

Texture and Shape based Classification of Brain Tumors using Linear Vector Quantization

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ABSTRACT

Brain cancer is one of the most common and deadly disease in the world. Detection of the brain tumor in its early stage is the key to its cure. Early diagnosis of the brain tumor is very important. With the development in Artificial Intelligence (AI) and Soft Computing Techniques, Computer-Aided Diagnosis (CAD) attracts more and more attention for brain tumor diagnosis. Accuracy and efficiency are two major issues in designing CAD systems. In the brain Magnetic Resonance Imaging (MRI), the tumor may appear clearly but for further treatment, the physician also needs the quantification of the tumor area. The computer and image processing techniques can provide great help in analyzing the tumor area. In this paper features based on shape and texture of image were tested for analysis and classification of brain tumors. After feature extraction, linear vector quantization is used to classify brain tumor in to malignant & benign types. MATLAB ® 7.01 image processing toolbox and ANN toolbox have been used to implement the algorithm. The results show that texture and shape features can be effectively used for classifying brain tumor with high level of accuracy.

General Terms

Pattern Recognition, Medical Image Processing.

Keywords

Medical image, shape, texture, malignant, benign, tumor.

1. INTRODUCTION

Image processing techniques are playing important role in analyzing Anatomical structures of human body. Image acquisition techniques like magnetic resonance imaging (MRI), X-Ray, ultrasound, mammography, CT-scan are highly dependent on computer technology to generate digital images. After obtaining digital images, image processing techniques can be further used for analysis of region of interest. A tumor is a mass of tissue that serves no useful purpose and generally exists at the expense of healthy tissues. Malignant brain tumors do not have distinct borders. They tend to grow rapidly, increasing pressure within the brain and can spread in the brain or spinal cord beyond the point where they originate. They grow faster than benign tumors and are more likely to cause health problems. Benign brain tumors, composed of harmless cells, have clearly defined borders, can usually be completely removed, and are unlikely to recur. A benign tumor is basically a tumor that doesn't revert and doesn't spread to other parts of the body. Benign tumors tend to grow more slowly than malignant tumors and are less likely to cause health problems.

In brain MR images, after appropriate segmentation of brain tumor, classification of tumor in to malignant and benign is

difficult task due to complexity and variations in tumor tissue characteristics like its shape, size, gray level intensities and location [1]. Feature extraction is an important issue for any pattern recognition problem. Most of the reported work is dedicated to tumor segmentation or tumor detection [1-5].

This paper presents a hybrid approach to classify malignant and benign tumors using fusion of texture and shape features. A CAD system for classification of brain tumor MR images is proposed. Both tumor and non-tumor regions appear with little distinction on an MR image. For accurate classification of brain tumor, computer and image processing techniques can provide great help in analyzing the MR images of brain. MATLAB ® 7.01 image processing toolbox is used for feature extraction and ANN toolbox has been used for classification.

2. OVERVIEW OF FEATURES EXTRACTION

A very difficult problem in classification techniques is the choice of features to distinguish between classes. An effective shape descriptor is a key component of content description; since shape is a basic property of an object present in the image itself [6]. Most of existing shape descriptors are usually either application dependent or non-robust, making them undesirable for shape description [7]. In this paper, a Fourier descriptor (FD) and moment invariants are used to overcome the drawbacks of existing shape representation techniques [8, 9, and 10]. Another set of features which we have used to describe a medical image is texture feature. Medical images possess different texture depending upon area of body considered for imaging. Texture refers to visual patterns which have properties of homogeneity and cannot result from the presence of only a single color or intensity.

Texture perception has a very important aspect in the human visual system of recognition and interpretation. Two main approaches concerning with texture analysis: statistical model-based, and spectral measure [9, 11]. We use Haralick's texture features [12] such as energy, correlation, inertia, entropy, inverse difference moment, sum average, sum variance, sum entropy, difference average, difference variance, difference entropy, information measure of correlation 1 and information measure of correlation 2. Features are extracted and represented in a single array called as feature vector.

3. EXPERIMENTS AND RESULTS

3.1. Database Preparation

80 brain MRI images consisting of 40 malignant and 40 benign tumors were collected from open source database and some hospitals. Expert radiologists were consulted to confirm whether the tumor is malignant or benign. Figure 1 shows some sample images from the database.

3.2. ROI Extraction

Before feature extraction, region of interest (ROI) consisting of tumor region was extracted using MATLAB `imtool` function for further analysis. Figure 2 shows extracted ROIs from some MRI Images from database.

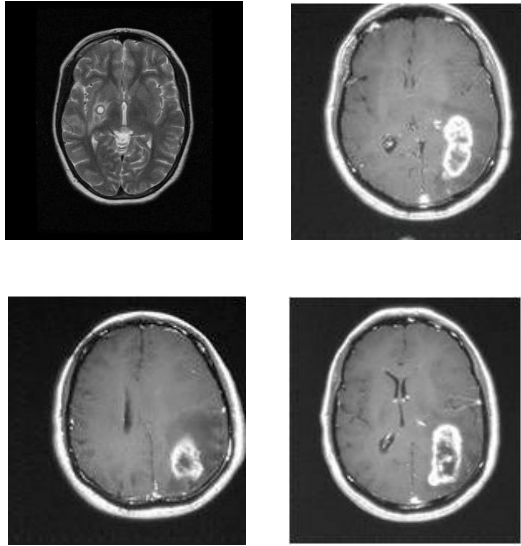


Figure.1. Example images from the database

3.3. Determination Feature Vector

Feature extraction is the main aspect of any CAD system. In our case the feature vector is a row consisting of shape features such as Fourier Descriptor coefficients and seven moment invariants along with 13 texture features discussed in section 2. The feature vector of each image in the database is stored as .mat file. Table 1 shows texture features of three malignant tumors and Table 2 shows texture features of three benign tumors. It is concluded from table that textures features of both benign and malignant tumors are very close to each other and hence texture feature alone may not give desired classification efficiency. Thus we use shape features along with texture features.

