Medical Image Classification Approach Based on Texture Information

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Abstract

Texture features play important role in most image classification technique to obtain high accuracy results. In this work, the medical image classification method considering texture analysis and statistical features have been proposed. The main concept of proposed method depends on extract statistical features from texture information for each medical image under consideration during classification process. The proposed classification method consists of two parts. In first part, the gray level co−occurrence matrix GLCM have been computed for gray medical image and then extract some statistical texture features with second order. In second part, each of input medical images will be assign to corresponding class depending on GLCM texture features that are extracted in pervious part. The performance of suggested method evaluated using multi classes for different medical image including heart, liver, and kidney. The experimental results show ability of proposed method to achieve high accuracy degree in medical image classification.

Keywords: Image Classification, GLCM, and Medical Image.

المستخلص

تؤدي ميزات النسيج دورًا مهمًا في معظم تقنية تصنيف الصور للحصول على نتائج عالية الدقة. في هذا العمل ، تم اقتراح طريقة تصنيف الصور الطبية بالنظر إلى تحليل النسيج والميزات الإحصائية . يعتمد المفهوم الرئيسي للأسلوب المقترح على استخراج الخصائص الإحصائية من معلومات النسيج لكل صورة طبية قيد النظر أثناء عملية التصنيف .تتكون طريقة التصنيف المقترحة من جزأين .في الجزء الأول ، تم حساب مصفوفة التراكب ذات المستوى الرمادي GLCM للصورة الطبية الرمادية ثم استخراج بعض خصائص النسيج الإحصائي بالترتيب الثاني .في الجزء الثاني ، سيتم تعيين كل صورة من الصور الطبية المدخلة للفئة المقابلة اعتمادًا على ميزات نسيج GLCM المستخرجة في الجزء السابق .تم تقييم أداء الطريقة المقترحة باستخدام فئات متعددة للصور الطبية المختلفة بما في ذلك القلب والكبد والكلى .تظهر النتائج التجريبية قدرة الطريقة المقترحة على تحقيق درجة عالية من الدقة في تصنيف الصور الطبية.

1. INTRODUCTION

Texture is a feature that clarifies the surface and structure of an image or can be known as an orderly repetition of an element or pattern on a surface. Textures of an image are complex visual patterns that are collected of entities or regions with sub−patterns with the characteristics of brightness, color, shape, size, etc.[1] A fixed texture in an image represents a group of its characteristics that are fixed, progressively changing or approximately cyclic. As well, it may be regarded as a similarity collection in an image [2]. Texture analysis distinguish the spatial divergence of image pattern depending on some mathematical procedures and models to elicit information from it and statistical method of examining texture that considers the spatial relationship of pixels is the gray−level co−occurrence matrix

(GLCM), as well known as the gray-level spatial dependence matrix. The GLCM functions recognize the texture of an image by calculating how often pairs of pixel with specific values and in a specified spatial relationship occur in an image, make a GLCM, and then extracting statistical measures from this matrix[3]. According to co-occurrence matrix, Haralick [4] defines fourteen textural features measured from the probability matrix to extract the characteristics of texture statistics of distant sensing images. [5] GLCM total 13 texture & geometric features extracted from images by region based active contour segmentation method & classified using SVM, KNN and Bayesian

In recent years, frequent research aimed to classified the medical images based on the features analysis of the images, that by using different techniques and methods: Nikita et al. [5] they exploit the many of statistical features that computed based on GLCM, after extracted in total 13 features the intelligent classifiers like Bayesian, SVM, KNN will be trained using the extracted features, the obtained results are compared against the truth table of classes produced from the radiologist. Nitish et al. [6] several classes represent four cases of brain tumors have been used based on extracted the textural features of each class from GLCM, and applied to multi-layer neural network, that reach to 97.5% classification accuracy rate. Tawfiq et al. [7] analysis GLCM feature extraction algorithm to detect the appropriate angle that can be chosen , relatively with the training of BP classifier had been used according to the number of hidden neurons inside the hidden layer of ANN as a result the system produce high accuracy with the best angle choosing of GLCM. Alaa et al. [8] proposed a hybrid approach to compute vector of features depend on GLCM for image classification. The vector produce by combination Haralick features and some statistical features computed directly using spatial domain, their results exhibit that the hybrid approach is better when compare with others works. Mohanaiah [9] apply GLCM in order to compute the second-order features of texture to estimate the motion of images, the evaluation tests illustrate that extracted features has high ability for discrimination accuracy with time complexity and can be used for real-time applications. The paper is structured as follows. The texture feature extraction explained in Section 2. The proposed approach for medical images classification is presented in Section 3. Section 4 shows obtained experimental results. Finally, Section 5 provides conclusions.

