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Contrast Enhancement of Chest X-Ray Images by Automatic Scoring

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Abstract: *This study aimed to automatic scoring of performance test in conventional diagnostic x-rays where its done in alkuity hospital and Dar alelag specialized hospital*, *to measure the resolution, contrast, noise and signal to noise ratio with different exposure factors, highlight the importance of the Quality Control (QC) methods in ensuring that a product complies with all the requirements and specifications laid out for it, enhance the X.ray image quality using different spatial and frequency domain filters and to optimize the exposure factors with patient body characteristics (gender, age, weight, height).patients sample was 100 their aged ranged from 18-70 years with chest X.ray.*

The study results in enhancement of image quality by increasing the resolution, contrast, signal to noise ratio with different exposure factors, and to optimize the exposure factors with patient body characteristics which lead to avoid image repeating for the patient and minimizing the cost for both patient and hospitals.

Key wards*: Automatic Scoring, Enhancement performance, chest, X-ray,*

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I. Introduction:

Image processing techniques have been used in a wide variety of applications nowadays to enhance the quality of raw image data [1]. As for example, in medical imaging, it has been accepted as a diagnostic tool to facilitate the doctors for fast check-up [2]. The system provides information and details of the patient’s health where an expert can analyse the symptom just by looking at the medical images. The importance of good image processing techniques in medical imaging are to produce better image quality, to sharpen the details of the image and to measure the features and structures of the images [3]. Moreover, the technologies nowadays enable a rapid diagnosis assessment compared to the manual method [4]. Medical image processing allows the doctors to see fine details of the images that are difficult to detect or distinguish just by using naked eyes [5].

There are several medical image modalities, for instance, x-ray images, computed tomography image (CT scan), single photon emission computed tomography (SPECT), magnetic resonance image (MRI), position emission tomography (PET) and digital radiography [5][6].

X-ray image is one of the oldest photographic films that is mostly used in medical diagnosis and treatment [6][7]. X-ray image is a very useful modality for the physicians and doctors to determine and analyze the bone fracture which is an important symptom used for diagnosis [6].

The valid method to enhance X-ray image is histogram enhancement. The histogram of industry X-ray in a smallfiled, most of pixels in the low frequency areas, and there are hardly few pixels in high frequency areas, Even theindustry X-ray image is an image seems like the black image. Therefore, it is need a method to image enhancement. Recently, many people researcher on this field. Shu Yang and Cairong Wang proposed an image enhancement algorithm based on multi-scale morphological reconstruction [8]. Stephane G. Mallat researches the theory for multi-resolution signal decomposition [9].

Pizer S. M. proposed adaptive histogram equalization and its variations [10]. Tang Jinshan adopted a direct image contrast enhancement algorithm in the wavelet domain for screening mammograms [11]. Wang Xiu-bi [12] refers to image enhancement based on lifting wavelet transform [13]. Jinshan Tang and Qingling Sun used contrast measure in the wavelet domain for screening mammograms image enhancement algorithm. In this paper, we will investigate image-enhancement technology based on automatic scoring of performance test in conventional diagnostic x-rays.

II. Material and Methods:

Instrumentations: AllengerX.ray machine 525 (floatex): Unit model: E7239, Serial No.:OH0312, -Max Voltage:125kv, Focal spot:2.0/1.0, Permanent filtration:0.9 AL/75 and Philips X.ray machine: Manufactured July 2010, Xray tube Housing Assembly R01750 ROT 360, REF/Model:989000086111, SN: 28717A229652, TUBE REF/Model:989000085271, SN:229652, Permanent filteration: 2.5 AL/75, 0.6 IEC 60336, NOMINAL VOLTAGE 150 KV 1.2 IEC 60336.This study will achieve Elkawiti Specialist Hospital and Dar Alelag specialized hospital in period from period of 2014 to 2018.

Method of Data Collection:

For conventional diagnostic x-rays, each image was scanned using digitizer scanner then treat by using image processing program (MatLab), where the enhancement and contrast of the image were determined. The scanned image was saved in a TIFF file format to preserve the quality of the image. The data analyzed used to enhance the contrast within the soft tissues, the gray levels which can be redistributed both linearly and nonlinearly using the gray level frequencies of the original conventional diagnostic x-rays image.

Study sample: A 200 Patients of age 18-70 years old were enrolled in the study, a100 case of chest X.ray and 100 case of abdomenX.ray(KUB).

