DOI: 10.24996/ijs.2023.64.5.14

ISSN: 0067-2904

Mask Laws to study Texture Features of the Kidney Infection

Enass Hammadi Hassan[1]*, Alyaa Hussein Ali[2], Russul Mohammad Shehab[3], Mohammed Salih Mahdi[4], Walaa Ahmad Abd Alrida[5]

[1]*Department of Radiology & Sonar Techniques., AL-Esraa University College, Baghdad, Iraq*
[2]*Department of Physics, College of the Science for women, University of Baghdad, Baghdad, Iraq*
[3]*Department of Radiology & Sonar Techniques, AL-Esraa University College, Baghdad, Iraq*
[4]*BIT Dept. Business Information College, University of Information Technology and Communication, Baghdad, Iraq*
[5]*Department of Prothodontics Techniques., AL-Esraa University College, Baghdad, Iraq*

Received: 27/2/2022 Accepted: 5/9/2022 Published: 30/5/2023

Abstract

This paper aims to early study of detection and diagnosis of kidney tumors and kidney stones using Computed Tomography Scanning CT scan images by digital image processing. Computerized Axial Tomography (CAT) is a special medical imaging technique that provides images with 3D, including much information about the body's construction consisting of bones and organs. A C.T scan uses X-rays to create cross-sectional images of the body and gives the doctor a full explanation of the diagnosis of the situation through the examination. It has been used in five cases of kidney images, including healthy, stones, tumors (cancer), cystic and renal fibrosis. The masking procedure is used to separate the required C.T. images from undesirable ones. The segmentation processes which was used in this study is a thresholding algorithm, applied on C.T. images, used to detect unhealthy tissues (tumor and stone). The results showed that the system is able to distinguish between different tumors of the kidney of cases mentioned above. It's important for the instructor to determine the area of the tumor and stone to avoid damaging the healthy tissue during the treatment. The histogram which was used to study the differences between the healthy and unhealthy depending on the intensity of the image

.

Keywords: Computed Tomography (C.T.), histogram, statistical features, threshold, a binary mask.

لدراسة خصائص النسيج لامراض الكلى *Law's mask* استخدام مصفوفة

ايناس حمادي حسن[1]*, علياء حسين علي[2], رسل محمد شهاب[3], محمد صالح مهدي[4], ولاء احمد عبد الرضا[5]

[1]قسم تقنيات الاشعة والسونار , كلية الاسراء الجامعة, بغداد, العراق

[2]قسم الفيزياء , كلية العلوم للبنات, جامعة بغداد, بغداد, العراق

[3]قسم تقنيات الاشعة والسونار , كلية الاسراء الجامعة, بغداد, العراق

[4]قسم تكنولوجيا معلومات الاعمال ,لكلية معلوماتية الاعمال, جامعة تكنلوجيا المعلومات والاتصالات, بغداد, العراق

[5]قسم صناعة الاسنان, كلية الاسراء الجامعة, بغداد, العراق

*Email: enasshammadi@gmail.com

الخلاصة

تهدف الورقة البحثية الى الكشف المبكر والتشخيص الاولي لاورام وحصى الكلى من خلال الصور الطبية المقطعية المحوسبة من خلال برمجيات الحاسبة باستخدام تقنيات معالجة الصور الرقمية. الاشعة المقطعية هي تقنية الصور الطبية خاصة تجهز صور ثلاثية الابعاد تتضمن وتوفر الكثير من المعلومات عن بنية الجسم المتكون من عظام واعضاء داخلية. الاشعة المقطعية تستخدم الاشعة السينية لتكوين الصورة المقطعية الماخوذة للجسم. الاشعة المقطعية الماخوذة لجسم المريض تعطي للطبيب المختص التصور الكامل في تشخيص الحالة من خلال الفحص, في هذه الورقة البحثية تم استخدام خمس حالات من الصور الطبية للكلى تتضمن الحالة السليمة, الحصى, الاورام, التكيس, والتليف. يتم عملية فصل الكلى من باقي اجزاء اعضاء الجسم الظاهرة في الصورة بواسطة برنامج خاص يدعى بال Mask, Region of Interest ROI منطقة الدراسة او المنطقة المهمة للدراسة في الصورة بفصل الكلى من بقية الاجزاء ال Mask مهم جدا يستخدم لفصل الاجزاء الغير مرغوب بها في الصورة المقطعية. بعد ذلك يتم استخدام طريقة التقطيع باستخدام خوارزمية Thresholding التي تطبق على الصور المقطعية بعد ماتم فصل الكلى من باقي الاجزاء لتحديد الانسجة الغير سليمة سواء كانت حصى او اورام ومن ثم يتم استخدام مصفوفة Law s mask لحساب خصائص النسيج للحالات السليمة والغير سليمة للكلى. النتائج المستحصلة من خلال استخدام برامج المعالجة الصورية اظهرت ان هذا النظام قادر على التمييز وتحديد مختلف الاورام التي تصيب الكلى المذكوره اعلاه. من المهم الكشف المبكر عن الاورام هو تحديد الاجزاء المتضررة جراء الورم او الحصى ومقدار ضغط الورم على الانسجة السليمة لتجنب ضرر النسيج السليم من التلف جراء التعرض للاشعاع على مناطق الورم خلال مرحلة العلاج. يتم عمل رسم بياني لصورة الكلى الغرض من الرسم البياني لدراسة وبيان الاختلاف مابين الاجزاء السليمة والاجزاء المصابة في الصورة اعتمادا على الشدة وبيان طاقة الاجزاء في الصورة.

