CBIR for CT Brain Images using SVM

Rinkeshkumar Patel[1] Shankar Parmar[2]
[1]Student: Dept of Electronics and Communication
[2]Assistant Professor: Dept of Electronics and Communication
[1, 2] G.H Patel College of Engineering and Technology Vallabh Vidyanagar , India

Abstract— Content Based Image Retrieval (CBIR) is emerging as important research in area of revolutionary internet and digital technology. The focus of this paper is on efficient retrieval of similar images in a particular brain images using supporting vector machine (SVM). Instead of traditional low level features like color texture and shape which are uses in most of CBIR system Current approaches replace reshaped Image intensity as a feature to guide SVM system and applied to brain CT images. Original image is reshape to predefined size to limit the size of feature vector. Single matrix is generated as a database and class is assign to this matrix rows to train the SVM. This system helps radiologist to assist for evidence based practice or image based reasoning in his daily practice. Experimental results shows that the propose method is adequate and condescending to some other existing method

Keywords: - content based image retrieval, query, database, feature, supporting vector machine, hyperplane.

I. Introduction To Cbir

Content Based Image Retrieval (CBIR) is also called query by image content (QBIC). It is a technique which uses the visual feature or content to retrieve an image from large databases according to users' demand. Image retrieval systems attempt to search through a database to find images that are perceptually similar to a query image. CBIR is an important alternative and complement to traditional text-based image searching and can greatly enhance the accuracy of the information being returned. It aims to develop an efficient visual-Content-based technique to search, browse and retrieve relevant images from large-scale digital image collections [2].

A. Basics Of Cbir

CBIR has become an outstanding research topic because of the abrupt growth of video and image data in digital form. The increased bandwidth availability to access the internet in the near future will allow the users to search for and browse through video and image databases located at remote sites.so it is necessary that image should be retrieve fast, so we have to design such a system that meets criteria like High retrieval efficiency and less computational complexity, With the rapid increase in computer accessing and processing speed with decrease in memory cost, image databases containing millions of images are used in many day to day application areas such as medicine, satellite imaging, web browsing, biometric databases, where it is important to maintain a high degree of precision. The image retrieval techniques based on visual image content has been in-focus for more than a decade. Many web-search-engines retrieve similar images by searching and matching textual metadata associated with digital images. For better precision of the retrieved resultant images, this type of search requires associating meaningful image-descriptive-text-labels as metadata with all images of the database. Manual image labeling, known as manual image annotation, is practically difficult for exponentially increasing image database [5]. In conventional image databases, images are text-annotated and image retrieval is based on keyword searching. Some of the disadvantages of this purely text-based approach are: 1. Keyword based image retrieval is not appropriate because there is no fixed set of words that describes the image content and that could generate different text labels to the same image. 2. Keyword annotation is very subjective and manual annotation was such a cumbersome and expensive task that it could not be applied to large image databases. Thus, there exists a dire need for developing an efficient expert technique that can automatically search the desired image from the huge database and avoid manual annotation. Content-based image retrieval (CBIR) is one of the commonly adopted solutions for such applications. In CBIR desired images are retrieved from a large collection, on the basis of features that can be automatically extracted from the images themselves.

Content based image retrieval system consists of following modules [3]:

1. Feature Extraction of database: In this module the features of interest are calculated for image database. This step is done in offline manner. User can save it as a database file.
2. Feature extraction of query image: This module calculates the feature of the query image. Query image can be a part of image database or it may not be a part of image database. This is online calculation. It is done at a time of retrieval
3. Similarity measure: This module compares the feature database of the existing images with the query image on basis of the similarity measure of the interest or based on most similar image.
4. Retrieval and Result: This module will display the matching images to the user based on threshold value of similarity measure.

