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# Removing Structure Noise in Digital Dental Radiography by Local Histogram Algorithm

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***Abstract:*** **The use of digital image processing has gained acceptance in dental diagnostic science. The major limitation of direct digital radiography (D D R) is noise. Noise in digital radiography may result from sources other than variation in projection geometry during exposure. Structure noise consists of all anatomic features other than those of diagnostic interest. Limitations of plain radiographs in detecting early, small bone lesions are also due to the presence of structure noise. This study was undertaken to apply image processing as an attempt to remove structure noise in digital dental radiography by using local histogram algorithm and compare these results by two previous methods such as digital subtraction radiography, derivative of the digital original image. After removing structure noise, the validity of the digitized image in detecting diseases is enhanced.**

***Index Terms:*** **Structure Noise; Digital Dental Radiography; Local Histogram Algorithm; Digital Image Processing; Digital Subtraction Radiography; Derivative Image.**

## I. INTRODUCTION

Using digital image processing has gained acceptance in dental diagnosis science. Noise is the major limitation of direct digital radiography (DDR). In projection geometry during exposure, noise in digital radiography may result from sources other than variation [4-6].

Structure noise consists of all anatomic features other than those of diagnostic interest. Small bone lesions are also due to the absence of structure noise. This study was undertaken to apply image processing as an attempt to remove structure noise in digital dental radiography by using local histogram equalization and median filter.

In the same field, the first related work minimizes structure noise by using digital subtraction radiography method (DSR) [7-10]. In the detection of minute bone, DSR has been shown to provide increased diagnostic accuracy over conventional radiography.

The operation of DSRis a reference radiograph turned into a positive image in the computer. After alignment, contrast and geometric correction, the reference radiograph (background image) is subtracted from a second follow-up radiograph (original image).

The second related work removes structure noise by using derivative of the original image in digital dental radiography essential appliance for the diagnosis of periapical bone lesions. The purpose of computerizing the procedure was to make maximum use of the radiologic features, to objectify detection process, and ultimately to enable bone lesions to be assessed quantitatively. Since periapical bone lesions appear radiographically as dark areas compared with surrounding tissues, an edge detection method was developed to extract the boundaries between anatomy and pathology [11-15].

In this method, to remove structure noise by using local histogram processing, the pixels are modified by transformation function based on the intensity distribution of an entire image. The number of pixels in these areas may have negligible influence on the computation of a global transformation whose shape does not necessarily guarantee the desired local enhancement. The solution is to devise transformation function based on the intensity distribution in a neighborhood of every pixel [16-18].

This paper is organized as follows. Section one is the introduction, section two presents the methodology, section three presents performance evaluation, section four presents results and section fife presents conclusion.

## II. MATERIALS AND METHODS

The histogram processing techniques are easily adapted to local enhancement. The procedure is to define a neighborhood and to move its center from pixel to pixel. At each location, the histogram of the points in the neighborhood is computed and either a histogram equalization or histogram specification transformation function is obtained [1]. This function is then used to map the intensity of the pixel centered in the neighborhood. The center of the neighborhood region is then moved to an adjacent pixel location and the procedure is repeated. Because only one row or column of the neighborhood changes during a pixel - to – pixel translation of the neighborhood, updating the histogram obtained in the previous location with a new data introduced at each motion step is possible.

This approach has obvious advantages over repeatedly computing the histogram of all pixels in the neighborhood region each time the region is moved onepixel location. Another approach used sometimes to reduce computation is to utilize non overlapping regions, but this method usually

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produces undesirable "blocky effect". Median filter is the best known order statistic filter, which, as its name implies, replaces the value of a pixel by the median of the intensity levels in the neighborhood of that pixel,

$$\hat{f}(x,y) = median_{(s,t)\in S_{xy}}\{g(s,t)\} \qquad (1)$$

The value of the pixel at location (x,y) is included in the computation of the median. Median filters are quite popular because, for certain types of random noise, they provide excellent noise - reduction capabilities, with considerably less blurring than linear smoothing filters of similar size. Median filters are particularly effective in the presence of both bipolar and unipolar impulse noise.