1. Introduction

The techniques of medical imaging produce images that contain much information about the anatomical structure, which may be used to make accurate diagnoses, choose the best treatment, and track the treatment's progress [1]. Appropriate treatment and early detection depend on a precise diagnosis which is critical stage in improving disease outcomes. The aim of the study is to use digital image processing to diagnose kidney stones and tumors from C.T. images. The procedure started by describing the use of computed tomography (C.T. scan) techniques, kidney anatomy, kidney disease, and classification of kidney tumor [2]. The next by separating the kidney from the selected C.T. images as they contain another organic part than the kidney. A binary mask has been created to crop the kidney image from the other images. As the kidney is selected and separated, the processing is applied to the kidney images. The simplest and earliest way of segmentation is the threshold method. This method has been applied to these images. When the tumor has been separated from the kidney, a texture feature is calculated from the law's mask texture feature properties. Using histogram processing. The histogram of a digital image is considered as the number of image pixels at a specific intensity level [3]. The shape of a gray-level histogram gives an indication about the general appearance of an image. For black areas, the elements of the histogram are concentrated on the low side of the intensity scale; while for light and white areas, these elements of the histogram are concentrated on the high side and sharper in the scale [3].

1.1 Methodology

1.2 Image Segmentation:

Image segmentation can be defined as one of the most effective image processing techniques. It can be benefited by dividing the main image into various sections, And might be utilized as a pre-processing phase before moving on to another method of image processing. Image segmentation techniques which are used for image processing can be done in a variety of approaches [4]. Segmentation algorithms depend on important properties of intensity values cutout and similarity. The first stage is to divide an image, depending on sudden changes in intensity such as edges, into regions that are the same according to referred-in advance criteria. Histogram threshold falls under this category [4].

1.3 Thresholding Method:

Thresholding is considered as an approach used for segmenting gray levels images in which a gray-scale image is converted to a binary one by selecting a gray level T in the main image and after that converting each one of the pixels white or black based on if its gray value is less than or greater than T [5]. Furthermore, it is an active method of image segmentation that focuses on separating objects from their background [5]:

$$f\,(x, y) = \begin{cases} 1 \text{ if } f(x,y) > T \\ 0 \text{ if } f(x,y) \leq T \end{cases} \quad (1)$$

Where T represents the threshold value. X and y are the coordinates of the threshold value point.
f (x, y) represents the intensity value of the pixel at (x, y) [6].

Background pixels were black, whereas foreground pixels were white (or vice versa). In simple applications, segmentation is restricted by a single parameter known as the intensity threshold. This threshold is applied to each one of the image pixels. In the case when the pixel's intensity value exceeds the threshold, the pixel is assigned to white in the output. It gets grouped to black if it is less than the threshold [6].