B. CBIR IN MEDICAL

Content Based Image Retrieval technology has seen proposed to benefit not only the management of increasingly large image collections, but also to aid clinical medicine, research, and education relying on visual content in the data [8].CBIR in the medical field presents a growing trend in research area. The use of CBIR in medical diagnostics is the most important and hardest application for image retrieval in the medical domain. Finding similar images or reference is one way to assist radiologist during daily clinical practice like image based reasoning or Evidence based practice, it is important task for a radiologist to find similar images in various stages of the disease progression. One of the fields that may benefit more from CBIR is medical domain, where the efficiency of digital images is huge. Image retrieval can be very rich to a big variety of companies. The field of medical imaging gains its importance with increase in the need of automated and efficient diagnosis in a short period of time. Computer and Information Technology are very much useful in medical image processing, medical analysis and classification. Medical images are usually obtained by X-rays and recent years by Computed Tomography (CT) and Magnetic Resonance (MR) imaging [11].

Medical images are usually fused, subject to high inconsistency and composed of different minor structures. So there is a necessity for feature extraction and classification of images for easy and efficient retrieval with less computational complexity. Every day large volumes of different types of medical images such as dental, endoscopy, skull, MRI, ultrasound, radiology are produced in various medical centers. Medical image retrieval has many significant applications especially in medical diagnosis, education and research fields. Medical image retrieval for diagnostic purposes is important because the historical images of different patients in medical centers have valuable information for the upcoming diagnosis with a system which retrieves similar cases, make more accurate diagnosis and decide on appropriate treatment in future. The main objective of this research work is to retrieve the similar images matching the query image from medical databases by using feature extraction and similarity measurement techniques.

II. EXISTING IN CBIR OR BACKGROUND

CBIR systems extract features from the raw images themselves and calculate an association measure between the query image and database images based on these features. The feature extraction and selection techniques adopted in content based image retrieval, is a technique that uses the visual content of a still image to search for similar images in large scale image databases, according to a user's interest. All the solutions, in general, perform the retrieval process in two steps. The first step is the feature extraction step, which identifies unique signatures, termed as feature vector, for every image based on its pixel values. The feature has the characteristics that describe the contents of an image. There are some common methods for extracting content from images so that they can be easily compared. The visual feature of the images in the database are extracted and described by multi-dimensional feature vectors. The feature vectors of the images in the database form a feature database. The methods outlined are not specific to any particular application domain. Visual features such as color, texture and shape are used more commonly used in this step. Most proposed CBIR techniques automatically extract this low-level features to measure the similarities among images by comparing the feature differences. Because low level visual features of the images such as color and texture are especially useful to represent and to compare images automatically. The classification step matches the features extracted from a query image with the features of the database images and group's images according to their similarity. The similarities/differences between the feature vectors of the query example and those of the images in the database are then calculated and retrieval is performed with the aid of an indexing scheme. Out of these two steps the extraction of features is considered to be important because the features selected for discrimination affects the effectiveness of classification. The generalized block diagram of system which is used commonly in all CBIR system shown in Fig 1

A. Feature Extraction

1) COLOR:

One of the most important features visually recognized by humans in images is color. Humans tend to distinguish images based mostly on color features. Color is a property that depends on the reflection of light to the eye and the processing of that information in the brain. It is relatively robust to background complication and independent of image size and orientation. Because of this, color features are the most widely used in CBIR systems and the most studied in literature. Color is a powerful descriptor that simplifies object identification, and is one of the most frequently used visual features for content-based image retrieval. To extract the color features from the content of an image, a proper color space and an effective color descriptor have to be determined. Usually colors are defined in three dimensional color spaces. Each pixel of the image can be represented as a point in a 3d color space. If we want to describe an image by its color features, we have to first determine the color space to use. There exist different space models such as RGB, HSV, CIE l*a*b*, CIE l*u*v* or opponent color [6][7]. The best representation depends on the special needs of the application. Most image formats such as jpeg, bmp, gif, use the RGB color space to store information. The RGB color space is defined as a unit cube with red, green, and blue axes. Thus, a vector with three co-ordinates represents the color in this space. When all three coordinates are set to zero the color perceived is black. When all three coordinates