## III. THEORIES AND CALCULATIONS

We introduce three experiments to minimize and remove structure noise in digital dental radiography. The first experiment minimizes structure noise by digital subtraction of radiographic images. In this method, the difference between these two images f(x,y) and h(x,y) are expressed as[2,19, 25, 26, 27]:

$$G(x,y) = f(x,y) - h(x,y) \qquad (2)$$

Where f(x,y) is the original image with structure noise, h(x,y) is the background of original image which is a reference image that has a great gray level (bright pixels) produced from original image, g(x,y) is the subtraction image which demonstrates differences between original and background image. Shown in Figs (1- 3).

The equation (1) is obtained by computing the difference between all pairs of corresponding pixels from (f) and (h). The key usefulness of subtraction is the enhancement of differences between images.

One of the most commercially successful and beneficial of image subtraction is in the area of medical imaging called mask mode radiograph. In this case h(x,y), the mask, is an x-ray image of a region of patient's body captured by an intensified TV camera(instead of traditional x-ray film) located opposite an x-ray source. The procedure consists of injecting a contrast medium into the patient's blood stream taking a series of images same anatomical region as h(x,y), and subtracting this mask from the series of incoming images after injection of the

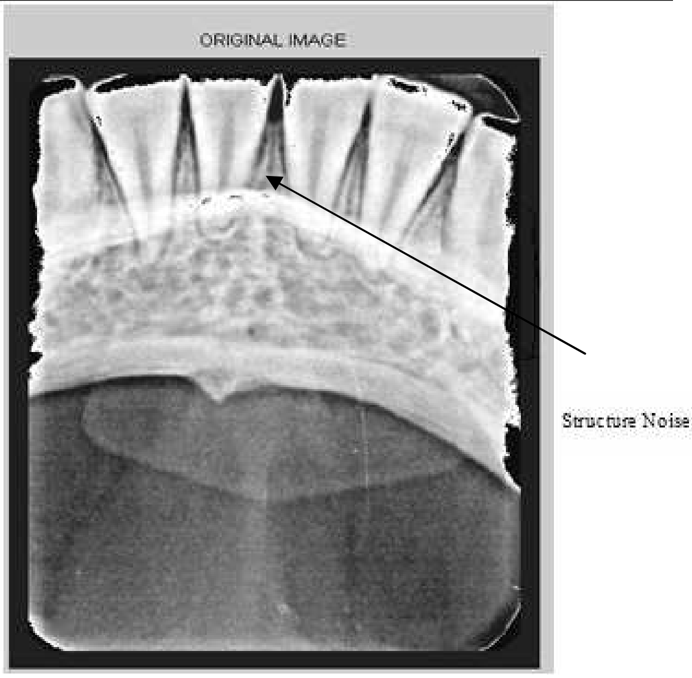


Fig.1. Original image with structure noise


Fig.2. Background of the original image

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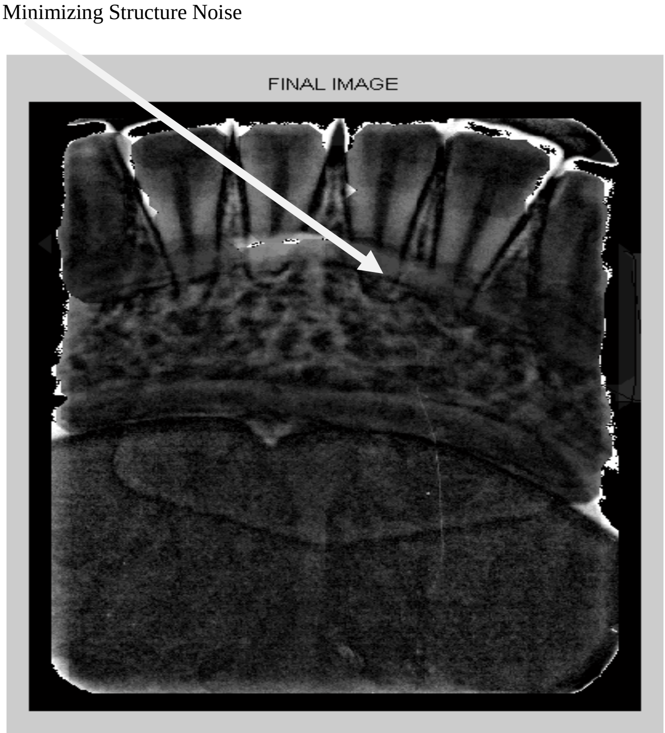


Fig.3. Final image of the original image with minimized structure noise

The second experiment, removes structure noise in digital dental radiography using edge detection derivative. In this method, two assumptions were made [3]:

- A periapical bone lesions was considered dark in relation to its surroundings,
- Outline of a periapical bone lesions was closed contour.

