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Kidney Texture Classification Using Local Binary Pattern and Geometrical Features

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Abstract: *A novel method of the texture classification of CT Images kidney and diagnosis is presented in this paper, the early detection and the textural classification using high-order local pattern descriptor is proposed .The local derivative pattern (LDP) is used to encode method pattern features which based on local derivative variations. The nth order LDP is suggest to encoding the (n-1) th order local derivative direction variations, it can take more details information. The local texture information for a given pixel and its neighborhood is characterized through the texture units which calculated in different methods. This paper uses the first, second and third order LDPs to classify the textures beside the geometrical features which is are the area, the perimeter and irregularity.*

Keywords: *Local Derivative Pattern, Local Binary Pattern, Texture classification, CT Images, Kidney stones, Geometrical features.*

I. Introduction

Medical imaging techniques produce images including a lot of information about the anatomical construction being inspected, valuable for making correct diagnoses, selecting the most adequate treatment, scanning development of the treatment and so on. The analysis of medical images has always been complete visually by physicians, but in the last two decades, a strong stimulus has been given to develop automated systems able helping physicians in this task, fundamentally because they have the desire of quantizing a number of anatomical and functional parameters, helpful for diagnosis and treatment, which can be estimated only qualitatively by human beings [1].The medical research has been perfectly receptive of image processing in enforcement like CT scan. The result of this technique, an image of the Patient's body, gives the physician to examine and diagnose without the need of surgery [2]. Early detection and right treatment based on exact diagnosis are important steps to improve disease result. The research, aim to diagnosis kidney stones from CT images using Digital image processing. The suggested local binary pattern (LBP) features for texture description based on the LBP features is that a texture can be seen as a formation of small patterns. LBP represents the first-order circular derivative pattern of images, however, the first-order pattern fails to extract more detailed information included in the input object. The best way is the high-order operator which can take more detailed, special information can appear in the high order Local Derivative Pattern (LDP). LBP can theoretically consider as a non-directional first order local pattern, which is the binary result of the first order derivative image. The second order LDP can take the change of derivative directions among local neighbors, and encode the turning point in a given direction. The paper computes the texture unit (TU) and texture spectrum by using second, and third order LDPs.

II. Methodology

The texture analysis in a local neighborhood, is defined as a grayscale fixed texture measure and is the best model of texture images. The LBP operator signs the pixels of an image by thresholding the (3× 3) neighborhood using 3× 3 window for each of each pixel with the value of the central pixel and series the results binomially to form a number [3][4]. The LBP can be formally represented in Fig. 1(a) and it is represented in equation 1.

$$E_i = \begin{Bmatrix} 0 & if & V_i < V_0 \\ 1 & if & V_i \geq V_0 \end{Bmatrix} \quad for\ i = 1,2,\dots\dots 8 \dots\dots (1)$$

When Ei, i=1,2...8 , is an 8-neighborhood point around E0 as shown in Figure. 1. Figure. 1(b) shows an example of obtaining an LBP. The resultant LBP for this is 101001111.

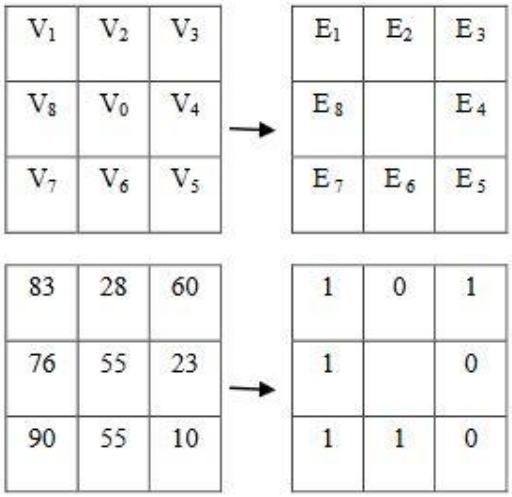

Fig. 1 (a) LBP representation (b) Example of obtaining the LBP.

III. Local Derivate Pattern (Ldp)

Given an image I(V), the first-order derivatives along 0, 45, 90 and 135 directions are denoted as I'α(V) when α=0, 45, 90 and 135. Let V0 be a point in I(V), and Vi, i=1,...8 be the neighboring point around V0(see Fig. 1(a). The four first-order derivatives at V=V0 are given in equations 2, 3, 4 and 5 for 0, 45, 90 and 135 respectively [2].