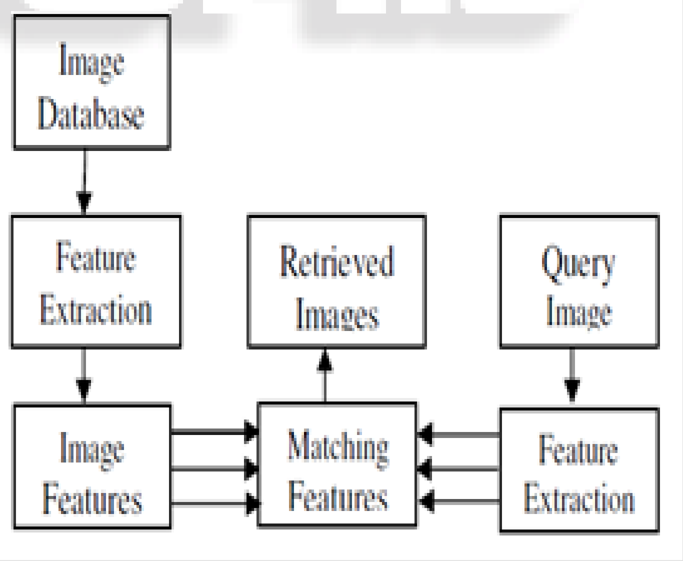


Fig 1: The generalized block diagram of system [1]

coordinates are set to 1 the color perceived is white. The other color spaces operate in a similar fashion but with a different perception.

The most commonly used color features are color histogram and color moments like mean, variance and skewness.

2) TEXTURE:

Texture is that innate property of all surfaces that describes visual patterns each having properties of homogeneity. It is defined as structure of surfaces formed by repeating a particular element or several elements in different relative spatial positions. Generally, the repetition involves local variations of scale, orientation, or other geometric and optical features of the elements. Image textures are defined as images of natural textured surfaces and artificially created visual patterns. It contains important information about the structural arrangement of the surface i.e., clouds, leaves, bricks, fabric, etc. It also describes the relationship of the surface to the surrounding environment. It is a feature that describes the distinctive physical composition of a surface.

A variety of techniques has been used for measuring texture similarity; Gabor wavelet is widely adopted to extract texture from the images for retrieval and has been shown to be very efficient. Basically Gabor filters are a group of wavelets, with each wavelet capturing energy at a specific frequency and specific orientation. The scale and orientation tunable property of Gabor filter makes it especially useful for texture analysis. Some other *Texture properties include* Coarseness, Contrast, Directionality, Regularity, and Roughness [4].

3) SHAPE:

Shape may be defined as the characteristic surface configuration of an object; an outline or contour. It permits an object to be distinguished from its surroundings by its outline. Shape representations can be generally divided into two categories: Boundary-based, and Region-based.

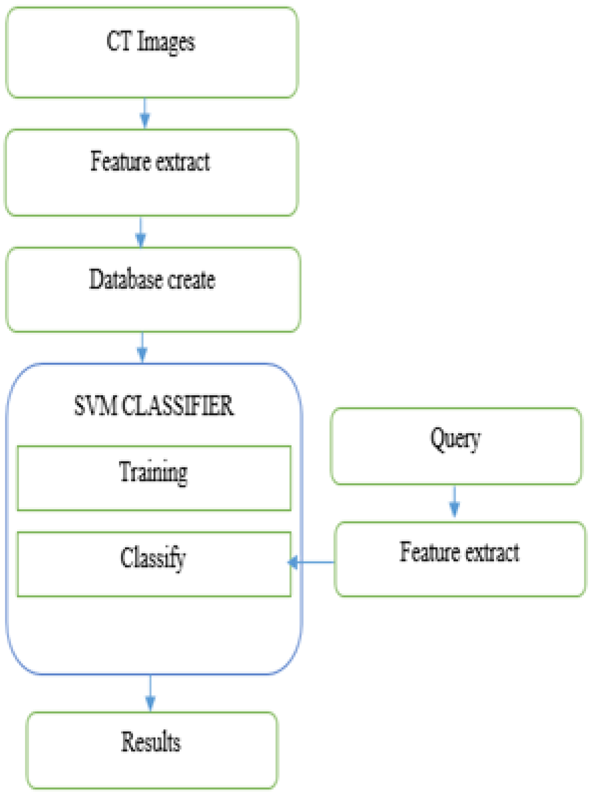
Boundary-based shape representation only uses the outer boundary of the shape. This is done by describing the considered region using its external characteristics; i.e., the pixels along the object boundary. Region-based shape representation uses the entire shape region by describing the considered region using its internal characteristics; i.e., the pixels contained in that region [2].