Patient position and technique for chest:

The choice of erect or decubitus technique is governed primarily by the condition of the patient, with the majority of patients positioned erect. Very ill patients and patients who are immobile are X-rayed in the supine or semi-erect position. With the patient erect, positioning is simplified, control of respiration is more satisfactory, the gravity effect on the abdominal organs allows for the disclosure of the maximum area of lung tissue, and fluid levels are defined more easily with the use of a horizontal central ray. The postero-anterior projection is generally adopted in preference to the antero-posterior because the arms can be arranged more easily to enable the scapulae to be projected clear of the lung fields. Heart magnification is also reduced significantly compared with the antero-posterior projection. This projection also facilitates compression of breast tissue with an associated reduction in dose to the breast tissue (15).

Selection of an appropriate kilovoltage should primarily provide adequate penetration from the hila to the periphery of the lung fields and should be in keeping with the patient thickness, habitus and pathology. In general, 60–70 kVp provides adequate penetration for the postero-anterior projection, in which case there will be minor penetration of the mediastinum and heart. An increase in kilovoltage is necessary for penetration of the denser mediastinum and heart to show the lung behind those structures and behind the diaphragm, as well as the lung bases in a very large or heavy-breasted patient. (15)

III. Results:

Table 1. show Descriptive Statistics for image quality parameters:

	Minimum	Maximum	Mean	Std. Deviation
signal white BF	180	2104	1302.57	415.342
noise white BF	23	46	35.65	5.810
signal to noise white BF	19	46	35.61	5.912
signal black BF	180	1264	501.45	180.856
Noise black BF	13	36	22.07	3.957
Signal to noise black BF	13	36	22.07	3.957
Contrast BF	0	1	0.33	0.474
Signal white AF	179	2283	929.69	520.211
Noise white AF	13	48	29.28	8.418
Signal to noise white AF	13	48	29.28	8.515
Signal black AF	1	681	143.33	132.952
Noise black AF	1	26	10.63	5.497
Signal to noise black AF	1	26	10.63	5.497
Contrast AF	0	1	0.87	0.339

Table 2. show Paired Samples Correlations for image quality parameters:

		Correlation	p.value
Pair 1	signal white BF & Signal white AF	.871	.000
Pair 2	noise white BF & Noise white AF	.880	.000
Pair 3	signal black BF & Signal black AF	.669	.000
Pair 4	Noise black BF & Noise black AF	.642	.000
Pair 5	signal to noise white BF & Signal to noise white AF	.876	.000
Pair 6	Signal to noise black BF & Signal to noise black AF	.642	.000
Pair 7	Contrast BF & Contrast AF	.275	.006