$$I'_{0^0}(V_0) = I(V_0) - I(V_4) \quad (2)$$

$$I'_{45^0}(V_0) = I(V_0) - I(V_3) \quad (3)$$

$$I'_{90^0}(V_0) = I(V_0) - I(V_2) \quad (4)$$

$$I'_{135^0}(V_0) = I(V_0) - I(V_1) \quad (5)$$

The second-order directional LDP, LDP_α^2 (V_0) in α direction at V=V0 is defined as:

$$LDP_\alpha^2(V_0) = \{f(I'_\alpha(V_0), I'_\alpha(V_1)), f(I'_\alpha(V_0), I'_\alpha(V_2)), \ldots f(I'_\alpha(V_0), I'_\alpha(V_7)), f(I'_\alpha(V_0), I'_\alpha(V_8))\} \quad (6)$$

Where f (.,.) is a binary coding function determining the types of local pattern transitions:

$$f(I'_\alpha(V_0), I'_\alpha(V_i)) = \begin{cases} 0 & if \quad I'_\alpha(V_i) I'_\alpha(V_0) > 0 \\ 1 & if \quad I'_\alpha(V_i) I'_\alpha(V_0) \le 0 \end{cases} \quad i = 1,2,\ldots 8 \quad (7)$$

Finally, the second-order Local Derivative Pattern, □ V LDP2, is defined as the concatenation of the four 8-bit directional LDPs as given in equation 8

$$LDP^2(V) = \{LDP_\alpha^2(V) \mid \alpha = 0^0, 45^0, 90^0, 135^0\} \quad (8)$$

To calculate the third-order Local Derivative Pattern, firstly compute the second-order derivatives along 0, 45, 90 and 135 directions, denoted as I"α (V) when α=0, 45, 90, 135. The third-order Local Derivative Pattern, LDP_α^3 (V_0), in α direction at V=V0 is defined as:

$$LDP_\alpha^3(V_0) = \{f(I''_\alpha(V_0), I''_\alpha(V_1)), f(I''_\alpha(V_0), I''_\alpha(V_2)), \ldots f(I''_\alpha(V_0), I''_\alpha(V_7)), f(I''_\alpha(V_0), I''_\alpha(V_8))\} \quad (9)$$

IV. The Local Binary Patterns (Lbp) For The Kidney Stones Images

Textures are described and classified by using Local Binary Pattern this can be shown in Fig. (2)

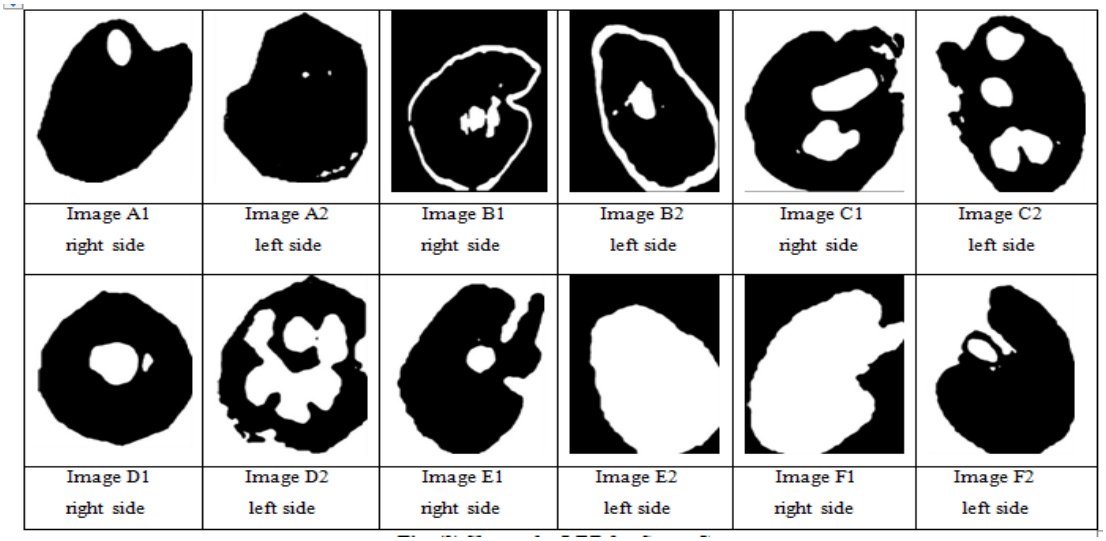

Fig. (2) Shows the LBP for Stone Cases.