Searching for edges, in this case defined as boundaries between two regions with different mean gray levels. Dealing with smooth changes in gray level, with different kinds of noise superimposed, edge detection was carried out by calculating a derivative function in eight directions. Considering g(i,j) as the original data, the convolution function to calculate a first derivative is given by:

g' (i , j) = max

$$\left[ \left| \sum_{m=0}^{1}\sum_{n=-2m}^{2m} g(i+2n, j-2m-2) - g(i+2n, j+2m+2) \right|, \left| \sum_{m=0}^{1}\sum_{n=-2m}^{2m} \big(g(i-2m-2, j+2n) - g(i+2m+2, j+2n)\big) \right|, \left| \sum_{n=0}^{2}\sum_{m=2-n}^{2} \big(g(i-2n, j-2m) - g(i+2n, j+2m)\big) \right|, \left| \sum_{n=0}^{2}\sum_{m=2-n}^{2} \big(g(i-2n, j+2m) - g(i+2n, j-2m)\big) \right| \right] \quad (3)$$

Where g (i, j) denotes the original image and g' (i, j) the derivative image; i and j are pixel coordinates in a rectangular coordinate system.

This procedure resulted in high values (bright pixels) for regions with great gray level changes, and low values (dark pixels) for more homogeneous regions.Next the picture was segmented into a binary image. The threshold chosen (T) was the mean gray level of the processed image:

$$T = \text{int}\left[ \frac{\sum g'(i, j)}{256^2} + 0.5 \right] \quad (4)$$

Result of this operation was a binary image which showed a pattern roughly resembling the contour of the presumed lesion was not continuous, the operator was required to indicate two points in the bright area, on each of a gap in the lesion contour, after which the gap was closed by finding a path of maximum values between those two points. The derivative of the original image results in high values (bright pixels) for regions with great gray level changes, and low values (dark values) for more homogenous regions as shown in Figs (4, 5).

In the original image, the structure noise region has a great level (bright pixels), after derivative of original image, the bright pixels became dark pixels; therefore the structure noise is removed. In the recognition of objects in images, edge detection is an important problem. A picture is obtained considering of edge points, when the edge detector is applied to an image. Several general operations can be performed on this edge picture such as thinning of edges, tracing edge segment, joining edges, and so on. Performing those operations by given algorithms shows the power of edge detection. An experiment is desired in which rib boundaries are extracted in the chest x-ray photographs.