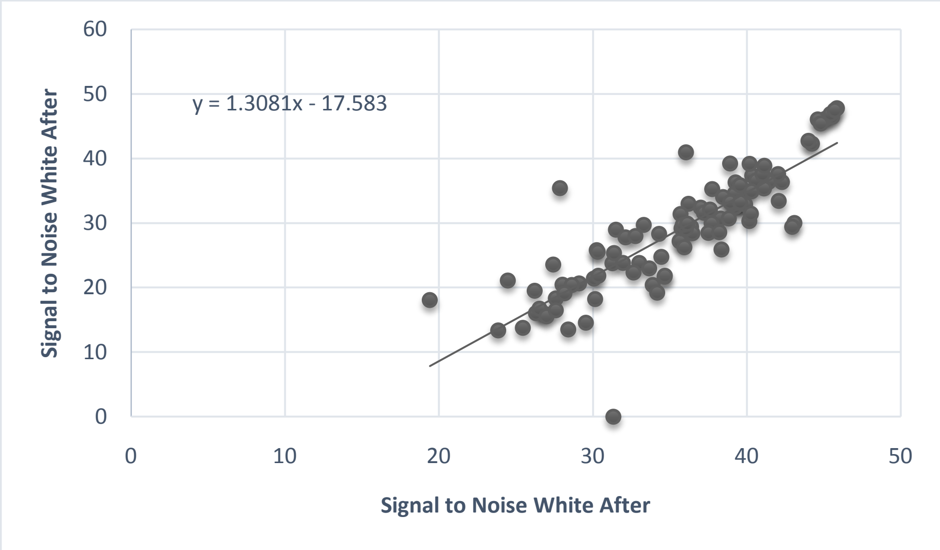

Figure 1. show correlation between the signal to noise white before and after

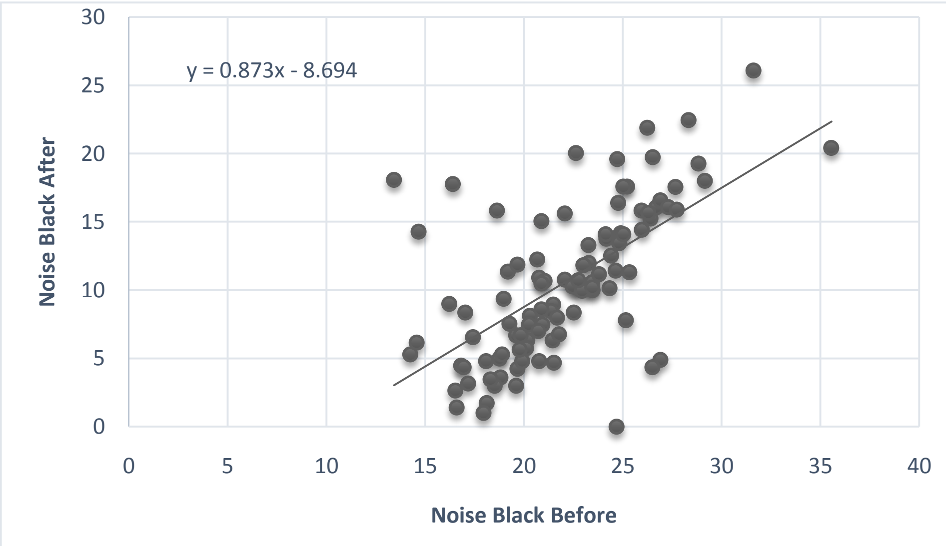

Figure 2. show correlation between the noise black before and after

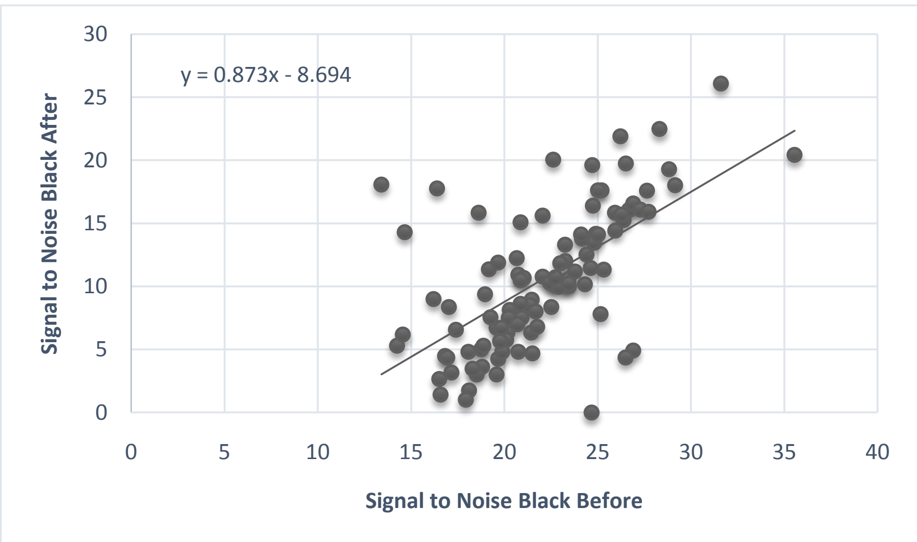

Figure 3. show correlation between the signal to noise black before and after

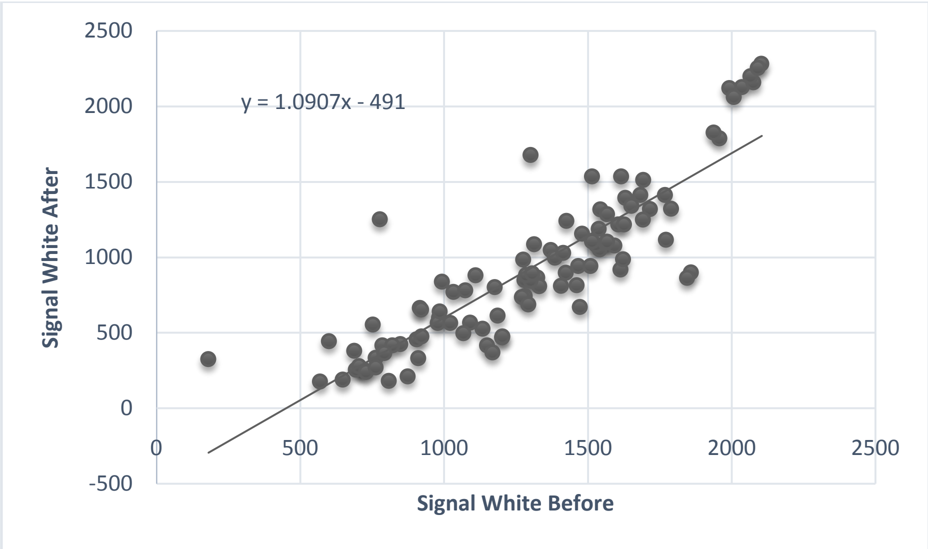

Figure 4. show correlation between the signal white before and after

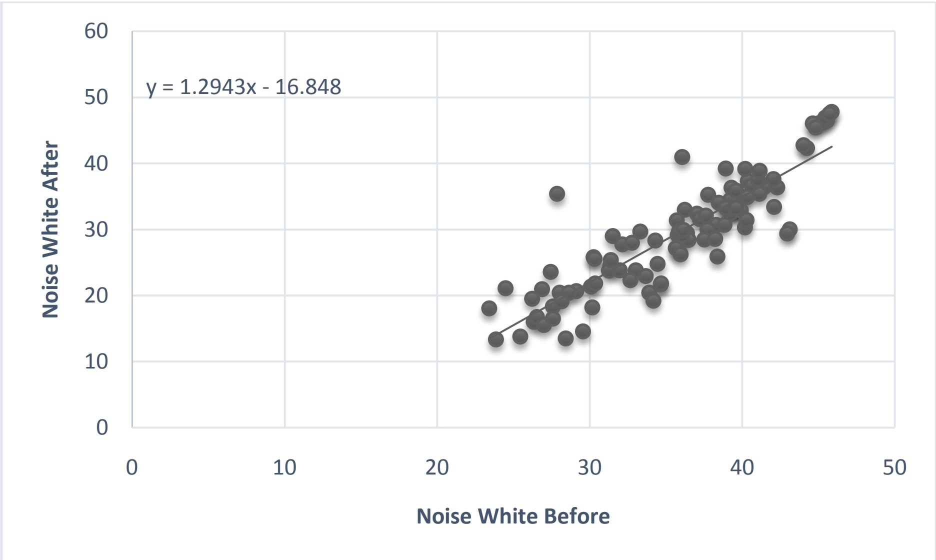

Figure 5. show correlation between the noise white before and after

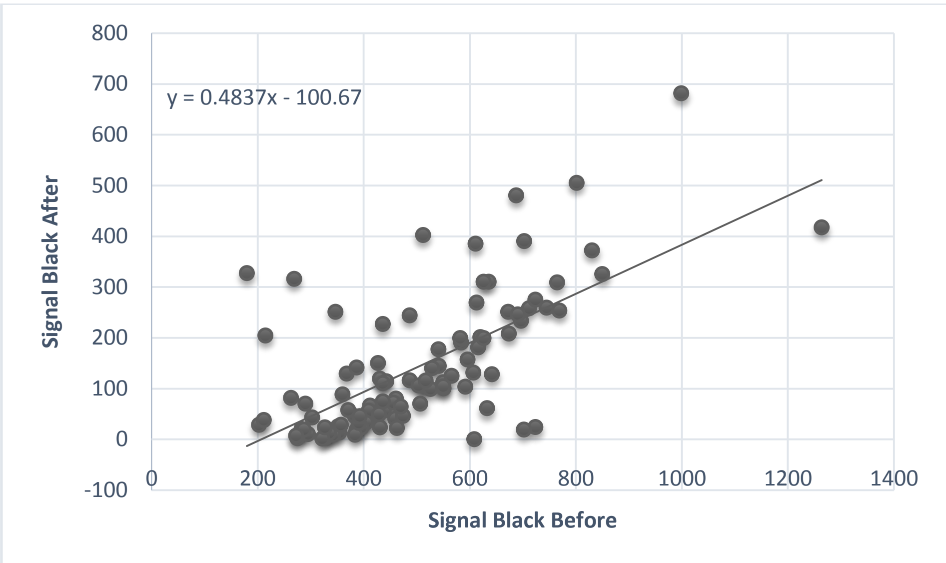

Figure 6. show correlation between the signal black before and after

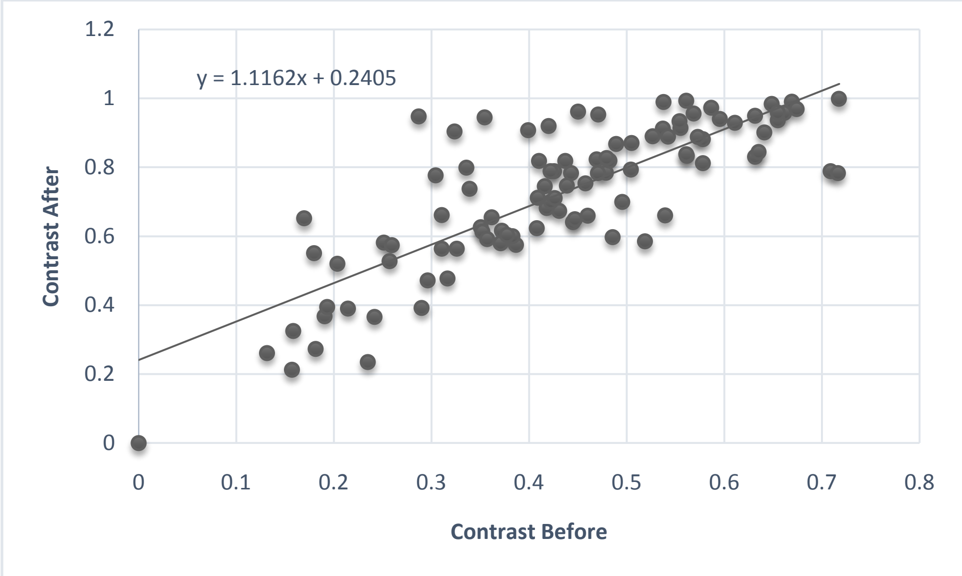

Figure 7. show correlation between the contrast before and after

IV. Discussion:

Automatic scoring of performance test in conventional diagnostic x-rays to patients examined for chest x-ray shows as Mean ±SD for all image quality parameters. Where the mean ± std for signal white before and after enhancement was 1302.57±415.342 and 929.69±520211, and noise white before and after was 35.65±5.810 and 29.28±8.515, signal to noise white before and after 35.61±5.912 and 29.28±8515, the signal black before and after enhancement was 501.45±180.865 and 143.33±132.952, while the