B. Existing Problem

There are many more techniques and feature with the help of that CBIR can be implemented but each one has its own advantages and disadvantages for example for a color feature has least amount of retrieval time but it cannot give the satisfied results for all the images, on other hand for a textural based retrieval Gabor wavelet is widely adopted. It has good discriminate power, but due to its non-orthogonally property it takes much time to take an output due to its computing complexity. So it cannot be applicable to retrieve online feature So there is a need of one retrieval system that can satisfied those conditions so for that purpose we have introduced SVM classifier in a CBIR system

III. PROPOSED METHODOLOGY

The proposed methodology to retrieve CT image of human brain is typically based on SVM classifier. The Figure 2 shows the overview of implementation flow. The method follows the steps of feature extraction training and it followed by classification. The various features of the CT images are given as input to the classifiers for training. If the features of new slices are given as input, the trained classifier can able to classify it



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A. Feature Extraction And Database Creation

In a CBIR using SVM, It replaces reshape image intensity to traditional low level features like color texture and shape which are uses in most of CBIR system, For feature extraction for SVM the given image is reshape to 80 X 80 pixels so the size of original image is reduced. By doing this the length of database vector is reduced, so the system take lesser time to retrieve image. After the reshape of image now we have new image of size 80 X 80 pixels means total 6400 pixels. If we rearrange the pixels in the form of one row only then the resultant image is size of 1 X 6400 pixels. Apply same procedure to all the image sequence and store in a matrix form.

To generate the feature vector for database combine all the separate matrix of image and create one matrix of size N x 6400 where the N represents the no of database image

B. SVM CLASSIFIER

To discriminate the groups of data into two group. Support Vector Machine performs classification by constructing an *N*-dimensional hyperplane that optimally separates the data into two categories [12].

Support vector machine (SVM) is a computer algorithm that learns by example to assign labels to objects SVMs have also been successfully applied to an increasingly wide variety of biological applications. A common biomedical application of support vector machines is the automatic classification of microarray gene expression profiles. In essence, an SVM is a mathematical entity, an algorithm(or recipe) for maximizing a particular mathematical function with respect to a given collection of data. SVM models are closely related to neural networks. It is based on the concept of decision planes or hyperplane that define decision boundaries. To understand the essence of SVM classification, one needs only to grasp four basic concepts: (I) the separating hyperplane, (II) the maximum-margin hyperplane, (III) the soft margin and (IV) the kernel function.

(I) The separating hyperplane, in two dimensions a straight line divides the space in half, and in three dimensions, we need a plane to divide the space. We can extrapolate this procedure mathematically to higher dimensions. The general term for a straight line in a high-dimensional space is a hyperplane, and so the separating hyperplane is, essentially, the line that separates the classes' sample.

(II) The maximum-margin hyperplane: we define the distance from the separating hyperplane to the nearest expression vector as the margin of the hyperplane, then the SVM selects the maximum margin separating hyperplane. Selecting this particular hyperplane maximizes the SVM's ability to predict the correct classification of previously unseen examples.

(III) The soft margin: So far, we have assumed that the data can be separated using a straight line. Of course, many real data sets cannot be separated as cleanly; we would like the SVM to be able to deal with errors in the data by allowing a few anomalous expression profiles to fall on the 'wrong side' of the separating hyperplane. To handle cases like these, the SVM algorithm has to be modified by adding a 'soft margin'. Essentially, this allows some data points to push their way through the margin of the separating hyperplane without affecting the final result.