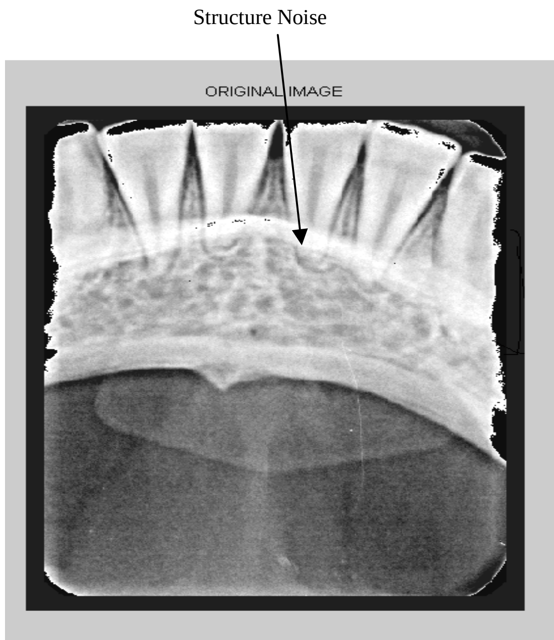


Fig.4. Original image with structure noise

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Removing Structure Noise

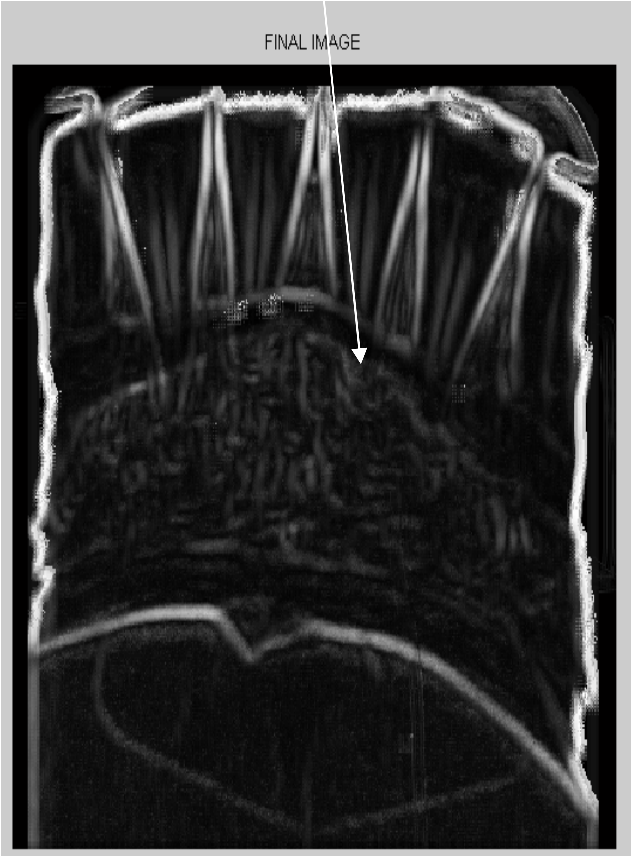


Fig.5. Final image of the original image withremoving structure noise

The third experiment removes structure noise in digital dental radiography by using local histogram algorithm and median filter [1,21]. Statistics obtained directly from an image histogram can be used for image enhancement. Let r denote a discrete random variable representing intensity values in the range [0,L-1], and let P(ri) denote the normalized histogram component corresponding to value ri .As indicated previously, we may view p (ri ) as an estimate of the probability that intensity ri occurs in the image from which the histogram was obtained. The nth moment or r about its mean defined as:

$$\mu_n(r) = \sum_{i=0}^{L-1} (r_i - m)^n p(r_i)$$

(5)

Were m is the mean (average intensity) value of r (i.e., the average intensity of the pixels in the image) :

$$\mu_n(r) = \sum_{i=0}^{L-1} (r_i - m)^n p(r_i) \qquad (6)$$

The second moment is particularly important:

$$\mu_2(r) = \sum_{i=0}^{L-1} (r_i - m)^2 p(r_i) \qquad (7)$$

We recognize this expression as the intensity variance, normally denoted by$\sigma$.

Whereas the mean is a measure of average intensity, the variance (or standard deviation) is a measure of contrast in an image. Observe that all moments are computed easily using the preceding expressions once the histogram has been obtained from a given image. When working with only the mean and variance it is common practice to estimate them directly from the sample values, without computing the histogram. Appropriately, these estimates were called the sample mean and sample variance. There are given by the following familiar expression from basic statistics:

$$m = \frac{1}{MN} \sum_{x=0}^{M-1} \sum_{Y=0}^{N-1} f(x, y) \qquad (8)$$

$$\sigma^2 = \frac{1}{MN} \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} [f(x, y) - m]^2 \qquad (9)$$

For x = 0, 1, 2,….., M-1 and y = 0,1,2,……., N-1.
In other words, as we know, the mean intensity of an image can be obtained simply by summing the values of all its pixels and dividing the sum by the total number of pixels in the image. A similar interpretation applies to the last equation.