3.4. Classification Using Linear Vector Quantization

Linear vector quantization (LVQ) is finally used for classifying the pattern of malignant and benign tumors. LVQ is a supervised version of Kohonen learning rule. In LVQ each output unit represents a class [13]. One feature vector consisting of shape and texture attributes was generated for each tumor image and save in .mat file in MATLAB environment. Fifty percent of the data was used for training and remaining fifty percent was used for testing. Table 3 shows information about data set used for classification using LVQ. Table 4 shows the classification simulation results using LVQ. The accuracy of 85% is obtained for learning rate of $\alpha=0.70$.

4. CONCLUSIONS

In this paper an automatic method for classification of brain tumors in to malignant or benign using fusion of shape and texture features is proposed. After extracting features, a one

dimensional feature vector consisting of shape and texture attributes was used for training and testing. LVQ was used for classification of the tumor. Results show that texture and shape features can give satisfactory result in analysis and classification of brain tumors. The performance of the system can be further improved by fusing other shape and texture features like GLRLM texture features etc. Further work is to check the performance of the system by increasing the size of database.

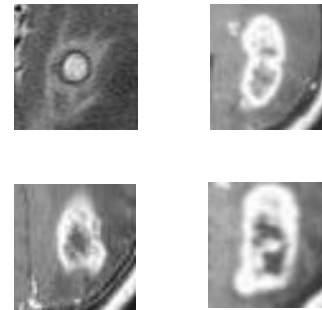


Figure.2. Extracted ROI consisting of brain tumors before feature extraction

Table 1: Texture features of three malignant tumors from the database

S.No	Texture Feature	Image id_M1	Image id_M2	Image id_M3
1	Energy	0.0000*10 ⁴	0.0000*10 ⁴	0.0000*10 ⁴
2	Correlation	0.0001*10 ⁴	0.0001*10 ⁴	0.0001*10 ⁴
3	Inertia	0.0323*10 ⁴	0.0350*10 ⁴	0.0461*10 ⁴
4	Entropy	0.0013*10 ⁴	0.0012*10 ⁴	0.0012*10 ⁴
5	Inverse Difference Moment	0.0000*10 ⁴	0.0000*10 ⁴	0.0000*10 ⁴
6	Sum Average	1.0011*10 ⁴	0.0344*10 ⁴	0.0355*10 ⁴
7	Sum Variance	0.0611*10 ⁴	1.4312*10 ⁴	1.7302*10 ⁴
8	Sum Entropy	0.0008*10 ⁴	0.0008*10 ⁴	0.0008*10 ⁴
9	Difference Average	0.0012*10 ⁴	0.0011*10 ⁴	0.0013*10 ⁴
10	Difference Variance	0.0181*10 ⁴	0.0236*10 ⁴	0.0303*10 ⁴
11	Difference Entropy	0.0005*10 ⁴	0.0005*10 ⁴	0.0005*10 ⁴
12	Information Measure of Correlation1	-0.0000*10 ⁴	-0.0000*10 ⁴	-0.000*10 ⁴
13	Information Measure of correlation 2	0.0001*10 ⁴	0.0001*10 ⁴	0.0001*10 ⁴

Table 2: Texture features of three benign tumors from the database

S.No	Texture Feature	Image id_B1	Image id_B2	Image id_B3
1	Energy	0.0000*10 ³	0.0000*10 ³	0.0000*10 ³
2	Correlation	0.0009*10 ³	0.0009*10 ³	0.0009*10 ³
3	Inertia	0.1890*10 ³	0.1657*10 ³	0.2618*10 ³
4	Entropy	0.0117*10 ³	0.0114*10 ³	0.0108*10 ³
5	Inverse Difference Moment	0.0002*10 ³	0.0002*10 ³	0.0002*10 ³
6	Sum Average	0.1950*10 ³	0.1948*10 ³	0.1765*10 ³
7	Sum Variance	5.8488*10 ³	6.2039*10 ³	3.8211*10 ³
8	Sum Entropy	0.0081*10 ³	0.0070*10 ³	0.0073*10 ³
9	Difference Average	0.0085*10 ³	0.0081*10 ³	0.0092*10 ³
10	Difference Variance	0.1167*10 ³	0.0993*10 ³	0.1776*10 ³
11	Difference Entropy	0.0045*10 ³	0.0045*10 ³	0.0046*10 ³
12	Information Measure of Correlation1	-0.004*10 ³	-0.004*10 ³	-0.003*10 ³
13	Information Measure of correlation2	0.0010*10 ³	0.0010*10 ³	0.0010*10 ³

Table 3: Information about data set used for LVQ classification

S.No	Information
1.	Number of instances =80 (Malignant: 40, Benign:40)
2.	Number of attributes =111+ class attributes. (Texture attributes:13, shape attributes:98)
3	Classes: 02 (Class 1: Malignant, Class 0: Benign)

Table 4: Classification result using LVQ

S. No	Training Vectors	α	Test Vectors	Time (sec)	Recognized Vectors	Efficiency
1	32 (40%)	1	48(60%)	13.9	33	69%
2	40(50%)	1	40(50%)	12.55	31	78%
3	40(50%)	0.7	40(50%)	16.64	34	85%

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