(IV) The kernel function: It provides a solution to this problem by adding an additional dimension to the data. In essence, the kernel function is a mathematical trick that allows the SVM to perform a 'two-dimensional' classification of a set of originally one-dimensional data. In general, a kernel function projects data from a low-dimensional space to a space of higher dimension. If one is lucky (or smart) and chooses a good kernel function, the data will become separable in the resulting higher dimensional space The kernel function provides a solution to this problem by adding an additional dimension to the

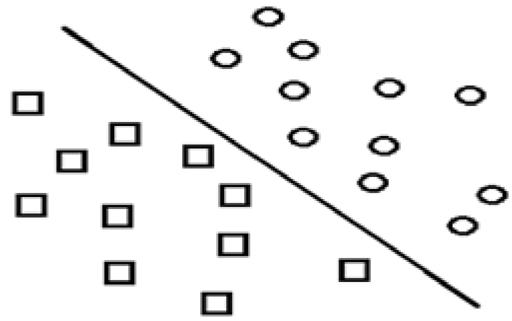

Fig 3: Schematic example of linear classifier

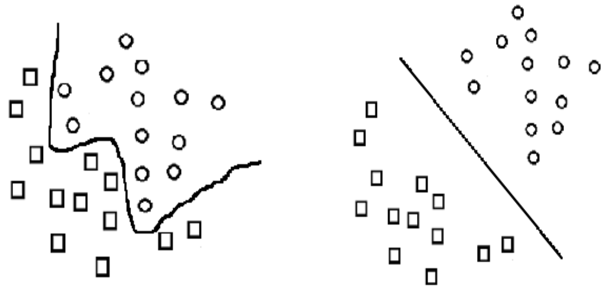

Fig 4: Rearranging of complex input space

data .For any given data set with consistent labels there exists a kernel function that will allow the data to be linearly separated. To understand kernels a bit better, consider the two-dimensional data these data cannot be separated using a straight line, but a relatively simple kernel function that projects the data from the two-dimensional space up to four dimensions (corresponding to the products of all pairs of features) allows the data to be linearly separated. We cannot draw the data in a four-dimensional space, but we can project the SVM hyperplane in that space back down to the original two-dimensional space.

A schematic example is shown in Figure 1. In this example, the objects belong either to class Square or Circle. The separating line defines a boundary on the right side of which all objects are Circle and to the left of which all objects are Square. Any new object falling to the right is labeled, i.e., classified, as Circle (or classified as Square should it fall to the left of the separating line) at the time of classification. The Figure 1 shown above is a classic example of a linear classifier, i.e., a classifier that separates a set of objects into their respective groups with a line. Most classification tasks, however, are not that simple, and often more complex structures are needed in order to make an optimal separation, i.e., correctly classify new objects (test cases) on the basis of the examples that are available (train cases). This situation is depicted in the figure 2. Compared to the previous schematic, it is clear that a full separation of the Square and Circle objects would require a curve (which is more complex than a line). Classification tasks based on drawing separating lines to distinguish between objects of different class memberships are known as hyperplane classifiers. Support Vector Machines are particularly suited to handle such tasks.

The figure 2 shows the basic idea behind Support Vector Machines. Here we see the original objects (left side of the schematic) mapped, i.e., rearranged, using a set of mathematical functions, known as kernels. The process of rearranging the objects is known as mapping (transformation). Note that in this new setting, the mapped objects (right side of the schematic) is linearly separable and, thus, instead of constructing the complex curve (left schematic), all we have to do is to find an optimal line that can separate the Square and the Circle objects. Support Vector Machine (SVM) is primarily a classier method that performs classification tasks by constructing hyperplanes in a multidimensional space that separates cases of different class labels. There are number of kernels that can be used in Support Vector Machines models. These include linear, polynomial, radial basis function (RBF) and sigmoid among all this paper based on the linear kernel.

C. Linear Svm Classifier

Let us begin with the simplest case, in which the training patterns are linearly separable. That is, there exists a linear function of the form

$f(x) = w^T x + b$ (1)

such that for each training example xi, the function yields $f(xi)>0$ for $yi=+1$. And $f(xi)<0$ for $yi= -1$. In other words, training examples from the two different classes are separated by the hyperplane $f(x) = w^T x + b =0$, where w is the unit vector and b is a constant. For a given training set, while there may exist many hyperplanes that maximize the separating margin between the two classes, the SVM classifier is based on the hyperplane that maximizes the separating margin between the two classes (Figure 1). In other words, SVM finds the hyperplane that causes the largest separation between the decision function [11].