Removing Structure Noise

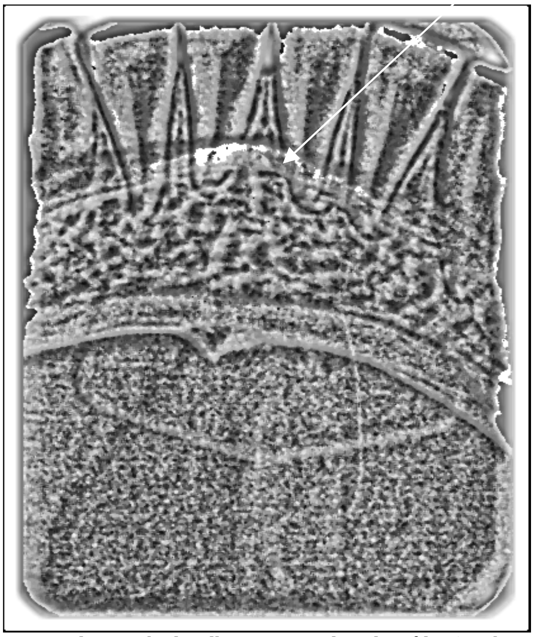

Fig.6. Final image by localhistogram and median filter(mask3x3)

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Removing Structure Noise

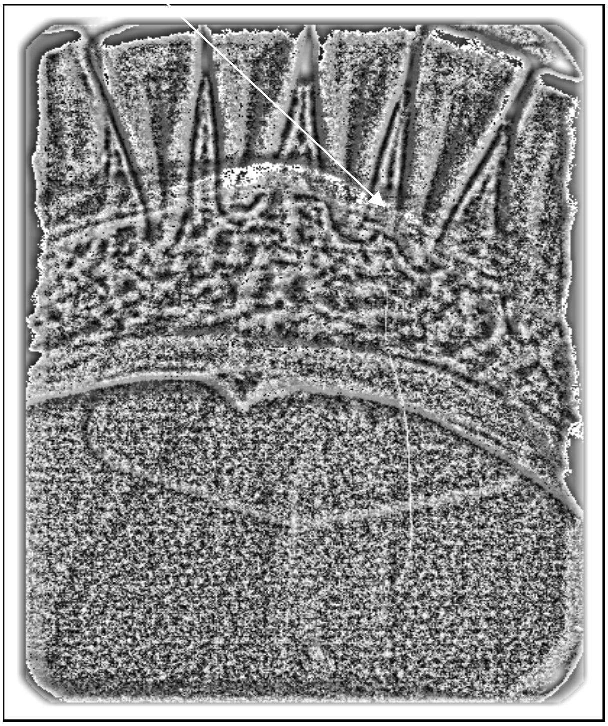

Fig.7. Final image by local histogram (mask3x3)

Removing Structure Noise

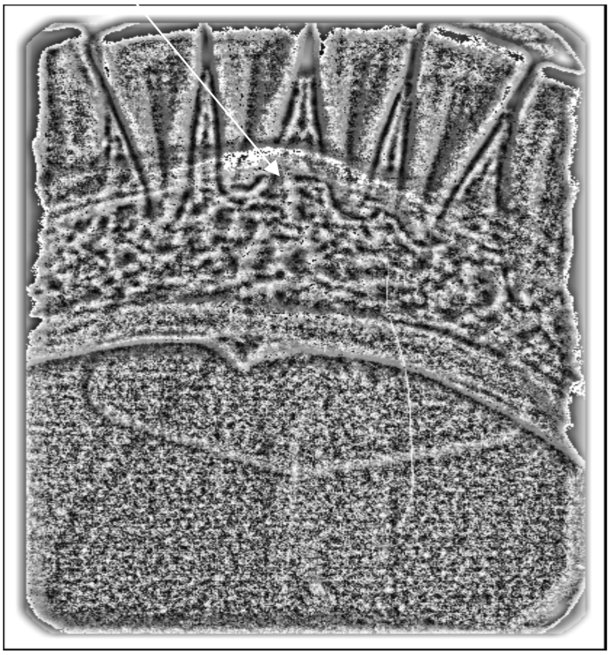

Fig.9. Final image by local histogram (mask5x5)