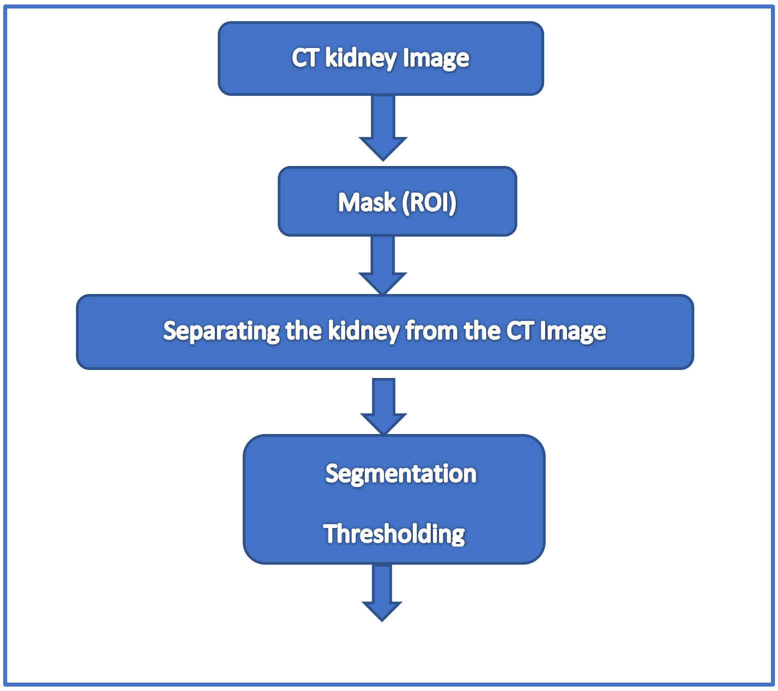


Figure 1: a diagram represented the image segmentation and classification.

The tests CT Kidney images taken from "Digestive system diseases hospital" from Baghdad\ Iraq[7]. CT Images of kidney cancer and stones [7], which are used in the search are shown in the following Figures:

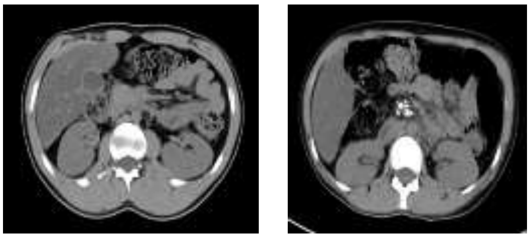


Image No.1, born in (1993) Image No.2, born in (1995

Figure 2: shows the C.T. kidney image healthy case [8].

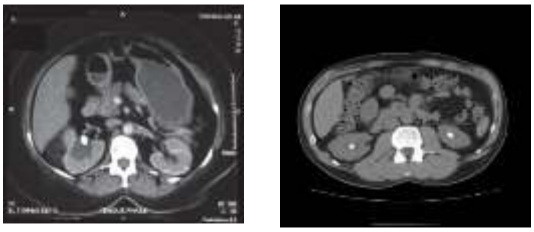


Image No.3 Image No.4

Figure 3: shows the C.T. kidney images stones case [8]

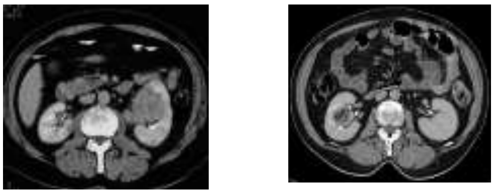


Image No.5 ImageNo.6

Figure 4: shows the C.T. kidney images cancer case [8].

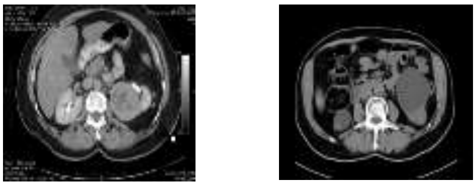


Image No.7 mage No.8, born in (1940)

Figure 5: shows the C.T. kidney images cyst case [8].

Image No.9 Image No.10

Figure 6: shows the C.T. kidney images failure (Fibrosis) case [8].

2. Results and Discussion

2.1 Segmentation: The technique of segmenting an image into distinct parts to extract structures or objects of interest from the background is known as segmentation. Segmenting a kidney C.T. scan separates the vital information from the background. Thresholding is specified as the first known segmentation method.

2.2 Thresholding: It is the simplest and easiest method of segmentation shows the image kidney for all cases, including healthy, stones, tumors (cancer), cystic, and renal fibrosis. The result of thresholding is shown in Figures (6), (7), (8), and (9). These Figures separated the stones and the tumors from the background depending on the selected threshold (T) representing the thresholding value.

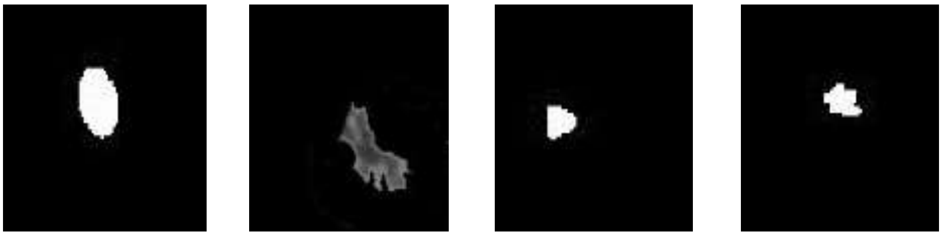


Image 3(C1) right side (T) < 200	Image 3(C2) left side (T) > 130	Image 4(D1) right side (T) < 150	Image 4(D2) left side (T) < 150