2. Texture Feature Extraction

In image analysis, texture feature is the result from the observed groups of the intensity in specific locations statistical distribution relative to each other from Image [9].

a. GLCM

Submit your manuscript electronically for review. The gray level co-occurrence matrix GLCM technique is a method used to extract statistic texture features from gray image, this method is good in many applications of image analysis such as remote sense techniques, medical image classification, ...etc. [11].

Matrix P (i, j, θ) contains a statistical result number for transfer between gray levels at an angle θ. By using the values result from GLCM, and normalize it to the range [0, 1]. Eight textural features are extracted in proposed system for each visible band from each land sample to be the vector of features which represented the entire land sample (see Fig.1) [12,13].

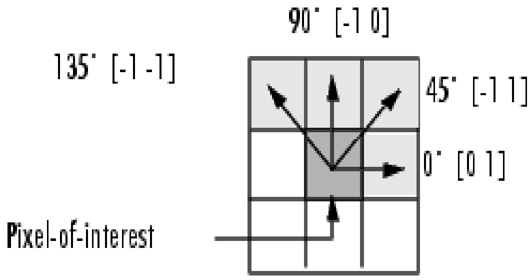


Fig 1: Directions for generation of GLCM

Haralick [10] suggest 14 texture features extracted from the co-occurrence matrix, and which have information of image textural properties such as Moment invariant, Contrast, Correlation, Variance, Inverse Moment, Average, Sum of Variance, Entropy, Difference Variance, Entropy, Mean of Correlation, and etc. In our proposed method, four Haralick feature functions are computed; they are Energy, Entropy, Contrast, and Homogeneity. Energy Returns the sum of elements in the GLCM and the range in [0 1], Entropy measures the randomness of intensity, Contrast measure of the amount of local variation in an image , and Homogeneity retrieve the values was measure the closeness of the distribution of items in the GLCM to the GLCM diagonal and range will be in [0 1].

b. The Features

Some of statistical features which used in this work summarize as follow [14, 15]:

1) **Contrast feature, is compute the intensity the pixel and its neighbor.**

$$\text{Contrast}_F = \frac{1}{(N-1)^2}\sum_{i=0}^{n-1}\sum_{j=0}^{n-1}(i-j)^2 P(i,j). \quad ...(1)$$

2) **Entropy Feature, the quantity of energy.**

$$\text{Entropy}_F = -\sum_{i=0}^{n-1}\sum_{j=0}^{n-1}P(i,j)\times \text{Log}(P(i,j)). \quad ...(2)$$

3) **Homogeneity feature, Compute the not-zero in the GLCM, it is the inverse of contrast weight.**

$$\text{IDM}_F = \sum_{i=0}^{n-1}\sum_{j=0}^{n-1}\frac{1}{1+(i-j)^2}P(i,j). \quad ...(3)$$

4) **Energy feature, compute the local homogeneity, it refer to the Entropy.**

$$\text{Energy}_F = \sum_{i=0}^{n-1}\sum_{j=0}^{n-1}P(i,j). \quad ...(4)$$

3. Medical Images Classification

Image analysis methods are an important way in many medical applications. The application was extraction of features from an image which used in classification target. The extracted of features like color properties, or certain textural properties of the image [11].