noise black before and after was 22.07±3.957 and 10.63±5.497, and the signal to noise black before and after was 22.07±3.957 and 10.63±5.497, and lastly the contrast before and after enhancement 0.33±0.474 and 0.87±0.339 as shown in table 1.

Table 2. show Paired Samples Correlations for image quality parameters as couple from pair 1 to 7, where the correlation between signal white BF & Signal white AF showed a strong relationship 0.871, and noise white BF & Noise white AF showed strong relationship 0.880, pair 3 signal black BF & Signal black AF with strong relation 0.669, while Noise black BF & Noise black AF showed slight decrease from the other parameters 0.642. the signal to noise white BF & Signal to noise white AF showed strong relation 0.876, Signal to noise black BF & Signal to noise black AF was 0.642 and the Contrast BF & Contrast AF showed lower values than the other parameters with 0.275. And the p.value show that there is no significant difference between the all variables were inconclusive using t-test at p = 0.05.

And the figures from 1-7 show that the enhancement was increasing for all parameters and the rate of change ranged from 0.4837 till 1.3081 as shown in the above figures.

V. Conclusions:

Automatic scoring of performance test in conventional diagnostic x-rays was done in alkuity and dardarelag specialized hospitals during the period of 2014 to 2018 and aimed to measure the resolution, contrast, noise and signal to noise ratio with different exposure factors, and to optimize the exposure factors with patient body characteristics (gender, age, weight, height). 100 Patients of age 18-70 years old were enrolled in the study of chest X.ray.

The study results in enhancement of image quality by increasing the resolution, contrast, signal to noise ratio with different exposure factors, and to optimize the exposure factors with patient body characteristics which lead to avoid image repeating for the patient and minimizing the cost for both patient and hospitals.

Using linear regression results showed that the variation between the different image quality parameters:

Signal white after = 1.0907 (signal white before) – 491

Signal black after = 0.4837 (signal black before) – 100.67

Noise white after = 1.2943 (noise white before) – 16.848

Signal to noise white after = 1.3081 (signal to noise white before) – 17.583

Noise black after = 0.873 (noise black before) – 8.694

Signal to noise black after = 0.873 (signal to noise black before) – 8.694

Contrast after = 1.1162 (contrast before) + 2405

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