Figure 7: the stones thresholding images with value (T).\

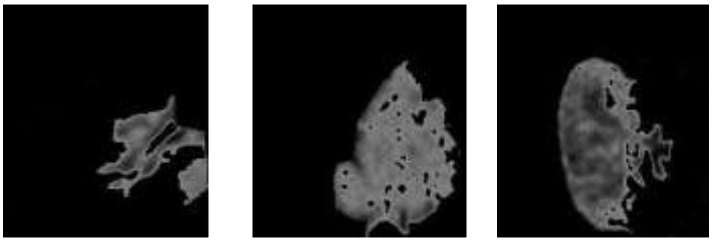


Image 5(I1) right side (T) > 130	Image 5(I2) left side (T) > 130	Image 6(J2) left side (T) > 130

Figure 8: the cancer thresholding images with value (T).

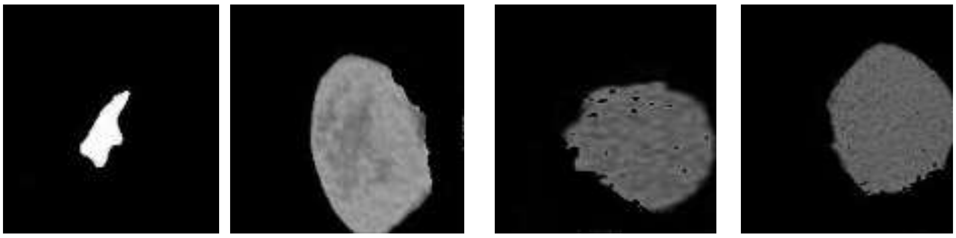


Image 7(O1) right side (T) < 230	Image 7(O2) left side (T) > 170	Image 8(P1) right side (T) > 115	Image 8(P2) left side (T) > 115

Figure 9: the cyst thresholding images with value (T).

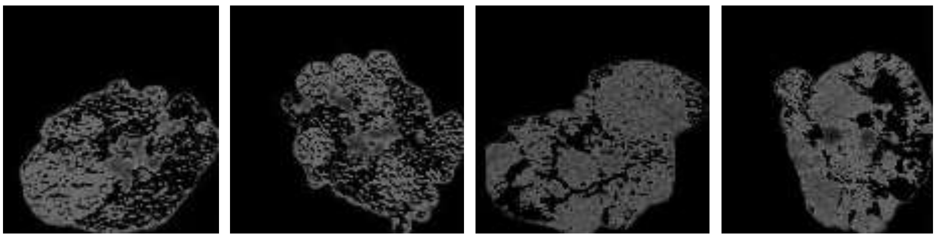


Image 9(S1) right side (T) > 120	Image 9(S2) left side (T) > 120	Image 10(T1) right side (T) > 100	Image 10(T2) left side (T) > 110

Figure 10: the fibrosis thresholding images with value (T).

2.3 Law's Masks Texture Feature Extraction: Five masks were used to analyze the texture features. Each mask is convolved with the test images to extract some statistical features: entropy, mean, mean-square, and energy. Law's select the following properties its plays an important role in describing texture: uniformity, density, coarseness, roughness, regularity, linearity, directionality, direction, frequency, and phase [9]. Texture energy measures by law′s mask method determine texture properties through rate calculation Gray Level, Edges, Spots, Ripples and Waves in texture [10]. The measures are derived from three simple vectors. L3= (1,2,3) which represents averaging; E3 = (-1,0,1) calculating first difference (edges); and S3 = (-1,2,-1) corresponding to the second difference (spots). After convolution of these vectors with themselves and each other, five vectors result [10]:

$$\text{Level } L_5 = [1, 4, 6, 4, 1] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$
$$\text{Edge } E_5 = [-1, -2, 0, 2, 1] \quad \ldots\ldots\ldots\ldots\ldots\ldots(2)$$
$$\text{Spots } S_5 = [-1, 0, 2, 0, -1] \quad \ldots\ldots\ldots\ldots\ldots\ldots(3)$$
$$\text{Ripples } R_5 = [1, -4, 6, -4, 1] \quad \ldots\ldots\ldots\ldots\ldots(4)$$
$$\text{Waves } W_5 = [-1, 2, 0, -2, -1] \quad \ldots\ldots\ldots\ldots(5)$$

Mutual Multiplying of these vectors, considering the first term as a column vector and the second term as row vector, results in 5 X 5 Matrix known as Law’s Masks [11].
\

By convoluting the Law’s Mask with Texture image and calculating energy statistics, a feature vector is derived that can be used for texture description.

