Medical Image Matching and Retrieval using Discrete Sine Transform

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***Abstract*—Visual information has been extensively used in the areas of multimedia, medical imaging and other numerous applications. Management of these visual information is challenging as the quantity of data available is very huge. Current utilization of available medical databases is limited due to the issues in retrieval of the necessary images from a huge repository. In this paper we propose a novel image matching scheme using Discrete Sine Transform and decision tree classification techniques for classification of the given input medical image. Our system classifies the images based on the similarity of the images.**

***Keywords*-Medical Image Retrieval, MRI, Discrete Sine Transform, Classification.**

I. INTRODUCTION

Based on the similarity of visual content for an given input query image, the task of medical image retrieval is to retrieve relevant medical images from an image repository. Query images are given as input by the user as example of his search [1]. The Medical Image Retrieval System classifies the database images and displays the retrieved results ordered with respect to their similarity of the input image [2].

Low level features are one of the most popular method for Image Retrieval systems [3,4] with each model using a combination of low-level features, and then define a distance metric that is used to quantify the similarity between image models. A disadvantage of this method is that low-level image features cannot always capture the human perception of image similarity. In other words, semantic content of an image are found to be difficult for feature extraction using only low-level image features. This is known in as the semantic *gap* problem [5].

The future medical information systems will emphasize in providing improved medical care with reduction in costs significantly. To helped in the clinical decision making process by a physician, it will be necessary to search large image databases for cases with similar pathologic appearances or anatomical features, in a manner that will rapidly provide the physician with significant information for improve diagnosis. Though, today's medical information systems provide some image search capabilities, annotated images have proven to contain error rates of up to 16% in identifying even the correct anatomical region [6].

Most of the image retrieval systems found in focuses on general purpose imagery of outdoor scenes. Advantage using such images are they tend to be rich in color and texture and can be characterized by global signatures of such properties. Examples of these earlier systems have been reported in various papers [7,8].

Medical Image Retrieval systems can be differentiated from regular image retrieval systems in several ways. For one, the retrieval has to take place with respect to pathological conditions that tend to be highly localized. This leads to retrieval on the basis of global signatures would not make any sense when used for medical databases.

Transforming the image from spatial domain to frequency domain is one of the popular methods used in Image Retrieval. Various methodology have been proposed in the literature[9,10]. In this paper we propose to use the Discrete sine transform with down sampling techniques to extract relevant features and apply classification techniques.

This paper is organized into the following sections. Section II describes the Discrete Sine Transform with the down sampling technique, Section III describes the classifier methodology, Section IV describes the experimental setup and results obtained and section V concludes the paper with a discussion on the result obtained.

II. DOWNSAMPLED DISCRETE SINE TRANSFORM

The discrete sine transform (DST) is related to the Fourier transform similar to the discrete Fourier transform (DFT), but with the difference of using a purely real matrix. Mathematically Discrete Sine Transform is represented by

$$y(k) = \sum_{n=1}^{N} x(n) \sin\left(\pi \frac{kn}{N+1}\right), k = 1, ..., N$$

Where y=dst(x) computes the discrete sine transform of the columns of x. The inverse of Discrete Sine Transform is calculated using

$$y(k) = \frac{2}{N+1}\sum_{n=1}^{N} x(n)\sin\left(\pi\frac{kn}{N+1}\right), k = 1,\ldots, N$$

x=idst(y) calculates the inverse discrete sine transform of the columns of y.

In this work the DST was down sampled by modifying the algorithm to y(2k) with k=0,1,2…,N. This reduces the dataset by a factor of four and decreased processing time.

III. CLASSIFIERS

Naïve Bayes is a popular supervised learning classifier based on the probability model. Bayes rule for supervised learning can be represented for an unknown target function by f : X →Y, or equivalently P(Y|X). Assuming Y is a boolean-valued random variable, and X is a vector containing ' n' boolean attributes. In other words,

$X = (X_1, X_2, \ldots, Xn)$, where X_i is the boolean random variable denoting the ith attribute of X. Applying Bayes rule, we see that P(Y = yi|X) can be represented as

$$P\left(Y = y_i \mid X = x_k\right) = \frac{P(X = x_k \mid Y = y_i)P(Y = y_i)}{\sum_i P(X = x_k \mid Y = y_j)P(Y = y_j)}$$

where y_m denotes the m^{th} possible value for Y, x_k denotes the k^{rh} possible vector value for X, and where the summation in the denominator is over all legal values of the random variable Y. A method to learn P(YjX) is to use the training data to estimate P(X|Y) and P(Y). We can then use these estimates, together with Bayes rule above, to determine $P(Y|X = x_k)$ for any new instance x_k.