In our research, Medical Image Classification system is divided into two main parts, Texture Features Extraction (TFE) algorithm, and Medical Image Classification (MIC) algorithm. A proposed system is designed for classification of medical images of the members of the main body inside a (heart, liver, and kidney) and depending on the different tissue type for each of these members. The medical images are available for each of the member

mentioned and took the medial part of it depending on the center of the image to that member and parts and then use it. Extraction of each features of the members of the medical tissue was used GLCM and then extract our features values for medical image entries, at this stage, we will have four values as features of each member (heart, liver, and kidneys), each class are saved in our database system to uses it in classification stage for this system, that mean we have three classes in the database system, each class for one type Medical image, each of this medical member call Class, i.e. Class1: Heart, Class2: Liver, and Class3: Kidney. The algorithm of texture feature extraction is summarized as shown in algorithm (1):

Algorithm 1: Texture Feature Extraction (TFE)

Input: read medical image and dimensions (N*N), for each class. Output: Saved the Fore values (features) for each class in database system.
Step 1: Convert a medical image into gray level. Step 2: Find GLCM values for Four Angles (0°,45°, 90°, and 135°). Step 3: Compute The four Features values, by Compute each feature (Eq. 1, 2, 3 and 4) with result of GLCM from step two, that we have four values (features) for each input medical image. Step 4: Compute the feature values from step three, for each image in one class, we have at last just four values for each class, that values are saved in our database system and uses to classified the images in classification part.

In second part of our work, classification algorithm , we used the values of from the Texture Feature Extraction algorithm (TFE) using to classified entry Medical image with the MIC systems, see algorithm(2).

Input: read new Medical image. Output: classified entry image belong one of three classes in DB.
Step 1: Applied Algorithm (1) on input image, to extract four Features for new medical image input Step 2: Compare the four Features from step 1 within each four Features for each class from our database : Using minimum distance Classifier, classify a new medical image data to classes which less distance between an image information and a class, By Euclidean distance to determine near reduces to computing the distance measures: $D_j(X) = \lVert X - M_j \rVert$ ....(Eq. 5) where : $M = \frac{1}{N}\sum_{i=0}^{n-1} x_j$ where j= 1,2,3,......w W, number of classes, , and j = 1, 2, 3, ... , W. we get three distance (have three class) Step 3: From step2 results, we chose minimum distance value to say what one features from database is same of features get it newly from new medical image input to classified it.

Algorithm 2: Medical Image Classification

4. Experimental of Results

From GLCM in Algorithm(1), we get GLCM values at each angle in our test medical image(Heart1), Table (1) show the result of GLCM for Test Heart1 image, and this result will be used in feature extraction steps.

Table 1: GLCM values for test heart1 medical image.

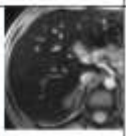
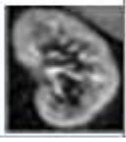
0°	45°	90°	135°
3572	236	4	0
285	985	256	12
1	287	1751	335
0	6	351	1263
0	0	4	292
0	0	0	1
0	0	0	0
0	0	0	0

In Table (1), eight values will be result for each Angles (0° , 45° , 90° , and 135°) when apply (Heart1 gray image) on Gray level co−occurrence matrix. This values results from GLCM for any input medical image in our proposed (heart, liver, and kidneys), it will be used in texture features extraction stage to extract four features (section 2.2).

a. Texture Features Extraction

Four feature Values results from Algorithm (1) (TFE) doing by calculate four features of medical images for three classes stored in database. Database systems have saved three feature types, Table (2) show that feature values for each class by algorithm (1).

Table 2: Four Features for each class stored in database System

Class No.	Image	Contrast	Entropy	Homogeneity	Energy
Class1 (Heart)		0.540	2.037	0.799	0.178
Class2 (Liver)		1.170	2.245	0.687	0.139
Class3 (kidney)		1.343	2.284	0.628	0.133

Where Class1: Heart, Class2: liver, and Class3: kidney.

Table (2) shows the values of the features of three medical image classes, where they were taking the average of images feature include in same class. That to compare this value with feature value from input medical image needed to classify.

b. Results of Medical Image Classification

Medical images are classified by using texture feature values. From TFE algorithm, four texture features stored in an images database for each class, that four features are used in classification part. Only the medical image (MRI type) for heart, liver and kidney is analyzer throughout this system. Table(3) show Four features value for Heart images in class1, all steps for this system part are explain in Texture Feature Extraction Algorithm (TFE).