$$L_5 * L_5 = \begin{bmatrix} 1 & 4 & 6 & 4 & 1 \\ 4 & 16 & 24 & 16 & 4 \\ 6 & 24 & 36 & 24 & 6 \\ 4 & 16 & 24 & 16 & 4 \\ 1 & 4 & 6 & 4 & 1 \end{bmatrix} \qquad E_5 * E_5 = \begin{bmatrix} 1 & 2 & 0 & -2 & -1 \\ 2 & 4 & 0 & -2 & -1 \\ 0 & 0 & 0 & 0 & 0 \\ -2 & -4 & 0 & 4 & 2 \\ -1 & -2 & 0 & 2 & 1 \end{bmatrix}$$

$$S_5 * S_5 = \begin{bmatrix} 1 & 0 & -2 & 0 & -1 \\ 0 & 0 & 0 & 0 & 0 \\ -2 & 0 & 4 & 0 & 2 \\ 0 & 0 & 0 & 0 & 0 \\ -1 & 0 & 2 & 0 & 1 \end{bmatrix} \qquad R_5 * R_5 = \begin{bmatrix} 1 & -4 & 6 & -4 & 1 \\ -4 & 16 & -24 & 16 & -4 \\ 6 & -24 & 36 & -24 & 6 \\ -4 & 16 & -24 & 16 & -4 \\ 1 & -4 & 6 & -24 & 1 \end{bmatrix}$$

$$W_5 * W_5 = \begin{bmatrix} 1 & -2 & 0 & 2 & 1 \\ -2 & 4 & 0 & -4 & -2 \\ 0 & 0 & 0 & 0 & 0 \\ 2 & -4 & 0 & 4 & 2 \\ 1 & -2 & 0 & 2 & 1 \end{bmatrix}$$

$$Average = \begin{bmatrix} 1 & 0 & 2 & 4 & 0.2 \\ 0 & 8 & 0 & 5.2 & -0.6 \\ 2 & 0 & 15.2 & 0 & 2.8 \\ 0 & 4.8 & 0 & 8 & 0.8 \\ 0.2 & -0.8 & 2.8 & 0.8 & 1 \end{bmatrix}$$

The average value of these matrices gives one matrix which convolved with the kidney CT [11].

Tables (1), (2), (3), (4), (5) represents the statistical features; the mean represented the average value of the pixel's intensities. If the mean value is high for a certain kidney than the others, it means this one is brighter than the other. The energy shows the distribution at the gray level; when the energy has a maximum value of (1), this means that the image is with a constant value of gray level, when mean value is small, that mean the pixel values have more distribution of gray level[12]. when the energy is high compared with the other kidney images means the numbers of gray level in the image is few, and the image has a few defects in its texture. The Entropy increases when the image's pixel values are distributed among more gray levels [13]. The Mean Square represented the square of the mean, which may be considered as the law's texture energy[13]. Pixels adjacent to the effected part are based on three statistical descriptors which are (absolute mean, mean, and standard deviation). These descriptors are computed as follows [14] :

$$\text{Mean}=\frac{\sum_{W} neighbouring\ pixels}{W} \quad (6)$$

$$\text{Absolute mean}=\frac{\sum_{W} abs(neighbouring\ pixels)}{W} \quad (7)$$

$$\text{Standard deviation}=\sqrt{\frac{\sum_{W}(neighbouring\ pixels-mean)^2}{W}} \quad (8)$$

Where W denotes the size of the window. Three images represent each of the statistical descriptors due to the operation. All of the collected images are normalized after the windowing procedure for showing an image. Following that, three statistics were evaluated for each one of the normalized images: mean square or energy (M.S.), absolute Mean (ABSM), and entropy, as follows [15]:

$$\text{ABSM}=\frac{1}{MN}\sum_{x=1}^{M}\sum_{y=1}^{N}|f(x.y)| \quad (9)$$

$$\text{MS}=\frac{1}{MN}\sum_{x=1}^{M}\sum_{y=1}^{N}f^2(x.y) \quad (10)$$

$$\text{Entropy}=\frac{1}{MN}\sum_{x=1}^{M}\sum_{y=1}^{N}f(x.y)(-log_2 f(x.y)) \quad (11)$$

Where f (x, y) represents the pixel value, and M and N are the image dimensions [15].