Based on the class label Classification and regression trees (CART) produces output that is either classification or regression. CART provides a classification tree if the class label is categorical and a regression tree if the class label is numeric.

An decision tree is created by rules formed on the attribute values in the given data. Each rule is formed based on the values of the dependent attribute. The rule so selected is applied to all the nodes till the last node is reached which is the class node. Figure 1 shows a simple decision tree.

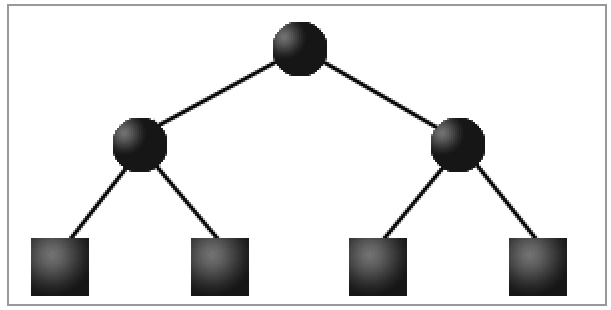

Figure 1. A decision tree

IV. EXPERIMENTAL SETUP

A program was developed in LabVIEW which can handle multiple input images and outputs the co efficient as a comma separated values with down sampling. Various MRI scan images along with noisy images were used as inputs. Some of the images used are as shown in figure 2. Many of the images were rotated by an angle of 90 degrees to simulate a real time database search. Four different types of medical images were used in the experimental setup with various degree of noise.

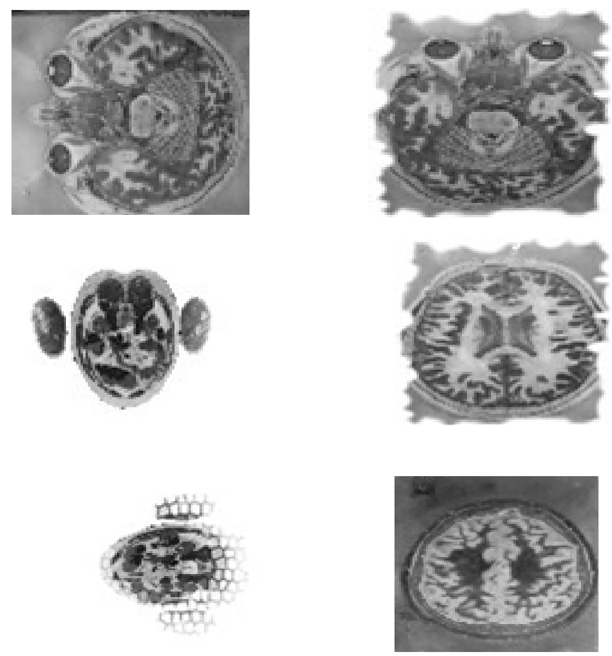

Figure 2. Sample images used in the medical retrieval system.

Classification was done using 60% of the data as training set and the remaining as test set. The results obtained and the classification accuracy is shown in table 1 and 2.

	Naïve Bayes	CART
Classification Accuracy %	86.96	73.91
Recall - type 1 images	1	0.6
Recall - type 2 images	0.571	0.571
Recall - type 3 images	1	1
Recall - type 3 images	1	0.833
Precision - type 1 images	0.625	0.75
Precision - type 2 images	1	1
Precision - type 3 images	1	0.714
Precision - type 3 images	1	0.082

Table 1 : Classification accuracy with Precision and Recall

Accuracy by Class	Naïve Bayes	CART
TP Rate - type 1 images	1	0.6
TP Rate - type 2 images	0.571	0.571
TP Rate - type 3 images	1	1
TP Rate - type 4 images	1	0.833
FP Rate- type 1 images	0.167	0.056
FP Rate- type 2 images	0	0
FP Rate- type 3 images	0	0.111
FP Rate- type 4 images	0	0.176

Table 2 : Detailed accuracy by class

V. CONCLUSION

In this paper we investigate retrieval of medical images from a database containing noisy and regular images using down sampled discrete sine transform. Images were also rotated to investigate the performance of our methodology. Results obtained by classifying using CART and Naïve Bayes classifiers is fairly good. Further investigation needs to be done to reduce the dataset size and with increased types of images.

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