinakar, K.JayaSudha,"*An Innovative Technique for Content Based Image Retrieval Using Color and Texture Features*," International Journal of Innovative Research in Computer and Communication Engineering,Vol. 1, Issue 5, July 2013.

[6]. M.C. Hingane, Satish B. Matkar, "*Classification of MRI Brain Image using SVM Classifier*," International Journal of Science Technology & Engineering | Volume 1, Issue 9, March 2015.

[7]. Mohammed Alkhawlani, Mohammed Elmogy, HazemElbakry, "*Content-Based Image Retrieval using Local Features Descriptors and Bag-of-Visual Words*," International Journal of Advanced Computer Science and Applications, Vol. 6, No. 9, 2015.

[8]. R.Senthil Kumar, M.Senthilmurugan, "*Content-Based Image Retrieval System in Medical Applications*," International Journal of Engineering Research & Technology (IJERT) Vol. 2 Issue 3, March – 2013.

[9]. Ramesh K Lingadalli, N.Ramesh, "*Content Based Image Retrieval using Color, Shape and Texture*," International Advanced Research Journal in Science, Engineering and Technology Vol. 2, Issue 6, June 2015.

[10]. S.Mangijao Singh , K. Hemachandran,"*Contents Based Image Retrieval using Color Moment and Gabor Texture Feature*," International Journal of Computer Science Issues, Vol. 9, Issue 5, No 1, September 2012.

[11]. S.Mangijao Singh, K.Hemachandran, "*Image Retrieval based on the Combination of Color Histogram and Color Moment*," International Journal of Computer Applications Volume 58– No.3, November 2012.

[12]. S.Pavani, Shivani, T.VenkatNarayanaRao, Deva Shekar," *Similarity Analysis Of Images Using Content Based Image Retrieval System*," International Journal of Engineering and Computer Science Volume 2, Issue 1, January 2013, pp.251-258.

[13]. Sanmukh, N.M. Tejaswini, M.L."*Color histogram features for image retrieval systems*," International Journal of Innovative Research in Science, Engineering and Technology, Vol.3, Issue 4, March 2014.

[14]. Suchismita Das, ShrutiGarg, G. Sahoo, "*Comparison of Content Based Image Retrieval Systems Using Wavelet and Curvelet Transform*", International Journal of Multimedia & Its Applications, Vol.4, No.4, August 2012.

[15]. T. Dharani, I. Laurence Aroquiaraj, "A Survey on Content Based Image Retrieval," IEEE-2013 International Conference on Pattern Recognition, Informatics and Mobile Engineering (PRIME), PRIME 2013, 978-1-4673-5845-3/13/2013.

[16]. SonaliBhadoria, etc.., "Comparison of Color, Texture and ICM Features in CBIR System", International Conference on Control, Robotics and Cybernetics (ICCRC2011).