Table 1: displays the value of statistical features of law's mask for healthy cases:

Class No.	Mean	Entropy	Mean-square	Energy
A1right kidney	0.2168	1.2403	6.4850	1.7226
A2 left kidney	0.2167	1.2329	1.1921	5.8208
B1 right kidney	0.1189	9.0046	2.9564	3.5800
B2 left kidney	0.1542	7.4284	2.0981	1.8030

Table 2: shows the value of statistical features of law's mask for stones cases:

Class No.	Mean	Entropy	Mean-square	Energy
C1 right kidney	0.1311	7.4284	2.0981	1.8030
C2 left kidney	0.1118	1.2957	9.0599	3.3621
D1 right kidney	0.2161	7.6294	9.5367	3.7253
D2 left kidney	0.2167	1.8354	2.8610	3.3528

Table 3: shows the value of statistical features of law's mask for cancer cases:

Class No.	Mean	Entropy	Mean-square	Energy
I1 right kidney	0.2188	7.6294	9.5367	3.7253
I2 left kidney	0.2181	1.3351	1.9073	1.4901
J1 right kidney	0.2447	1.1562	5.1498	1.0863
J2 left kidney	0.1116	7.6254	2.1935	1.9707

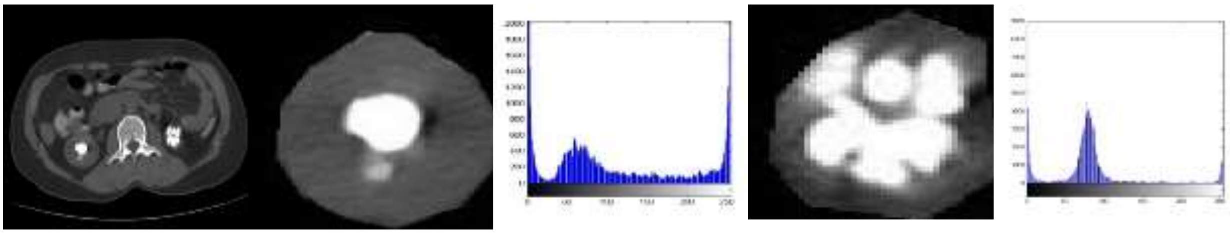
Table 4: shows the value of statistical features of law's mask for cysts cases:

Class No.	Mean	Entropy	Mean-square	Energy
O1right kidney	0.1329	6.1134	1.0881	2.8730
O2 left kidney	0.1384	7.4284	2.0981	1.8050
P1 right kidney	0.1266	9.2438	1.6594	1.1279
P2 left kidney	0.2524	1.2357	6.3896	1.6723

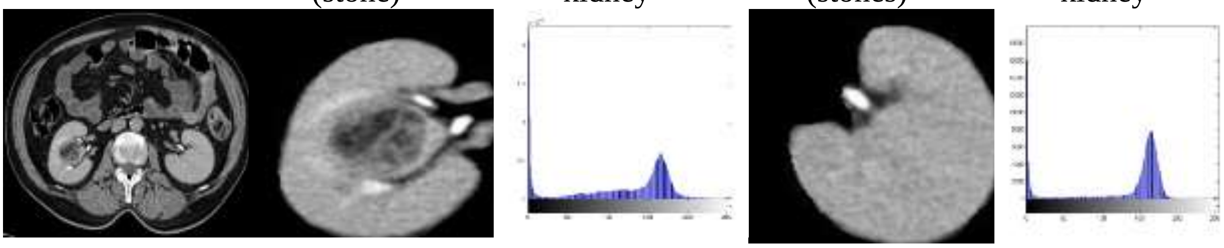
Table 5: shows the value of statistical features of law's mask for the fibrosis cases:

Class No.	Mean	Entropy	Mean-square	Energy
S1right kidney	0.1738	7.2252	2.0027	1.6429
S2 left kidney	0.1362	7.4284	2.0981	1.8030
T1 right kidney	0.3449	8.2403	6.4850	1.1236
T2 left kidney	0.3161	8.3643	6.7740	1.2226

2.4 Histogram Processing: The histogram of a digital image is a number of image pixels at a certain intensity level. In an image processing context the histogram of an image normally refers to intensity levels. These effects are likely to decrease as the number of pixcels and intensity quantization are increased [16]. Histograms form the basis for many spatial domain processing techniques. Its treatment can be used for image enhancement. The shape of a gray-level histogram indicates the general appearance of an image[17]. For dark images, the histogram elements are concentrated on the low (dark) side of the intensity scale, while for light images, these elements of the histogram are concentrated on the high side of the scale [17]. A low-contrast image has a narrow histogram typically in the middle of the intensity scale. In the high-contrast image, the histogram has a wide range of intensity scales, and the distribution of pixels extends along the scale, with very few vertical lines [18], As shown in figure 11 [18].