To implement the CBIR system for Brain images first images are divided into six classes of similar images. The system which we have implemented it differentiate two classes so in this paper we follow the approach of one versus others, at a onetime one class is marked as class 0 and remaining classes as class 1 and stores it to database. SVM make classification based on the given features of the objects which we want to classify. In this paper we want to classify the Brain images of different classes for that purpose Image intensity is consider as a feature of an image. For retrieval of feature we have to perform few steps enlisted below

1. Take the images for creating database;
2. Resize the image of 80X80 pixel;
3. Rearrange it in the fashion of 1X6400 pixel;
4. Apply similar to all images Put all images in single matrix;
5. Dimension of final matrix is No of images X 6400;
6. Assign a class to each database images in form of binary value like 0 or 1;
7. Train the database image using SVM to classify images by generating separating hyperplane;
8. Calculate feature for query image;
9. Compare parameter using SVM and Detect the class from which query image belongs;

IV. IMPLIMENTATION OUTCOMES

For testing the system we have chosen some attributes for CBIR system which are described below

A. CT image data

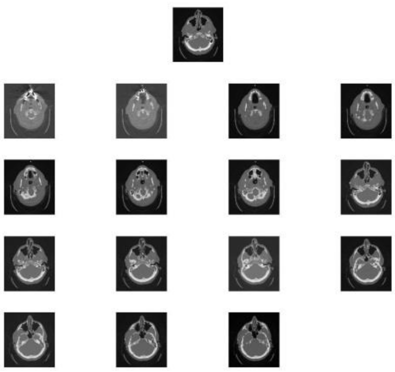

Fig. 5:

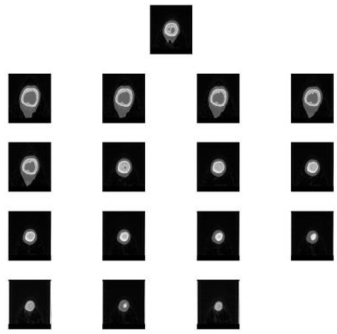

Fig. 6:

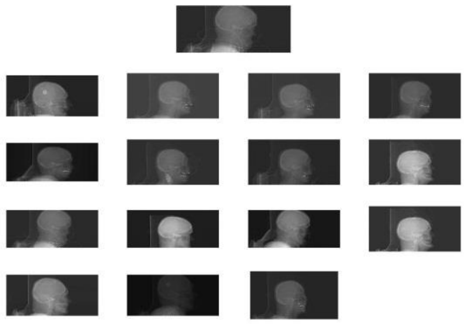

Fig. 7: Results of Proposed System

The image used in this work, were taken from Frederick National laboratory for cancer research available at online large archive of medical images of cancer accessible for public download. The images are organized as "Collections", typically patients related by a common disease (e.g. lung cancer), image modality (MRI, CT, etc) or research focus. This are 2 dimension gray scale image with size of 512X512. Any random images of brain were considered in this work[13].

B. Training & Testing Data

For training to SVM the CT image slices were grouped into six classes of different categories and 15 images of each treated as the training data. The database generated by feature extracting which contains 90 images (6 group) and 27 images used for testing purpose which are similar but not the same as training data.

C. Classifier

The CT images were classified using SVM. The proposed system is implemented in MATLAB 2013.In our study we used linear function as the kernel to implement SVM.

For testing the system various similar images of different classes are tested on their appropriate database created by training. The system is implement on Platform of Intel Core i5 Processing power of 2.30 GHz CPU with 6GB RAM with windows 8 operating system Figure 4 shown below represents some results for the query images. The average time taken by the query to retrieve similar image from its database is 1.50 second. By observing the results it can be said that retrieval is done satisfactorily

V. CONCLUSION AND FUTURE WORK

This experiment can successfully detect the class of query image but it is not yet designed to detect multiple query from various class at one instant. In future focus on the various features that can reduce computing complexity and retrieval

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