Removing Structure Noise

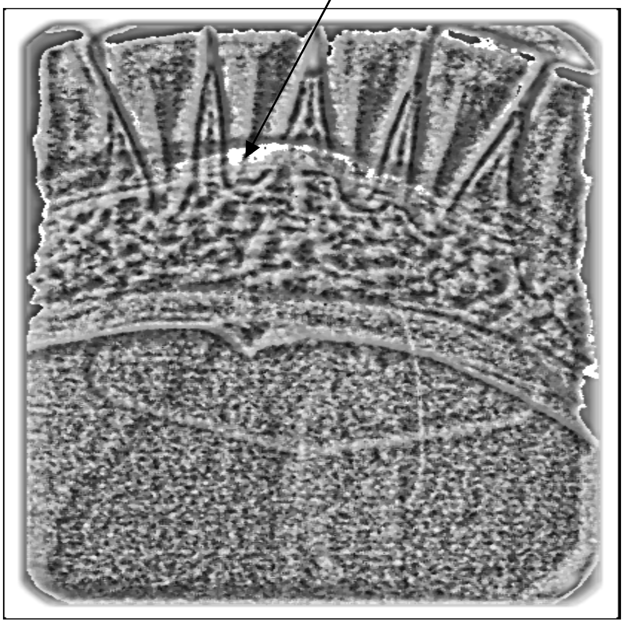

Fig.8. Finalimage by local histogramand medianfilter (mask 5x5)

Removing Structure Noise

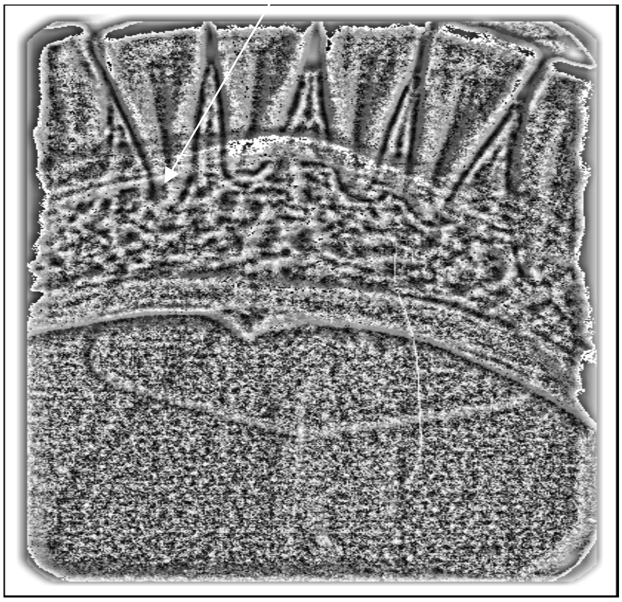

Fig.10. Final image by local histogram and median filter (mask7x7)

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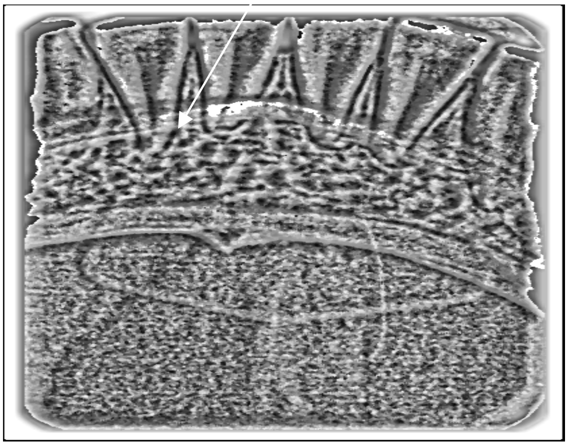

Fig.11. Final image by local histogram (mask7x7)

## IV. RESULTS

We introduce one original image m3. After inserting local histogram and median filter by different sizes masks (using Matlab program)[22, 23, 24, 28, 29], we noticed removing structure noise and enhancement overall images in the small scale mask than large scale mask shown in Figs (6-10). Final comparison between the experiments shows that subtraction experiment is the best than the other two experiments (derivative image, local histogram). Local histogram is the worst than the other two experiments; this method uses median filters to remove the noise in overall original images.

## V. CONCLUSION

To increase diagnostic accuracy, over digital radiography, digital subtraction radiography, derivative image and local histogram procedures were implemented and their performance is compared in removing structure noise. Due to increasing the image quality after structure noise removal, the human errors inherent with visual interpretation of dental diseases from images will be minimized [20][21]. These procedures increase the utility of digitized radiographs in providing qualitative and quantitative information concerning the investigated diseases. This is a step forward in achieving accurate diagnosis.


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