Original image | Right kidney (stone) | Histogram right kidney | Left kidney (stones) | Histogram lift kidney



Original image | Right kidney (cancer) | Histogram right kidney | Left kidney (stone) | Histogram lift kidney

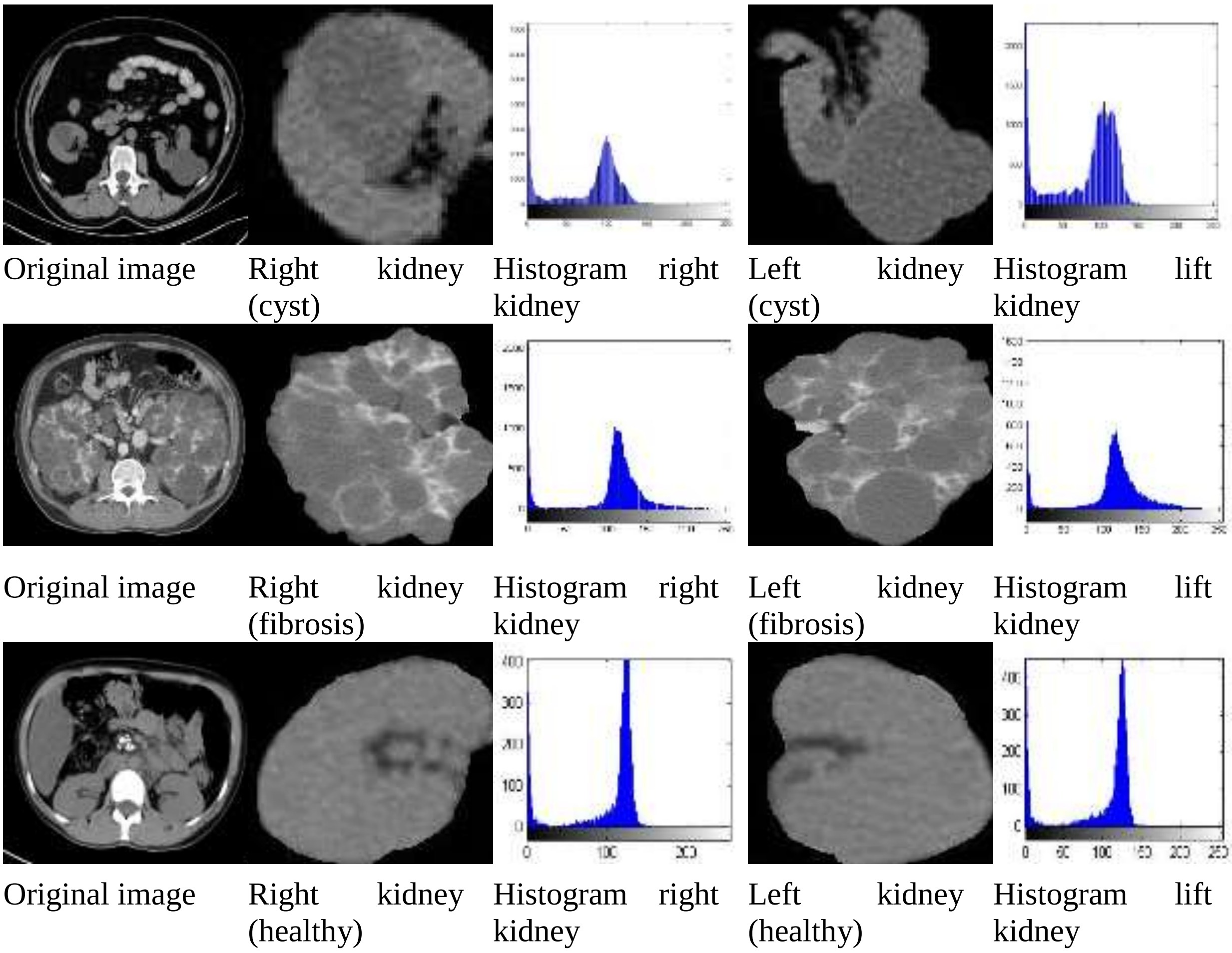


Figure 11: the histogram of the original image, healthy and unhealthy kidney.

3. CONCLUSIONS

The accurate diagnosis of a renal stone and tumors depends on the experience of the radiologist and the quality of the examination tool. Doctors go to multiple techniques in the medical field to detect and locate the kidney tumor; in this research, an automatic technique has been offered for determining the tumor. This approach will allow doctors to identify tumors and stones, facilitating treatment. It will also assist physicians and radiologists in identifying the damaged parts of the kidney for protecting the normal kidney parts as much as possible from radiation exposure. The proposed system might help physicians better diagnose tumors and distinguish exactly tumor size and region for further treatment. Detecting the kidney from the C.T. images is a defect work since the image contains more organic parts than the kidney; creating a binary mask helps give a good presentation of the kidney from the other C.T. Image part. Statistical features are the mean, entropy, energy, and mean-square. The mean represents the average value of the pixel's intensities. If the mean value is high for kidney mean this one is brighter and this means the kidney is healthy. The energy tell us about the distribution at the gray level, when it is small mean's that the pixel values has more distribution of gray level, when the energy is high compare with the other kidney images means the numbers of gray level in the image is few and the image has a few defect in it texture hence unhealthy texture. The entropy increase when the pixel values in the image are distributed among more gray levels hence unhealthy texture and vice versa entropy few that's mean healthy texture or tissue. The Mean Square represented the square of the mean which may be considered as law's texture energy.