Table 3: Four features value for sample Heart image

Medical Image	Contrast	Entropy	Homogeneity	Energy
	0.421	2.040	0.809	0.169

The relation between four features for three classes based on features value in Table (2) in Database shown in Fig.2:

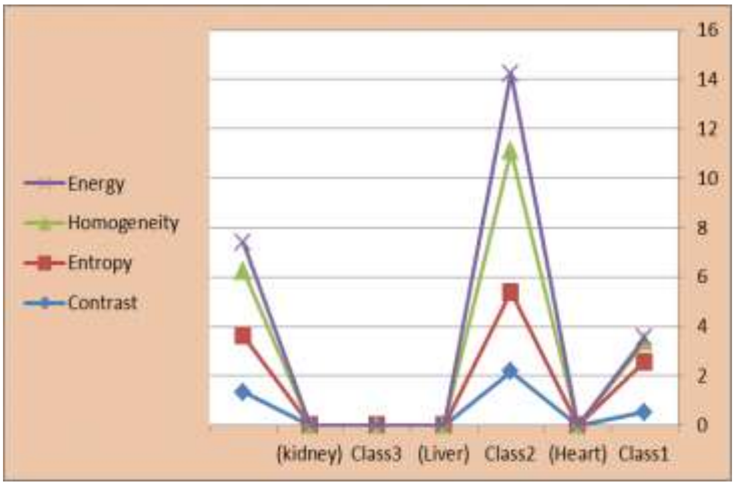


Fig2: Relation between Four Texture features and three classes.

From the feature of test image shown in Table(3)and features of three classes shown in Table(2), we finding the minimum distance by (Eq. 5) (step2 in algorithm (2)),the test image nearest from class1 at (0.141) , from class2 at (10.802), and from class3 (3.319), that mean the test image classified belong class1for heart medical image.

Were tested 10 images for each class and, from Class1 succeeded 8 images at a rate of success of 80%, Class2 succeeded 5 images at a rate of 50%, and Class3 succeeded 8 at a rate of 80%. Fig.3 shown relation between samples entry test medical images and three classes' features in classification stage.

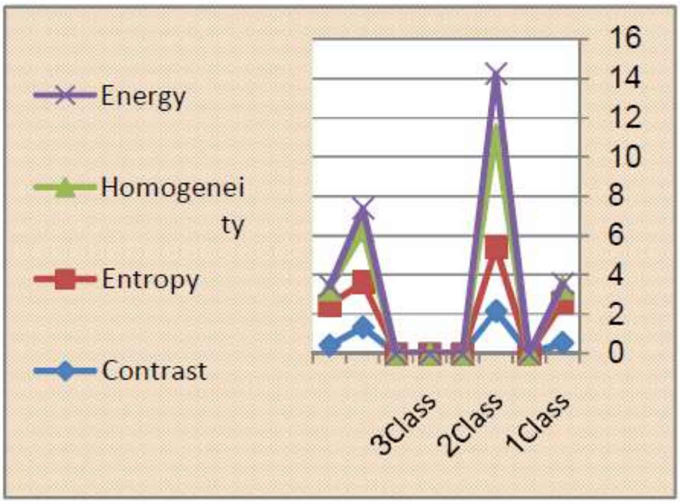


Fig 3: Classified Relation between TEST IMAGE and three classes.

5. Conclusions and Suggestion Work

In this paper, MRI medical image types will be classified based on its texture features. The TFE method has been used to extract the features values using statistical technique called as GLCM. One of the ways to do that image classification by comparing input test medical image features entry with three classes features saved in database, so the class has minimum distance value is the class that test image entry related it. The experimental results shows ability of proposed method to achieve high accuracy degree in medical image classification From For more features, we suggest uses color information to classified images with texture features, it possible to merge the texture features with color information for new classification method, and can used our method for other types of images.

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