V. Geometrical Features

Geometrical features like area, diameter, perimeter, and irregularity index have been estimated from the separated kidney nodules. The number of pixels having the values (1) in the image array gives the area of the segmented stone image. The value (0) gives the background of the image which is black. For this analysis, the irregularities in the stone are computed by [5].

$$I = \frac{4\pi A}{P^2} \quad \dots\dots\dots\dots\dots\dots\dots (10)$$

When, p is the perimeter of the tumor and A is the area of the tumor in pixels. The irregularity index is equal to 1 only for circle and it is < 1 for any other shape .Area of the segmented stone is computed by counting, the number of pixels which have the value 1 in the image array. For computing area, binary image is used [5].

$$\mathbf{A} = \sum white\ pixel\ in\ the\ image \quad \dots\dots\dots\dots\dots\dots\dots (11)$$

Table (1-a, b) represented the value of the Area and the Perimeter for the stones right and left of the kidney. Fig. (3) and Fig. (4) shows the graph of the Irregularity value for both side of kidney.

Table (1-a) shows the value of the Area, Perimeter and Irregularity Index of stones right kidney.

Image No.	Area (A) in pixels	Perimeter (P) in pixel	Irregularity Index (I)
1	9684	9882	0.0012455315
2	10818	9699	0.0014443841
3	30075	14061	0.0019105696
4	3357	5088	0.0016287213
5	4365	12222	0.0003670197
6	\	\	\

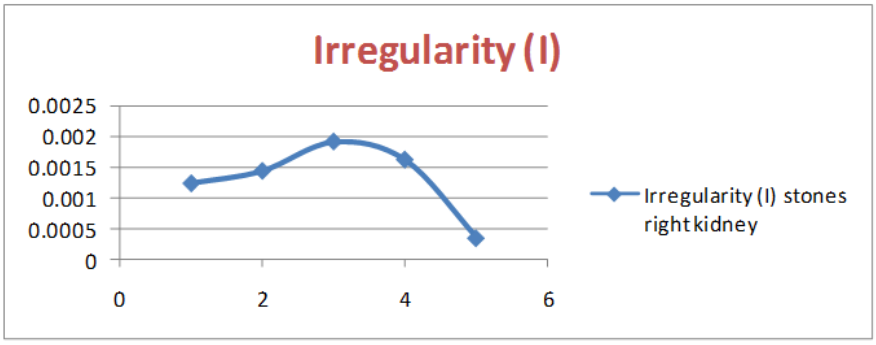

Fig. (3) Shows the graph of the Irregularity for Stone right kidney in table (1-a).

Table (1-b) shows the value of the Area, Perimeter and Irregularity Index of

stones lift kidney.

Image No.	Area (A) in pixels	Perimeter (P) in pixel	Irregularity Index (I)
1	20712	10221	0.0024901465
2	1197	8724	0.0001975388
3	19731	11628	0.001832857
4	7068	12291	0.0005876405
5	\	\	\
6	12882	5667	0.0050380968

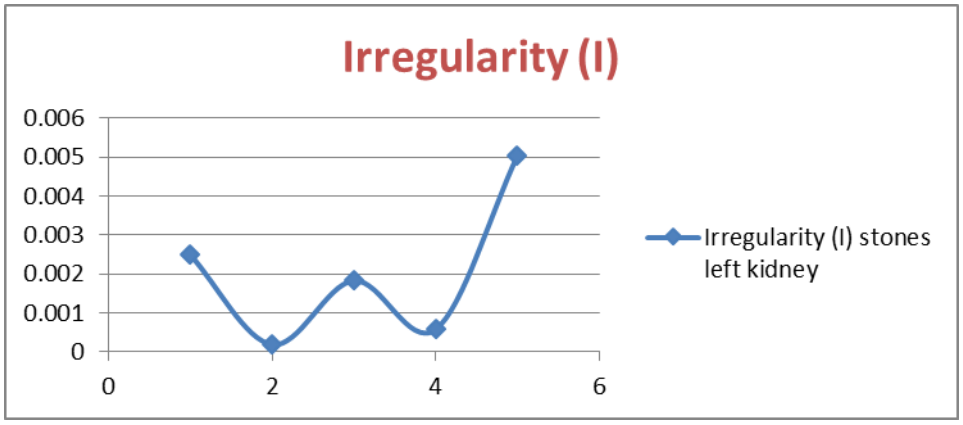

Fig. (4) Shows the graph of the Irregularity for stone right kidney in table (1-b)

VI. Conclusions

This paper proposed a new method of texture classification using high order local patterns: Local Derivative Patterns (LDP). The second, third order LDP in the four directions i.e. 0, 45, 90 and 135 are calculated from which texture spectrum is obtained. The LDP extract high order local information by encoding various distinctive spatial relationships contained in a given local region. The study presented. The geometrical parameters which are perimeter, diameter and area have been calculated in order to obtain irregularity of stone. This system can be applied to detect stone like growth much before they are visible to the human eye. The Irregularity value gives indication about the shape and the area of the stone which help the physician to treated the patient in a good way, the value of irregularity is very small this means it shape is different from one case to another and it far away from the circle shape also the area gives information about the largeness of the stone shape.

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