REFERENCES

[1] R. Dobrescu, M. Dobrescu, S. Mocanu, and D. Popescu, "Medical images classification for skin cancer diagnosis based on combined texture and fractal analysis," International Journal of Wseas Transaction on Biology and Biomedicine, *" WSEAS Transactions on Biology and Biomedicine* , vol. 7, no. 3, pp. 223-232, 2010

[2] E. Kohilavani, E. Thangaselvi, and O. Revathy, "Analysis and Classification of Ultrasound Kidney Images Using Texture Properties Based on Logical Operators," *International Journal of Engineering and Technology (IJET)*, vol. 2, no. 5, 2012.

[3] Sh. I. Abdulsalam, "Detection and Classification of Stroke Using Textural Analysis on Brain CT Digital Images," M.Sc. Thesis, University of Baghdad, 2015.

[4] A. Kaur, and Aayushi, " Image Segmentation Using Watershed Transform," *International Journal of Soft Computing and Engineering (IJSCE),* vol 4, no. 1, 2014. IISSN: 2231-2307.

[5] A. M. Andrew, "An Introduction to Digital Image Processing with MATLAB". Book, Notes for SCM2511 Image Processing 1. Victoria University of Technology.

[6] Z.K.Huang, and K.W.Chau, "A New Image Thresholding Method Based on Gaussian Mixture Model," *Applied Mathematics and Computation*, vol. 205, no. 2, pp 899-907, 2008.

[7] C.T. Images of kidney cancer and stones. Enters in India | kidney cancer surgery, Health from Trusted Sources: kidney stones.

[8] CT Kidney images taken from "Digestive system diseases hospital" from Baghdad\Iraq.

[9] G. Srinivasan, and G. Shobha, "Statistical Texture Analysis," Proceedings of World Academy of Science, Engineering and Technology, vol. 36, pp 1264-1269, 2008. ISSN 2070-3740.

[10] K.V.Yaduvir .."Enhancement of Images Using Histogram Processing Techniques," *Journal Int. J. Comp*., vol. 2, no. 2, pp 309-313, 2014.

[11] H.S.Gan and T.S.Tan, "Research on Law's Mask Texture Analysis System Reliability," Research Journal of Applied Sciences, Engineering and Technology, vol. 7, no. 19, pp 4002-4007, 2014.

[12] R.A. Azeez, M.K. Abdul-Hussein, M.S. Mahdi, and H.T. ALRikabi, "Design a system for an approved video copyright over cloud based on biometric iris and random walk generator using watermark technique," Periodicals of Engineering and Natural Sciences, vol. 10, no. 1, pp 178-187, 2021.

[13] H. A. Elnemr, "Statistical Analysis of Law's mask Features for Cancer and Water Lung Detection," *IJCSI International journal of Computer Science issues*, vol 10, issue 6, no.2, pp 196-202, 2013

[14] M.S. Mahdi, "Computer aided diagnosis system for breast cancer using ID3 and SVM based on slantlet transform," *QALAAI ZANIST JOURNAL*, vol. 2, no. 2, pp 142-148, 2017.

[15] R.Mahshid, " Implementation Texture Feature Extraction Algorithm on FPGA," A Thesis, Computer Engineering. The Netherlands, 2009.

[16] S.K. Patra and K. J. Raju, "Texture Analysis Using Statistical and Structural Approaches," International Journal of Latest Trends in Engineering and Technology (IJLTET), vol. 3, no. 1, 2013.ISSN: 2278-621X.

[17] F.A.Dawood, "Unsupervised Segmentation of Microscopic White Blood Cells Images Using Histogram Equalization Technique," Iraqi Journal of Science, vol. 49, no. 1, PP. 204-211, 2008.

[18] M.S.Mahdi, Y.M.Abid, A.H.Omran, and G.H.Abdul-Majeed, "A novel aided diagnosis schema for covid 19 using convolution neural network.," *IOP Conference Series: Materials Science and Engineering*, vol. 1051, no. 1, p. 012007, 2021.